REPORT OF THE COMMITTEE TO ENQUIRE THE GRID DISTURBANCE OCCURRED IN MUMBAI GRID SYSTEM ON 12.10.2020

NEW DELHI

DECEMBER 2020

ACKNOWLEDGEMENT

The Committee acknowledges with thanks the cooperation extended by WRLDC, MSETCL, Maharashtra SLDC, Tata Power and Adani Electricity Mumbai Ltd for providing the necessary data for analysis of the Grid disturbance in Mumbai. The Committee also acknowledges the cooperation extended by GETCO for providing PMU data of 220 kV Vapi – Tarapur line for analysis of the disturbance.

The Committee acknowledges the sincere efforts of Shri P.D. Lone, SE, WRPC, in analysis of the initiating cause, islanding scheme and other inputs and co-relating PMU data and DRs. The Committee also thanks Shri K. Muralikrishna, CGM, WRLDC for sharing his views on various aspects of the Mumbai system, Analysis and recommendations for improvements of the same.

In addition, the Committee acknowledges the sincere efforts of Shri Shashank Jewalikar, Chief Engineer, MSETCL, Shri Peeyush Sharma, SE, MSLDC, Shri Milind Gole, Head(Opn), PSCC, TPC, Shri Girish Jawale, Group Head Testing, TPC, Shri D.M.Devasthale, AVP, AEML and other engineers from WRLDC, WRPC, MSETCL, TPC and AEML for active participation in discussions and providing useful inputs from load flow contingency analysis, during analysis of the initiating sequence.

The Committee also thanks engineers of WRPC, CEA who were associated with the compilation of the Report and also to all members of the committee for their active participation and helping in bringing out the report. Last but not the least, the Committee extends its heartiest thanks to the management of AEML, who extended their facilities at 220 kV Aarey S/S in Mumbai for conducting the meetings at a very short notice.

Abbreviations

AEML	Adani Electricity Mumbai Limited
APM	Administrative Price Mechanism
BEST	The Brihanmumbai Electric Supply & Transport Undertaking
CEA	Central Electricity Authority
CT	Current Transformer
CTU	Central Transmission Utility
D/C	Double circuit
DISCOMs	Distribution Companies
DR	Disturbance Recorder
EHV	Extra High Voltage
EL	Event Logger
EPS	Electric Power Survey
GETCO	Gujarat Energy Transmission Corporation Ltd.
GTG	Gas Turbine Generator
HVDC	High Voltage Direct Current
ICT	Interconnecting Transformer
IEGC	Indian Electricity Grid Code
LBBU	Local Breaker Back-up Unit
LILO	Line In Line Out
LP	Low pressure
LTS	Load Trimming Scheme
MMR	Mumbai Metropolitan Region
MSDCL	Maharashtra State Load Dispatch Centre
MSETCL	Maharashtra State Electricity Transmission Company Limited
OCC	Operation and Coordination Sub-Committee
ONGC	Oil and Natural Gas Corporation Ltd.
PG	Power Grid Corporation of India Ltd.

PLCC	Power Line Carrier Communication
PMU	Phasor Measurement Unit
PSCC	Power System Control Centre
RAPH	Regenerative Air Preheater
RLDC	Regional Load Dispatch Centre
RLNG	Re-gasified Liquefied Natural Gas
RPUF	Reverse Power Under Frequency
RTU	Remote Terminal Unit
S/C	Single circuit
SCADA	Supervisory Control and Data Acquisition
SER	Sequence of Event Recorder
SOP	Standard Operating Procedure
SPS	System Protection Scheme
S/S, SS	Substation
STU	State Transmission Utility
TBCB	Tariff based Competitive Bidding
TPC	TATA Power Company
UFLS	Under Frequency Load Shedding
UFR	Under Frequency Relay
UG	Under ground
URTDSM	Unified Real Time Dynamic State Measurement
VC	Video Conference
VSC	Voltage Source Converter
WAC	Wide Area Control
WAMS	Wide Area Management System
WR	Western Region
WRLDC	Western Regional Load Dispatch Centre
WRPC	Western Regional Power Committee

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Chapter 1: Introduction

1. A partial grid disturbance occurred in Mumbai Grid system on **12th October, 2020** at **09:58Hrs** leading to multiple tripping of transmission lines and loss of embedded Generating units of TATA Power Company (TPC) which affected the supply to a large part of Mumbai Metropolitan Region(MMR). The islanding scheme of Mumbai operated and the composite island consisting of TPC and Adani Electricity Mumbai Limited (AEML) got separated wherein TPC island could not survive due to tripping of generation units in TPC network leaving only AEML network supplying approximately 385 MW with its own generation at Dahanu thermal power station.

2. To find the root cause of the grid disturbance and to suggest remedial measures so that similar disturbance does not reoccur in Mumbai, which is the financial capital of the country, Central Electricity Authority vide O.M. No. 2/AI/GRD/GM/2020/336-338 dated 12.10.2020 (copy given at **Annex-1.1**) constituted an enquiry committee with the following composition:

(i)	Shri Goutam Roy, Chief Engineer (PSPA-I), CEA	- Chairman
(ii)	Shri Satyanarayan S., Member Secretary, WRPC	- Member
(iii)	Shri V.K. Shrivastava, ED, WRLDC	- Member
(iv)	Shri Ashok Pal, CGM, CTU	- Member
(v)	Representative of Maharashtra State Electricity Transmission Company Limited (MSETCL)	- Member
(vi)	Representative of Tata Power Limited	- Member
(vii)	Representative of Adani Electricity Mumbai Limited	- Member
(viii)	Director (Grid Management), CEA	- Member Secretary

3. The Committee was also authorized to co-opt any other Member. The terms of reference of the Committee are as follows:

   (i) To analyze the causes and circumstances leading to the grid disturbance affecting power supply in the Mumbai system;

   (ii) To suggest remedial measures to avoid recurrence of such disturbance in future;

(iii) To review the restoration of system following the disturbance and suggest measures for improvement in this regard, if any;

(iv) Requirement of system strengthening in Mumbai area:

(v) Other relevant issues concerned with the safe and secured operation of the Mumbai system.

4. The Member Secretary of the committee requested all the organisations associated with the enquiry committee to nominate suitable officers to be members of the committee. All the organizations furnished the name of their officers to become a part of the committee. Accordingly, the composition of the Committee stood as under:

(i) Shri Goutam Roy, Chief Engineer (PSPA-I), CEA - Chairman

(ii) Shri Satyanarayan S., Member Secretary, WRPC - Member

(iii) Shri V.K. Shrivastava, ED, WRLDC - Member

(iv) Shri Ashok Pal, CGM, CTU - Member

(v) Shri Sanjay Taksande, Director (Operations), MSETCL - Member

(vi) Shri PallikuthDevanand, Head(PSCC), Tata Power Limited - Member

(vii) Shri Arvind Kumar Sharma, COO(Transmission), AEML - Member

(viii) Shri Prakash Khichi, Director (GM), CEA - Member Secretary

5. The First and Second meeting of the Committee was held on 13.10.2020 and 14.10.2020 in Mumbai (Copy of meeting notice is given at **Annex-1.2**), the list of participants of the meeting is given at **Annex-1.3.** The Committee members discussed various aspects of the events which led to Grid disturbance in Mumbai system on 12.10.2020, the islanding scheme of Mumbai, process of restoration of supply and the requirement for system strengthening. The enquiry Committee requested WRLDC, Maharashtra SLDC, MSETCL, TPC and AEML to furnish the tripping details of the lines, relay indication, DR/EL & SCADA event list and PMU data to further analyze the cause of the disturbance which led to partial blackout in Mumbai.

6. For facilitating the functioning of the committee the Committee co-opted Shri Hemant Jain, Chief Engineer (Grid Management), CEA as Member of the Committee vide O.M. No. 2/AI/GRD/GM/2020/349 dated 19.10.2020. Order is given at **Annex-1.4**.

7. Meetings through VC were held with MSETCL, TPC and AEML on 01.11.2020 to get

the tripping details during the disturbance and load flow patterns on various lines to establish the exact sequence of tripping of 220kV lines from MSETCL feeding to Mumbai system.

8. The third e-meeting of the Committee was held on 06.11.2020 through Video Conference (VC). In the meeting, Shri Satyanarayan S., member of the committee presented the Analysis of Grid disturbance in Mumbai System based on the PMU data and other details submitted by the utilities, SLDC and WRLDC to all the Members of the Committee.

9. The fourth e-meeting of the Committee was held on 09.11.2020 through VC in which the restoration of power supply to Mumbai Grid and the problems faced during the restoration process was discussed. In the meeting, the issues encountered by the utilities in restoration of the Mumbai system, the reason for the delay in restoration and recommendations given by the Members of the Committee were also discussed. Various aspects such as failure of the TPC Island, conditions in which the Island is suspected to fail were also discussed. Based on the outcome of the discussions and decisions taken in the meetings, the draft report of the Committee was prepared and circulated to all the Members of the Committee. The comments received by all the Members were deliberated in detail in the meetings held through VC on 04.12.2020, 07.12.2020 and 25.12.2020 by the Members of the Committee. The Report of the Committee has been finalized incorporating all the comments and deliberations by the Members which contains the analysis of the incidence, restoration, review of islanding scheme, system strengthening required in Mumbai system and recommendations of the Committee. These have been put up in the subsequent Chapters.

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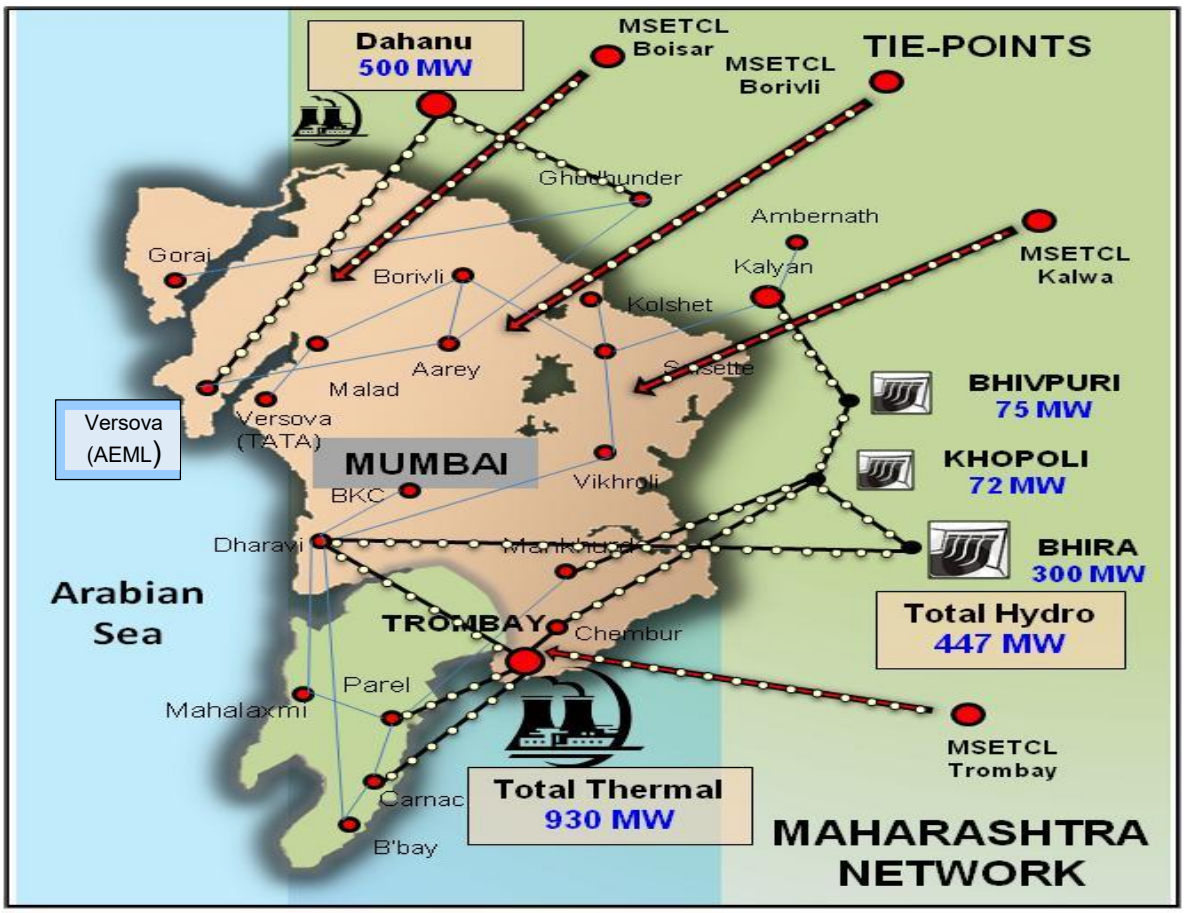
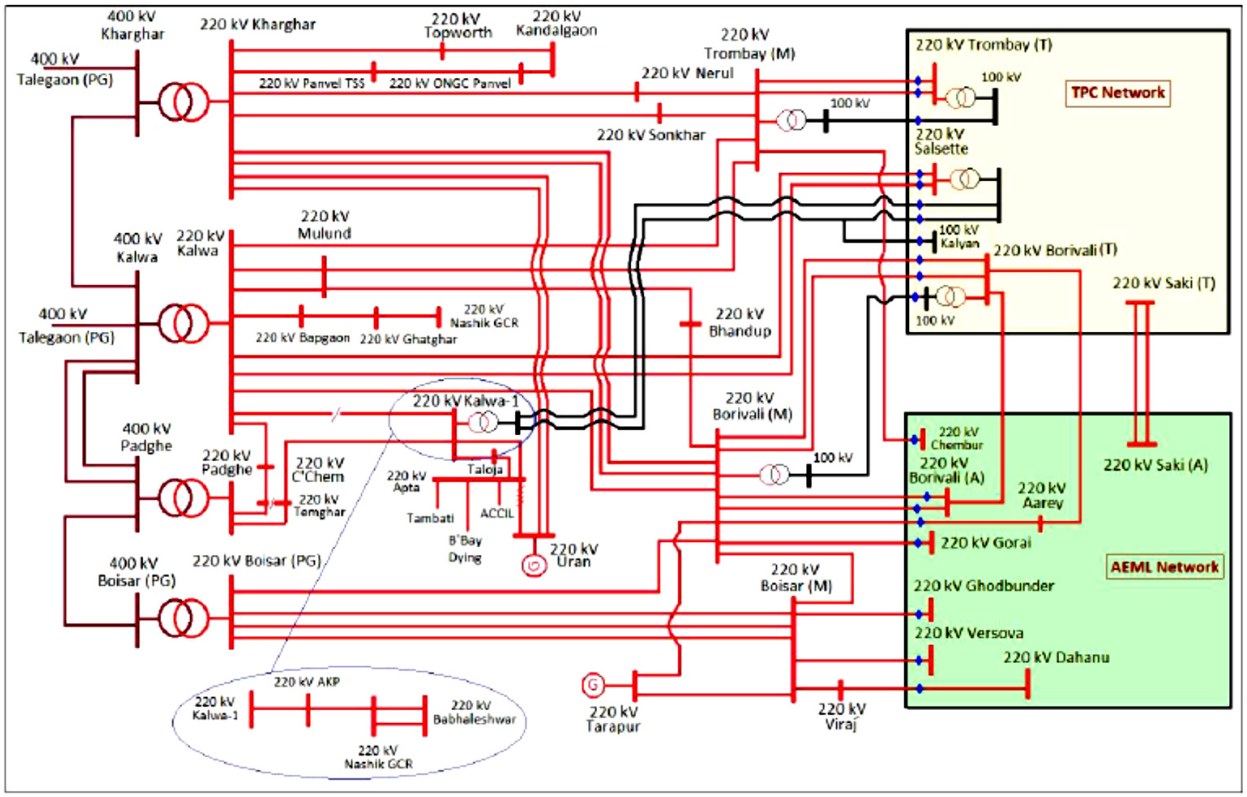
Chapter 2: Overview of Mumbai Grid System

2.1 Mumbai Power System comprising of transmission network of Tata Power Co. Ltd. (TPC) and Adani Electricity Mumbai Ltd. (AEML) network is connected to State Transmission Grid of Maharashtra State Electricity Transmission Co. Ltd. (MSETCL) through 220kV tie lines at Trombay, Kalwa, Boisar, Borivali and Viraj substations of MSETCL. The embedded generation and the connectivity of Mumbai System through tie-points are shown in the figure given below:



A single line diagram showing the details of inter-connection of MSETCL network with TPC and AEML network is given below:



The import point of Mumbai system are as follows:

I. 220 kV Boisar(M) S/s

II. 400 kV Kalwa(M) S/s

III. 400 kV Kharghar (M) SS

IV. 220 kV Borivali(M) S/s

V. 220 kV Trombay(M) S/s

Incoming lines from these S/s are:

	220 kV Transmission Lines Feeding to Mumbai
S. No.	**Transmission Lines**
1	220 kV Kalwa-Salsette D/c line
2	220 kV Sonkhar-Trombay S/c line
3	220 kV Nerul-Trombay S/c line
4	220 kV Mulund-Trombay S/c line
5	220 kV Kalwa-Trombay S/c line
6	220 kV Kalwa-Borivali S/c line
7	220 kV Kharghar-Borivali D/c line
8	220 kV Bhandup-Borivali S/c line

9	220 kV Boisar-Borivali S/c line
10	220 kV Boisar PG-Borivali S/c line
11	220 kV Tarapur - Borivali S/c line
12	220 kV Boisar – AEML Versova S/c line
13	220 kV Boisar – AEML Ghodbunder S/c line
14	220 kV Viraj –AEML Dahanu S/c line
15	220 kV Borivali –AEML Ghodbunder S/c line

Further, the feeding points to above sub-stations are given below:

i. **Talegaon (Pune) 400 kV S/s:** Talegaon – Kalwa/Kharghar 400 kV D/c line

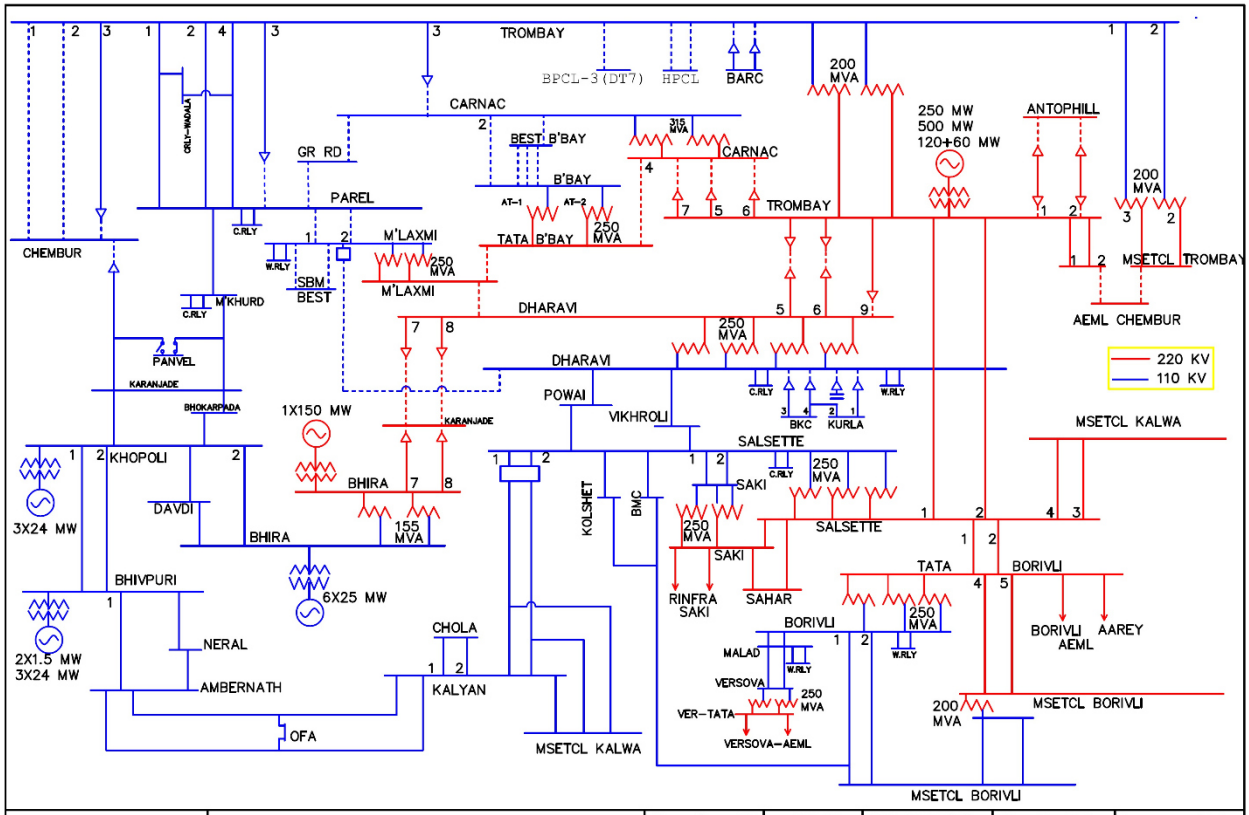
ii. **Padghe (M) 400 kV S/s:** Padghe (M) – Kalwa 400 kV D/c line

iii. **Tarapur 220 kV S/s:** Tarapur – Borivali/Boisar(M) 220 kV D/c line

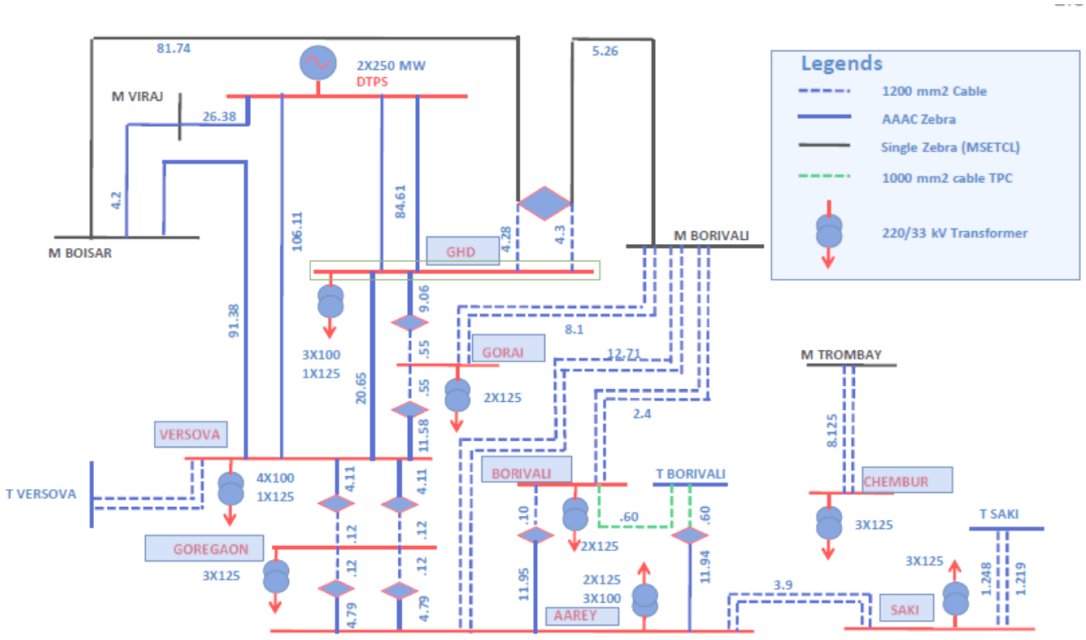
iv. **Boisar(PG) 400 kV S/s:** Boisar(PG) – Boisar(M) - 3 Nos of 220 kV Circuits

v. **Kharghar 400 kV S/s:** Kharghar – Borivali 220 kV D/c line & Kharghar – Nerul/Sonkhar/Trombay 220 kV D/c line

A single line diagram showing details of 220kV and 110kV transmission lines of TPC network is given below:



Similarly, single line diagram showing details of 220 kV transmission lines and inter-connections of AEML network is given below:



AEML NETWORK

2.2 The embedded generation capacity available in Mumbai system is 1877 MW out of which thermal/gas and hydro generation, available in TPC system is 1377 MW (Thermal-930 MW and Hydro - 447MW) and in AEML system available generation capacity is 500 MW from Dahanu thermal power plant. The Plant-wise installed capacity available in Mumbai system is given below:

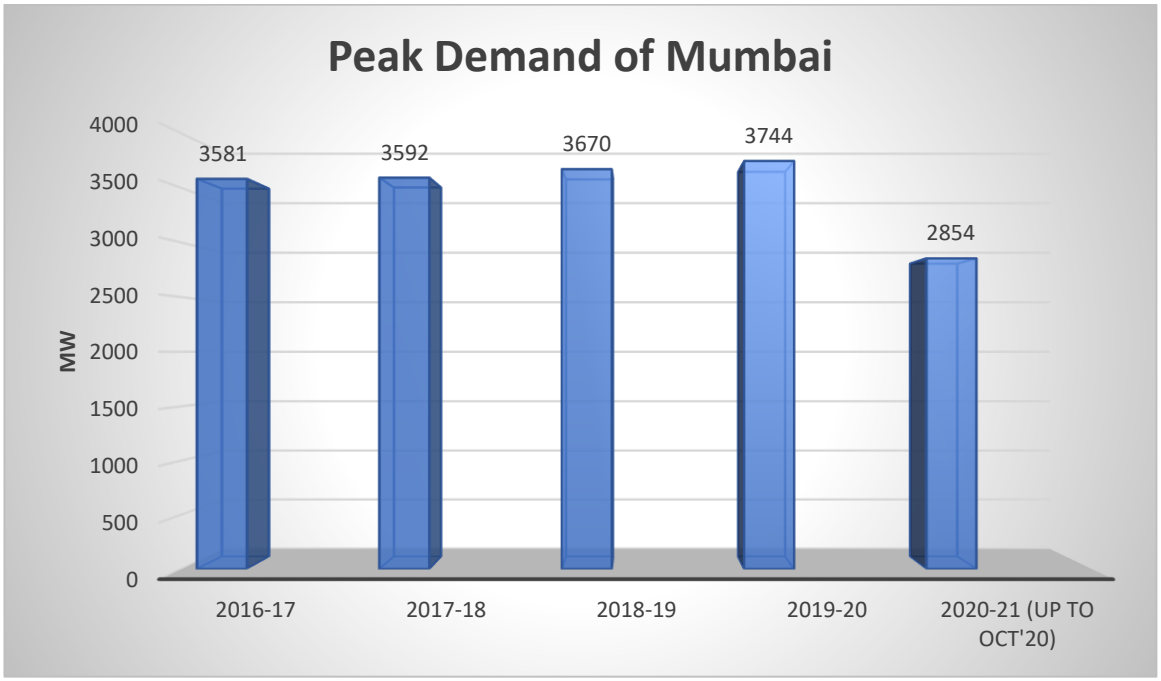
Mumbai Generation Plants	Gen Capacity (MW)
KHOPOLI	72
BHIVPURI	75
BHIRA (including 150 MW PSP)	300
TOTAL HYDRO GENERATION	**447**
TROMBAY	
UNIT-5	500
UNIT-7	180
UNIT-8	250
TOTAL TROMBAY GENERATION	**930**
TOTAL TPC GENERATION	**1377**
AEML- DAHANU	500
MUMBAI TOTAL GENERATION	**1877**

2.3 The distribution utilities of Mumbai Grid comprise of Tata power, AEML, BEST and MSEDCL. In the total power demand of Mumbai, the load share percentage of utilities are - AEML 36%, TPC + AEML 16%, TPC 14%, BEST 24%, MSEDCL 5.5% and Railways4.5% (approximately). The peak demand of Mumbai during 2016-17 to 2020-21 (up to Oct,20) is given in the table below:

	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21 (Up to Oct'20)
Peak Demand of Mumbai (MW)	**3581**	**3592**	**3670**	**3744**	**2854**

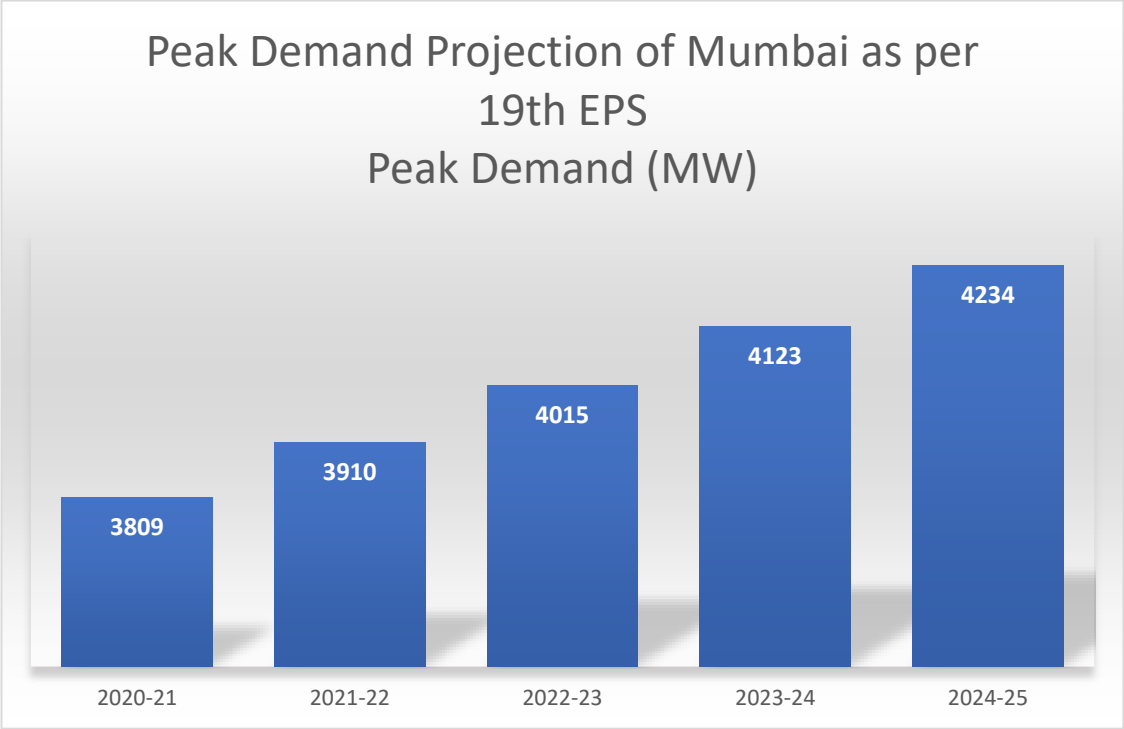
Source: SLDC Maharashtra

The Peak demand of Mumbai has increased from 3581 MW in the year 2016-17 to 3744 MW in the year 2019-20. The peak demand of Mumbai (as well as All India) during the current year i.e. 2020-21 has reduced due to Nationwide lockdown imposed to contain spread of Covid-19 pandemic in India. The demand of power is likely to increase subsequently due to relaxation in lockdown and increase in economic activities. A graph showing the peak demand of Mumbai from 2016-17 to 2020-21 (up to Oct,20) is given below:



Source: SLDC Maharashtra

Further, as per the 19th Electric Power Survey of India released by Central Electricity Authority, the Peak Demand of Mumbai is expected to increase to 4234 MW in the year 2024-25 from 3809 MW in the year 2020-21. A graph showing the expected peak demand of Mumbai as per 19th EPS upto year 2024-25 is given below:



The peak demand of Mumbai which is around 3800 MW and total embedded generation in Mumbai system is 1877 MW which is approximately 50% of the peak demand of Mumbai. The power requirement of Mumbai is met by importing power from the Grid through MSECTL transmission network as embedded generation of Mumbai is not enough to meet its demand and in future also embedded power generation capacity is likely to reduce due to retirement of old thermal units of embedded generating plants. Therefore, reliable connectivity of Mumbai system with the Grid is important to meet the power requirement of Mumbai.

2.4 **Islanding Scheme of Mumbai**:

The islanding scheme of Mumbai transmission system was first commissioned in 1981 by TATA Power with the embedded generation within Mumbai. This scheme

had successfully saved Mumbai from several blackouts (on 27 occasions so far) during Major grid disturbances.

Mumbai islanding scheme has been designed to intentionally isolate parts of the power system network during grid disturbance leading to possible black out. The Objectives of islanding are:

- To provide un-interrupted power supply to essential category consumers
- To avoid tripping of Thermal Generators
- To facilitate quick restoration of the failed system

The details of Islanding scheme of Mumbai are discussed in Chapter – 5 of the Report.

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Chapter 3: Analysis of Grid Disturbance of Mumbai on 12.10.2020

3.1 Introduction:

A partial grid disturbance started in Mumbai Grid system on **12th October, 2020** at about 09:58Hrs., which led to the cascaded tripping of transmission lines in MMR region and ultimately led to the separation of Mumbai Power System from the WR (All-India) Grid. The Mumbai Power system experienced a loss of synchronism with the WR grid leading to an uncontrolled separation at 49.54 Hz.

Subsequent to this separation, as frequency declined sharply at a heavy rate of change of frequency, the islanding systems in Tata Power Company (TPC), AEML operated and tried to separately function as independent islands. Of these, the TPC Island and Uran generation could not survive and collapsed. The AEML system could survive the separation and supplied about 385 MW at the instant of islanding.

It was a matter of technical interest to find out the exact underlying causes of the above incident, particularly because of the fact that the TPC and AEML power system islands have a very good history of survival in the past, and usually manage to survive most of the times when there is a problem with the main WR grid.

In order to systematically analyze the situation, first the pre-disturbance position is analyzed. Then the sequence of tripping, islanding and restoration is taken up for discussion. The evidences in the form of PMU records, DRs/SER, SCADA data etc., for the conclusions, wherever available, are also presented along with the summary of analysis of the event.

The pre-disturbance conditions, sequence of events and analysis of the disturbance are described in this Chapter.

3.2 System Conditions prior to Grid Disturbance:

As informed by MSLDC, following is the position prior to the blackout at about 09:50 hrs.

i. Power supply position

Maharashtra State Demand: 17664MW

Mumbai Demand: 2839 MW which includes the demands of the DISCOMs of TPC, AEML, Railways, BEST and MSEDCL including losses and auxiliary consumptions.

Mumbai Generation (Ex-Bus): 1349 MW as detailed below:

S.No.	Description	Capacity (MW)	Actual Generation (MW)
1	TPC-G Unit – 5	500	454
2	TPC-G Unit – 7A &7B	180	182
3	AEML-G Dahanu Units	500	485
4	TPC-G Hydro	447	228
Total		**1627**	**1349**

Hence the Mumbai system was drawing a net exchange of power of about **1490 MW** through interconnected lines.

Note: *These values were taken from SCADA data of MSLDC, AEML and TPC. SCADA data is indicative and not exact.*

The Overview of WR Grid as furnished from WRLDC is given in Exhibit 3.*1.* ***Overview of AEML flows from SCADA data of AEML is given in Exhibit 3.2.***

ii. Major Outages in Maharashtra Grid at 400 kV Kalwa s/s:

(i) 400 kV Talegaon (PG) – Kalwa S/c line was under break down since **10.10.2020**at13:47 Hrs due to conductor snapping at Location No.33 &34.

(ii) 400 kV Padghe–Kalwa -1 line tripped on over-voltage on **12.10.2020** at 04:33 Hrs. An emergency outage was availed on this Line at 06:53 Hrs. for replacing de-capped insulator string at the location No.1044 which occurred during the fault on B phase to Earth fault on 10.10.2020. The above line was scheduled to complete its emergency outage by 09:00 Hrs as load pickup by that time

was estimated. Outage feasibility was confirmed by MSLDC as the Mumbai demand was in the range of 1842 MW, at the time of outage and the duration of completion of outage was till 09:00 AM. However, owing to the nature of the field-works, this line could not come back in scheduled time. MSLDC informed that the arrangement to do the replacement of one string at location No. 1044 was in process from 06:53 Hrs, however, due to the blackout at 10:05 hours, the matter was taken by them with the field and the permits were asked to be returned so that the line can be charged and used for restoration. The above line permit was therefore returned and replacement of string work was not completed. However, the line had one healthy string and stood after charging.

(iii) WRLDC informed the Committee that 400 kV Kalwa – Padghe-1 line had tripped 12 times (from 01/01/20 till 12/10/20) on Overvoltage at Kalwa end and almost every night voltage was going more than 435kV at Kalwa substation. The voltage remains above 420 kV for 55% of time of the day.

(iv) WRLDC also informed the Committee that there was near miss situation of Mumbai collapsing on 22nd May, 2019 and 10thJune, 2019 and issues were raised by WRLDC with a request to review the situation for a comprehensive solution. It may be noted that, 22nd May, 2019 incident was discussed at 520th WRPC OCC as agenda item from WRLDC and OCC recommended review meeting to look into Mumbai System Strengthening.

iii. Measures taken by MSLDC: The generation pick-up and line loading control measures taken by MSLDC to handle the situation are given below:

- **Generation Pickup measures taken:**

  a) MSLDC at 09:30 Hrs. on 11.10.2020 directed TPC-G and AEML-G to maximize their respective generations in view of non-availability of 400kV Talegaon (PG)- Kalwa line.

  b) MSLDC instructed Tata PSCC at 07:41 hrs. on **12.10.2020** to maximize thermal generation.

  c) At 09:15 hrs. MSLDC instructed Tata PSCC to pick up hydro generation (which was 71 MW) and same was picked up to 312 MW at 09:30 hrs.

d) Unfortunately, Bhira Pumped Storage Unit (BPSU) of TPC-G (150 MW) tripped on 12.10.2020 at 09:45 hrs., due to Butterfly Valve (BFV) open feedback fail.

Note: *TPC-G Unit-8 (250 MW) was issued Zero schedule by TPC-D and BEST with MSLDC concurrence since 16:55 hrs. dated 11.04.2020. In view of breakdown of the 400 kV Talegaon (PG) – Kalwa S/C Line and increasing demand MSLDC at 15:30 hrs of 10.10.2020, telephonically took up with TPC PSCC for reviving unit-8 which was under "Zero schedule" w.e.f. 11.04.2020 16:55 hrs., as per the provisions of the Maharashtra State Grid Code.*

- **220 kV Line Loading Control measures taken and planned:**

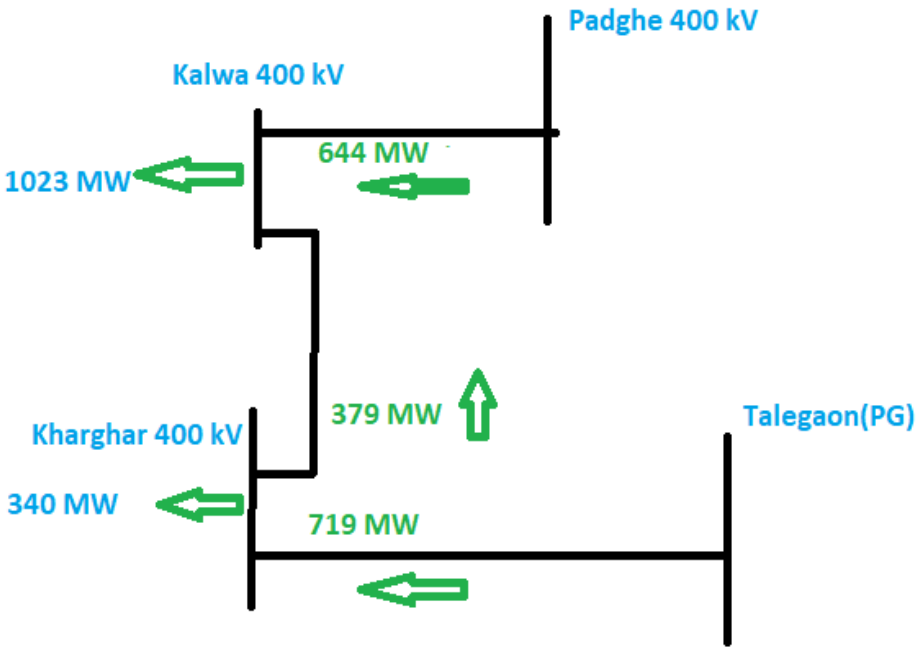
a) Due to continuous increase in line loading from 600 to 650 MW of 400 kV Talegaon-Kharghar line, opening of following 220 kV lines for load management was done:

- 220 kV Kharghar-Borivali and 220 kV Trombay-Nerul lines opened at about 09:15 hrs. on 12.10.2020.

b) Plan to open 220 kV Kalwa-Mulund D/c and 220 kV Kalwa-Colorchem lines in the eventuality of line loading increase depending on system loading conditions was also chalked out.

iv. 400 kV Kharghar and Kalwa s/s in-feeds prior to blackout:

The Figure given below shows the flows at 400 kV Kalwa and 400 kV Kharghar s/s just prior to the incident.



3.3 Sequence of events on 12.10.2020 that led to blackout:

A) In order to establish the sequence of events that led to the blackout from the above pre-fault condition, the Committee relied on the following resources.

i. PMU data of URTDSM project available at WRLDC for PMUs at Pune (PG), Boisar (PG), Padghe, Kalwa, Vapi (PG) and Navsari was used. In addition, 220 kV Vapi-Tarapur line flow, PMU data from 220 kV Vapi s/s was requested from GETCO. PMU data was one of the most reliable sources of data and helped a lot in the analysis.

ii. For almost all the lines that tripped, DRs were available from MSLDC, AEML and TPC (except one or two lines). However, time stamping of DRs is always an issue and requires to be interpreted carefully. DRs gave good clues of the position of the system just prior to and at tripping.

iii. Events log from WRLDC and MSLDC SCADA was perused. In MSLDC SCADA, for a number of 220 kV lines that tripped, did not have their digital

events telemetered to MSLDC SCADA, which created difficulties and makes their tripping time unknown. General power system behavior in such cases is of great help in giving a clue which of the lines may have tripped earlier.

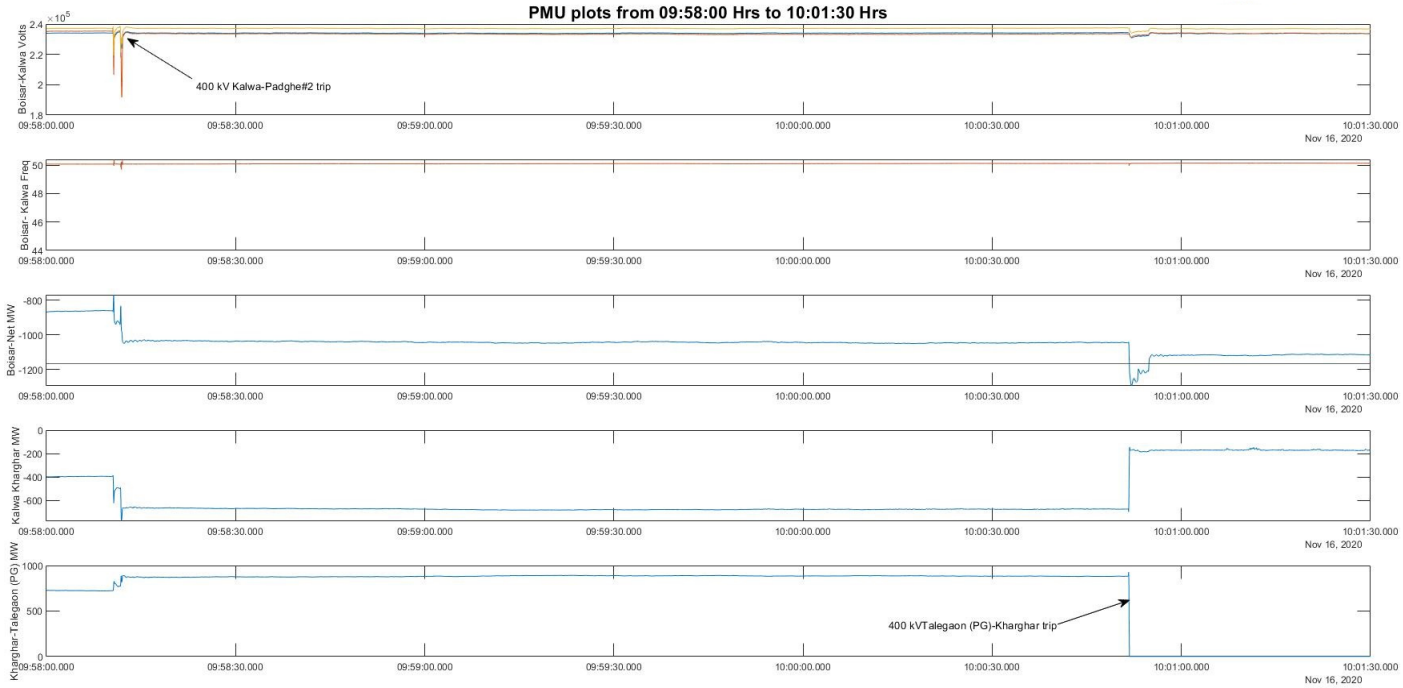
iv. Copies of important messages exchanged between WRLDC and MSLDC, and other relevant small pieces of data supplied by the utilities were perused by the Committee.

v. The Committee also held discussions with the utility engineers so that the interpretation of the data submitted is correct to the best effort.

B) Tripping Sequence and Analysis:

i. Event 1: Tripping of 400 kV Kalwa-Padghe -2 at 09:58:12.960 hrs.

On 12.10.2020 at 9.58:12.960 Hrs., 400 kV Padghe –Kalwa circuit 2 tripped due to snapping of R-Phase conductor creating a permanent fault. The operation of the protection is in order. With respect to the figure in 3.2 (iv), 400 kV Kalwa had only one source left, namely from 400 kV Kharghar-Talegaon (PG).



ii. Event 2: Automatic Operation of Load trimming Scheme (LTS) on 400 kV

Kharghar-Talegaon (PG) The above event resulted in a load flow of 878 MW (from 720 MW) on 400 kV Talegaon (PG) -Kharghar S/C and 664 MW (from 394 MW) on 400 kV Kharghar-Kalwa S/C line. The LTS installed on this line operated and provided a load relief of 18 MW as against an expected 180 MW relief (due to some problems in PLCC command transfer to loads). The LTS provided at Kharghar, along with testing done to investigate the failure of tripping loads at Kharghar, is enclosed at **Annexure 3.1**.

iii. **Event 3: Emergency Hand Tripping of 400 kV Kharghar-Talegaon (PG) at 10:00:51.760 hrs.** The high loading on 400kV Talegaon (PG) -Kharghar S/C line and ultimately on 400 kV Kalwa-Kharghar line, resulted in sparking on Y-phase CT clamp on 400 kV Kharghar-Kalwa line at 400 kV Kharghar substation. The operator at Kharghar hurriedly hand tripped, 400 kV Talegaon (PG) -Kharghar line in emergency from Kharghar end at 10.00:51.760 hrs. With this event, the connectivity of Kalwa and Kharghar substations to the 400 kV grid was lost. *An important point to remember in the analysis is that 400 kV Kalwa-Kharghar line, henceforth, was carrying 220 kV power flows from/to Kharghar and Kalwa sides and the voltage/current measured at Kalwa PMU is an indicator of 220 kV voltage/currents at Kalwa-Kharghar areas*.

iv. **Event 4: Automatic Closing of 220 kV interconnector between Kalwa-I and II busses:** The availability of 220 kV Kalwa Substations coupled with the non-availability of 400 kV source at Kalwa Substation caused the auto-closing of 220 kV Interconnector between 220 kV Kalwa -1 Substation and 220 kV bus of 400/220 kV Kalwa Substation, (which is generally operated in a split mode). The scheme operation was as per design.

v. **Notes on the Power system condition after Event 4:** The following points can be made at this stage.

a) The drawl from 400 kV side of Kalwa and Kharghar stations is now going to be primarily fed from 400 kV Padghe through ICT to 220 kV Kalwa side and 400 kV Boisar (PG) stations through ICT to 220 kV Boisar(M) and Borivali (M).

b) The 220 kV network of Maharashtra state started feeding to Kalwa from Padghe, Nasik areas via 220 kV Padghe-Temghar line 1&2. 220 kV Kalwa-

AKP, 220 kV Kalwa-Bapgaon-Ghatghar lines from Nasik. Apta/Kharghar side started feeding from 220 kV Apta-Bombay Dyeing from Chinchwad, 220 kV Apta-ACCIL from Nagothane, 220 kV Apta-Tambati from Pedambe, and 220 kV Kandalgaon-Topsworth -Kharghar and 220 kV Kandalgaon-ONGC-Kharghar lines from Kandalgaon side.

c) The power system, however, shows no major changes in parameters and the system is seen running synchronously, and voltages are fine from 09:58 to 10:01 Hrs incidents, from PMU plots.

d) From the PMU records, after events 01 and 03 are over, system settles down to steady state and the flows are as per table given below.

(09:58:12.960 to 10:00:51.760 hrs.)

Entity	**Flow Before Event 1 (MW)**	**Flow After Event 1 (MW)**	**Flow After Event 3 (MW)**
Net Boisar (PG) ICT	850	1050	1150
400 kV Kalwa-Kharghar line	395	664	100

e) The pre-incident flows on the 220 kV lines, collected from the field, that are feeding Mumbai outskirts from within Maharashtra only (excluding Boisar and Tarapur).

Sl. No	**Transmission Line**	**Side of feed**	**0900 hrs. Flow in MW**	**1000 hrs. Flow in MW**	**Subsequently tripped on**
1	220 kV Padghe-Temghar -1	Padghe	216	216	Over-current backup trip
2	220 kV Padghe-Temghar- 2	Padghe	215	213	Over-current backup trip
3	220 kV Kalwa- AKP	Nasik	31	12	Over-current backup trip
4	220 kV Ghatghar-Bapgaon	Nasik	14	14	Over-current backup trip
5	220 kV Apta-Tambati	Pedambe	58	73	Over-current backup trip
6	220 kV Apta-Bombay Dyeing	Pune	87	96	Over-current backup trip
7	220 kV Apta-ACCIL	Nagothane	113	162	Over-current backup trip

8	220kV Kandalgaon-ONGC	Kandalgaon	74	99	E/f trip
9	220 kV Topsworth-VileBhagad-Kandalgaon	Kandalgaon	56	82	Cleared on Bus fault at Topsworth
10	220 kV Topsworth-Kharghar	Kandalgaon		153	Cleared on Bus fault at Topsworth

f) The 220 kV feeds that are being used to draw power from Boisar-Borivali complex to MMR and the protection under which they tripped subsequently, as below.

Sl. No	Transmission Line	Pre-fault flows at 09:57 hrs. in MW	Subsequently Tripped on
1	220 kV Boisar(M)- Viraj	105	B/u E/f
2	220 kV Viraj- Dahanu	101	B/u E/f
3	220kVBoisar(M)Ghodbunder	121	Over-current backup
4	220 kV Boisar (M)-Versova	122	Over-current backup
5	220 kV Boisar (M)-Borivali	115	LTS Trip
6	220 kV Tarapur-Borivali	154	Over-current backup
7	220 kV Boisar(PG)-Borivali (M)	177	Zone 1

vi. Events between 10:00:51.760 to 10:05:07.760 Hrs.

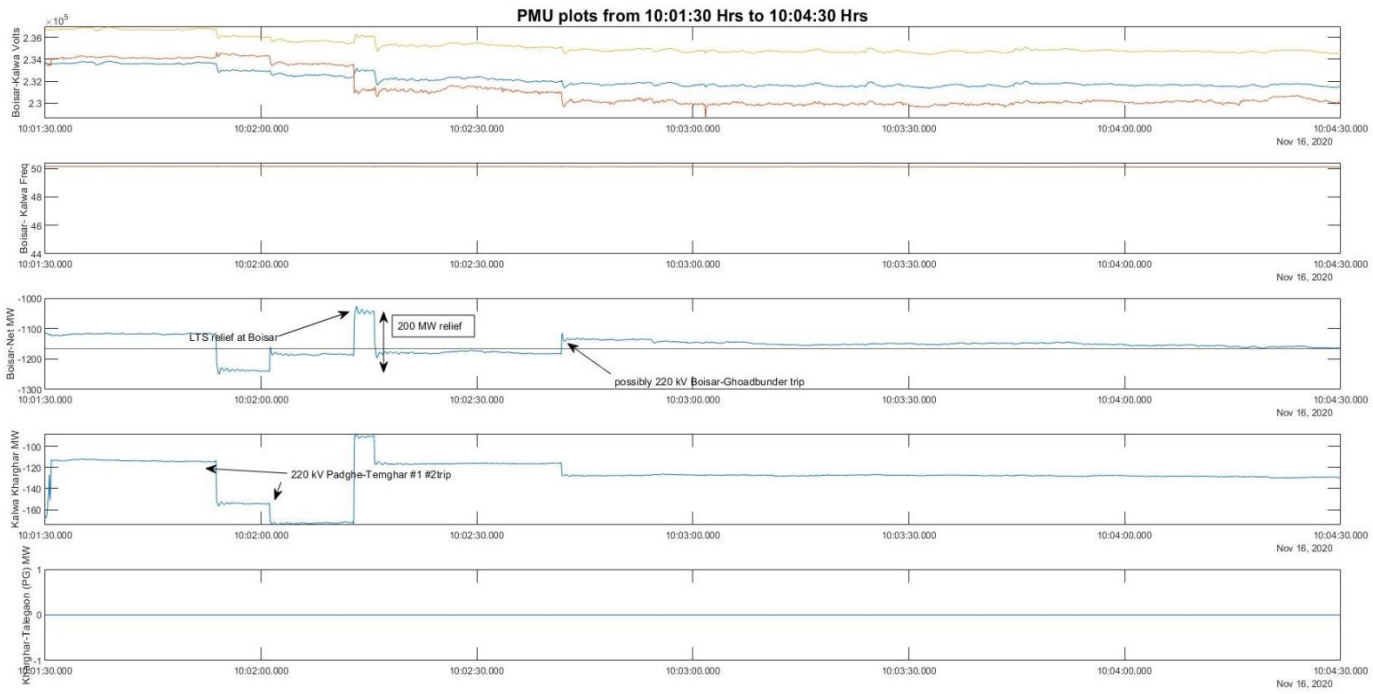
a) From the tripping of 400 kV Kharghar-Talegaon line till about 10:05:01.520, a number of events are seen happening in PMU signatures. However, it is difficult to say with full certainty which event/tripping this is, particularly for MSETCL lines feeding to outskirts of Mumbai, because there are no digital events telemetered to MSLDC from the RTUs and also the DR timings are at variance.

b) As stated in para (v) above, there are 17 trippings of lines, and the PMU data is from limited nodes. Certain power system signatures are definitely seen, and helped to make a correct estimate of what is happening in the system.

c) 220 kV Boisar(M)-Borivali (M) line trips on LTS Stage-1: Just simultaneously to the 400 kV tripping of Talegaon (PG)- Kharghar line at

10:00:51.760, momentary increase of Boisar ICT to 1290 MW or so is seen, which is very likely to trip 220 kV Boisar (M)-Borivali (M) on stage-1 LTS at Boisar as per the scheme.

(***Note**: Boisar ICT drawl also includes a flow on Boisar (PG) line to Borivali(M) and also some local loads at Boisar (PG) of MSETCL. Boisar (M) line LTS operates @300 MW per circuit)*



d) 220 kV Padghe-Temghar line 1&2 trips: A sharp two-step move in MW towards Kalwa on the PMU is seen at **10:01:53.960 and 10:02.01.560**. The most probable cause is tripping of 220 kV Padghe-Temghar line 1 & 2, that causes Kalwa to draw more from Kharghar side. The Boisar net drawl initially increases to 1250 MW or so. The next dip, however, in Boisar Net flow a clear relief of about 200 MW is seen. This indicates LTS operation Stage-2 at Boisar. As already stated above, 220 kV Boisar(M)-Borivali(M) line is tripped slightly earlier in Stage-1 LTS. Further from AEML SCADA, flow on 220 kV Dahanu – Viraj line is seen to start decreasing at about the same time, confirming with loss of 220 kV Boisar(M)-Borivali(M) line.

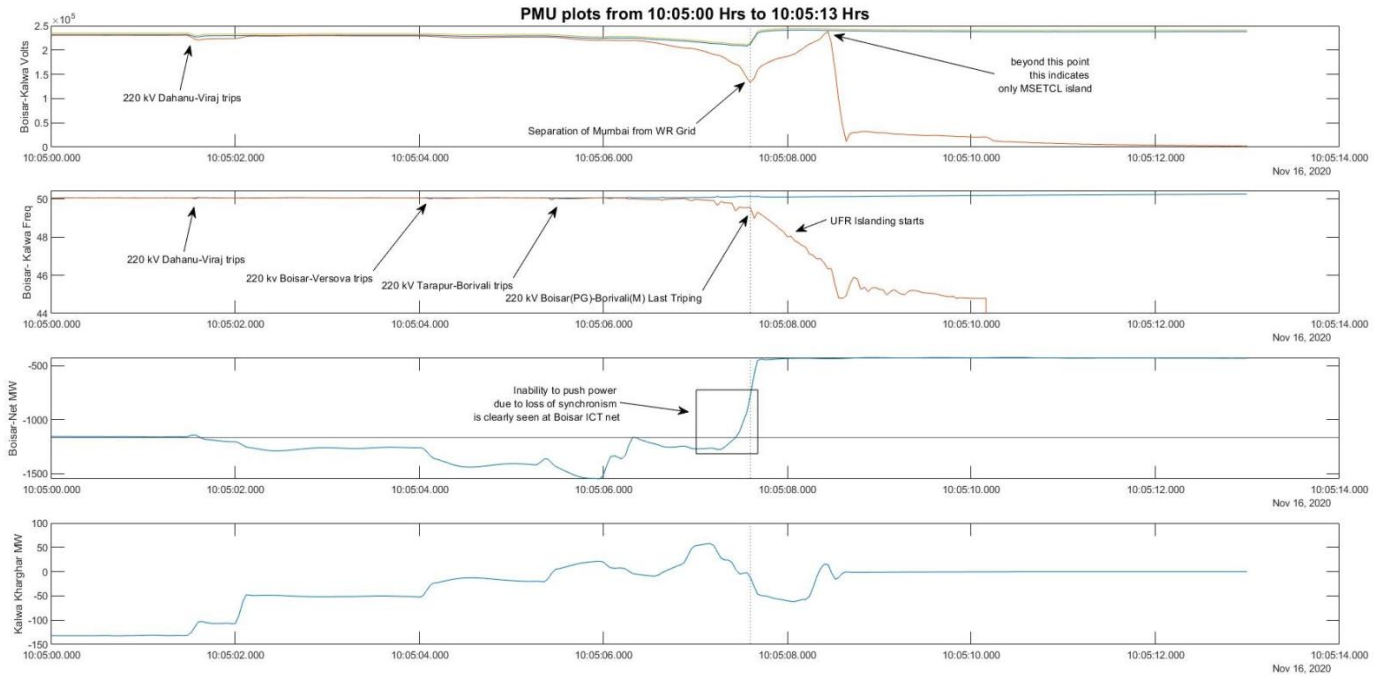
e) **220 kV Boisar(M)-Ghodbunder(A) trips:** The operation of the LTS reduces loads at Boisar. At **10:02:42.040**, 220 kV Boisar-Ghodbunder line trips on over current from Boisar end. This is in agreement with AEML SCADA information. The DR for this line was not available.

f) **220 kV Tarapur-Borivali(M) trips:** As per WRLDC SCADA 10:02:41.000 is the tripping of 220 kV Tarapur-Borivali on overcurrent, which also sees two bumps of current rise in DR before tripping. However as per PMU co-relation of Gujarat PMU for 220 kV Vapi-Tarapur line, a sharp reversal of 140 MW is seen later at 10:05:05.800 and we are of the view that 220 kV Tarapur-Borivali line tripped later.

g) **Impact of above tripping on power flows:** With the above tripping, AEML system is seeing a flow reversal with power flow to Boisar (M) on Viraj line. In general, AEML Versova is drawing power from Borivali and power diversions in AEML system is seen from SCADA also. There is a net increase of power flow to Tata system.

h) **220 kV Boisar(M)-Viraj(M) and 220 kV Viraj(M)-Dahanu(A) trips:** Between 10:05:01.600 and 10:05:04.200 two trips are seen. The first is tripping of 220 kV Boisar(M)-Viraj and 220 kV Viraj-Dahanu lines at 10:05:01.600 hrs. The line has line-differential protection, and Boisar(M) end has a single-phase Y pole opening on a suspected maloperation of the line differential protection. A note received by MSETCL is enclosed at **Annexure 3.2.** The tripping from Viraj or Dahanu end on back-up earth-fault is in order. It is noted that there was **no fault** on the line, as the Y pole opening has resulted in neutral current, and operation of relays at Viraj and Dahanu is in order. The little racing between Viraj and Dahanu requires to be coordinated by the utilities (so that only one line is lost).

i) **220 kV Boisar (M)-Versova (A) trips:** At 10:05:04.220 hrs., 220 kV Boisar (M)-Versova (A) tripping on over-current is estimated. With this tripping, AEML is no longer connected at Boisar (M). This also explains why the 220 kV Tarapur-Boisar did NOT trip, as by then the overload scenario was cleared by tripping of lines at Boisar (M).



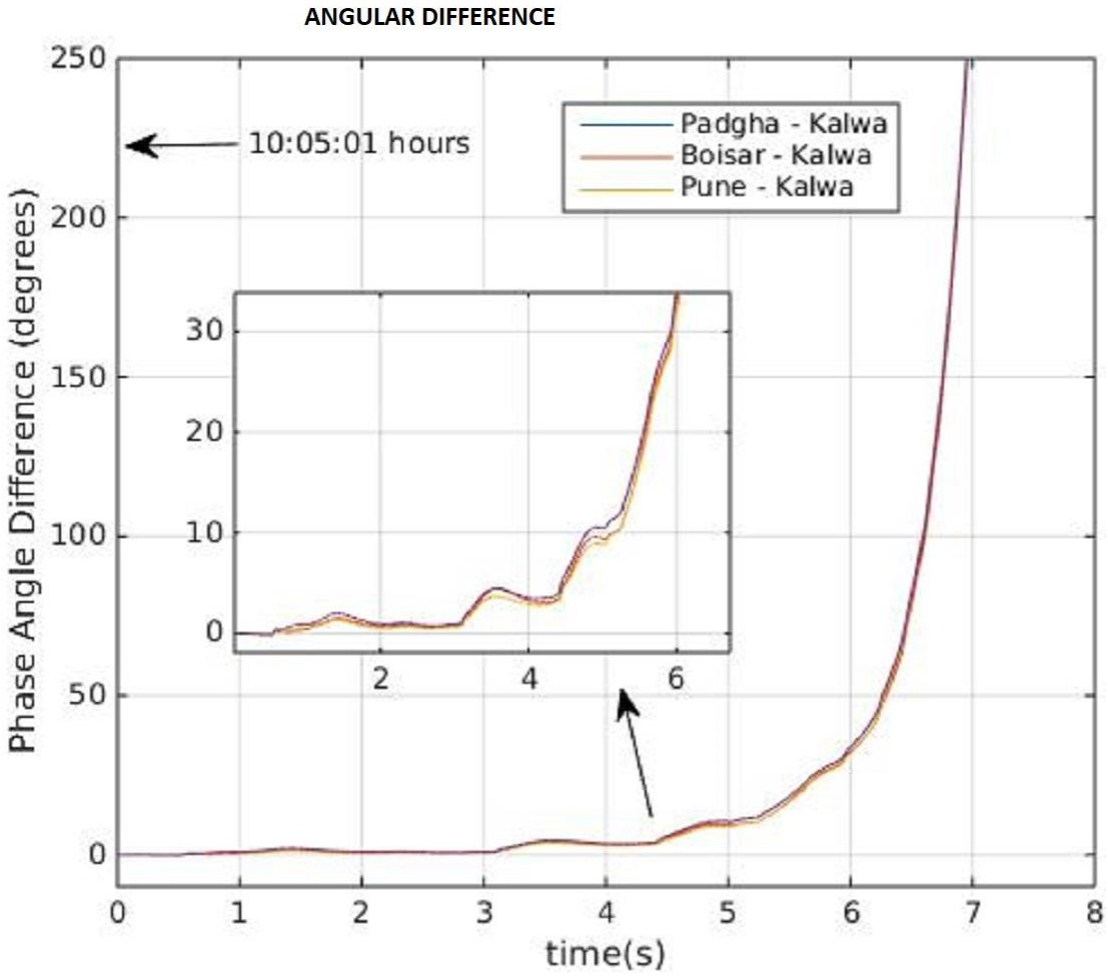
220 kV Borivali(M)-Boisar(PG) trips and separates the Mumbai system: From here till 10:05:07.760 hrs., there are possibly two feeds to Borivali(M) left. One is from 220 kV Tarapur-Borivali(M), which trips at 10:05:05.800 on over-current. The last line holding the two systems, is 220 kV Borivali(M)-Boisar (PG) line has tripped on zone one at 10:05:07.760 hrs. The voltage signatures match with the PMU plot of Kalwa and DRs at Trombay, which means that the systems were intact up to this point. An Under Voltage DR triggering in Borivali (A) of AEML station has the same voltage signature. The voltages have fallen to about half the normative value. The loss of synchronism process is clearly visible from 10:05:01.520 to 10:05:07.760 hrs. from the frequency of Boisar (PG) and Kalwa PMUs. As a double check to see loss of synchronism, the phase change was obtained by integrating the difference of the Boisar frequency and Kalwa PMU frequency which confirms the rapidly losing synchronism between the two systems.

Further from the DR at Borivali end, the frequency was retrieved which matches with the PMU frequency signatures. The protection at Borivali end is Zone-1, but in quadrant two. A check with the impedance locus seen by the relay, the

operation comes in the forward zone of operation of the characteristics of the relay, and so the relay operated correctly. **This is a clear evidence to conclude that the uncontrolled separation of Mumbai power system from the WR grid has happened on loss of synchronism at 10:05:07.760 hrs., and 220 kV Borivali(M)-Boisar (PG) is the last line that finally cut the Mumbai system from WR Main grid.** With this, Boisar(M) was with WR grid and Borivali(M) bus with Mumbai system.

It should also be noted that the Committee examined the Voltage Collapse theory angle to the possible initiation cause of separation (where the lines get successively loaded, require more reactive power support, and voltage drops continuously and lines trip on Zone-1 eventually). Due to the fact the voltages after separation improve suddenly (even in Mumbai part where there is actually loss of import), the frequency deviations seen prior to separation and the rising phase angle, all point to loss of synchronism as the driving cause of low voltages. Hence it was concluded that loss of synchronism is the cause for the separation.

The Separated Mumbai system now comprised of TPC, AEML systems and from MSETCL system the 220 kV nodes at Borivali, Kalwa, Kharghar, Apta, Uran, Trombay, Temghar areas and Generation of TPC, AEML and Uran and the analysis of the same is included in the Chapter on islanding.



All relevant PMU plots for this section are given at Annexure 3.3.1 to 3.3.6. The relevant DR Extracts are available on CEA Website at the following link https://cea.nic.in/wp-content/uploads/gm_and_npc/2020/12/Relevant_DR_Extracts.pdf

j) Coming to the outskirts tripping of ten lines mentioned in para (v) in MSETCL system, the mention of 220 kV Padghe-Temghar line-1 & 2 tripping is already done. For the other lines, the ones with a higher value pre-fault are believed to have tripped earlier. However, this cannot be guaranteed in a mesh system. Since in an over-current tripping scenario, once 'A trips-> B trips' is equally valid if the order is reversed and as such in absence of more information, is difficult to pinpoint.

k) 220 kV Kandalgaon-ONGC line tripped on Zone-1 fault at Kandalgaon end and on Zone-2 at ONGC end. The fault cleared in Zone 2 has an implication of hanging for 500 milliseconds, and pulling voltages down. In an already stressed system, whether this fault pushed the system down was explored. It is seen from the DRs that the pre-fault voltages are very healthy, so this pushes the time of the event earlier, and not during the loss of synchronism stage. Also the frequency before and after trip, is of the order of 50.05 Hz which is the pre-incidence frequency. It is suspected that the high flow of power flow caused by the power diversions have caused Y phase jumper to give way.

l) A similar incident at 220 kV Topsworth is seen. There is a bus fault, cleared quickly by busbar protection, at 220 kV Topsworth. Barring these two lines, the rest of the tripping is on over-current.

vii. Summary of the Analysis till Uncontrolled separation at 10:05:07.760 hrs.

a) **Pre-fault Analysis:** In the pre-incidence portion, the system is seen to be entering into an alert state and when 400 kV Kalwa-Padghe-1 was out, along with 400 kV Talegaon-Kalwa line, and on 12-10-2020, 400 kV Kalwa was left with only two sources (one each from Padghe and Talegaon(PG)).

b) The focus of the load dispatcher appears to be on (i) Maximizing generation to meet coming anticipated load of the coming day (ii) Bringing the 400 kV Kalwa-Padghe -1 back on time.

While the above focus is appreciated what to do if the line does not come back in time? Almost all generation available was picked-up. In field, the nature of repair works can cross the estimated time due to field problems. Anticipating this, that leaves only one option left, **to shed loads**.

c) Perhaps Mumbai being a prestigious load center, there is a general reluctance to shed loads manually. But the reality is when there were transmission constraints, the load dispatcher should have full freedom to explore the option to shed loads as a last resort, at least till the time the constraints are removed, and restore the loads gradually when the constraints are removed. This manual layer must be first tried as per a plan, and LTS or SPS based load shedding schemes/ over-current tripping etc., should be in the event of

inadvertent load flows/ tripping. Accordingly, there is a need to evolve a protocol/SOP, based on system studies offline and also operator experience, to shed loads in Mumbai/MMR to handle the emergency situations.

d) In the future, there is a need to bring in WAMS (wide area management system) based synchro-phasor data and utilize the State Estimator/ Dynamic contingency analysis, so that the amount of load to be shed in such cases would have been told very specifically and accurately by the computer. However, at present the visibility of all 220 kV network for MSLDC is not available due to inadequate communication infrastructure as well as inadequate number of RTUs in Maharashtra system. In addition to 400 kV network data, 220 kV visibility is a must for MSLDC operator. In MSLDC the SCADA State Estimator is facing issues with the Network Analyzer modules, as the digital inputs are not telemetered, and so they are unable to perform the same on day to day basis. It is also informed that Synchro Phasor data from PMUs is not materializing by them even though PMUs are installed in MSETCL system, as the associated Broadband Communication is not there at present. Accordingly, there is a need to augment RTUs, and/or plan additional PMUs and build a strong and reliable backbone of communication infrastructure so that the full 220 kV network is also visible to MSLDC in real time. Then only the WAMS or WAC or WAP can be meaningful and utilized to its potential.

During the discussions, WRLDC informed that they are running the non-linear State Estimator of SCADA regularly and RTCA (Real Time Contingency Analysis) is run before clearing any emergency outage in real time or as soon as any 400 kV line trips. Further the Linear State Estimator (Based on PMU data) is also available after commissioning of the URTDSM system.

e) Hand tripping of 400 kV Talegaon (PG)—Kharghar line: A unilateral decision was taken by the operator at Kharghar and he opened the line on seeing heavy sparking. As per the IEGC 5.2 (b), no part of the grid can be deliberately isolated except under a few conditions such as an emergency condition, to save human life, prevent imminent damage to costly equipment or under advice from RLDC. It was informed that the sparking was on 400 kV Kalwa-Kharghar line, however, the operator hand tripped 400 kV Talegaon-

Kharghar line. This shows an absence of protocols and so there is a need for MSLDC/MSETCL to evolve a set of operating procedures with DOs/DONTs to be followed under such emergency conditions faced in substations.

f) With the tripping of 400 kV Kalwa-Padghe-2 line and 400 kV Talegaon (PG)-Kharghar line, and with continued tripping of 220 kV feed from Maharashtra system to outskirts of Mumbai, the real power transfer to Mumbai was shifting to Boisar and Borivali and there was a serious dynamic congestion. The loss of lines in this portion on over-current, increased the reactance, leading to loss of synchronism, that was swift and sudden.

g) **Tripping of lines on over-load:** The relay setting for tripping of lines on over-current needs to be reviewed and coordinated. Losing a line does not always provide the required advantage, but may create instability in the system. There is a need for the MSLDC to study similar contingencies, like failure of Boisar gate, failure of Padghe gate, failure of Kharghar gate etc., and prepare SPS/LTS plans accordingly. The 220 kV Mumbai system can transfer maximum power only when all the interface gates are fully available. With transmission constraints, if some gate is experiencing problems, the power transfer capability would necessarily get reduced. These and such other contingencies should be studied by MSLDC, validating their plans using offline power system studies, and Alert and Emergency plans must be in place, in the interim. Instead prior to tripping of lines on overcurrent, there is a need to shed adequate loads at appropriate places through SPS, in one or two stages, automatically, in case the manual actions are inadequate and remove the tripping of **220 kV Boisar(M)-Borivali(M) line in Boisar LTS scheme.** The future need is to have dynamic WAMS, PMU based measurements for such a priority load of Mumbai covering MMR areas, and a wide area control (WAC) in place that would resort to appropriate automatic emergency control actions.

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Chapter 4: Restoration of Supply to the Grid in Mumbai

4.1 Sequence of steps taken for restoration of power to Mumbai system are:

The sequence of steps taken to restore the supply to Mumbai and restoring the connectivity of the system to the Western Region Grid are given below:

i. The restoration attempt began at 10:15 hrs by black-starting generating units at Khopoli and Bhivpuri hydro power plants. However, at 10:41 hrs while charging 110 kV Karanjade-Chembur line the units at Khopoli tripped on under-excitation and units at Bhivpuri tripped on Emergency Shut Down. (The reason of tripping of generating units at Khopoli has been analysed in the para given below in Analysis of Restoration.) The other route from Bhivpuri Via Ambernath-Kalyan-Salsette to Trombay was not fully available due to opening of breaker at Neral S/s by MSETCL.

ii. Meanwhile the restoration of the grid commenced primarily by extension of supply from the WR Maharashtra Grid to TPC and AEML network.

iii. The 400 kV Talegoan-Khargar line was restored at 10:27 hrs through which the supply was extended to 220kV Nerul and Sonkhar S/s. At 10:41 hrs, 400 kV Kalwa-Padghe -1 line was restored. Extension to TPC system was done at 10:55 hrs by extending supply from 220 kV Kalwa-Salsette and to Trombay at 10.56 Hrs. from 220kV Nerul and Sonkhar.

iv. Since AEML was surviving, synchronization attempts were made through closing 220 kV Versova-Boisar(M) lines. During this, Unit-2 at Dahanu tripped on Reverse Power protection at 11:11 hrs which was later on synchronized at 13:06 hrs.

v. During restoration by MSLDC, TPC and Adani, MSLDC was advised by WRLDC to regulate flow on Chandrapur-Padghe HVDC for controlling voltage at Kalwa for maintaining total flow on 400kV Talegaon(PG)-Kharghar and Kalwa-Padghe-1 to 1000MW. It was also advised by WRLDC not to synchronize 400kV Kalwa-Kharghar line which could be ready for revival at 14:30 hrs till the internal

generation in Mumbai system is maximized or till the 400kV Kalwa-Padghe-2 line is restored.

vi. As submitted by WRLDC to the Committee the restoration of load in Mumbai was as under:

Time	Mumbai Load
11:01Hrs	482 MW
11:49 Hrs	520 MW
11:55 Hrs	552 MW
11:56 Hrs	570 MW
11:57 Hrs	600 MW
12:02 Hrs	640 MW
12:14 Hrs	800 MW
12:25 Hrs	963 MW
12:48 Hrs	1284 MW
12:48 Hrs	1354 MW
13:32 Hrs	1430 MW
13:47 Hrs	1628 MW
13:53 Hrs	1770 MW
13:58 Hrs	1870 MW
14:01 Hrs	1930 MW
14:21 Hrs	2037 MW
14:31 Hrs	2109 MW
14:49 Hrs	2119 MW
15:02 Hrs	2125 MW

Note: The load figures mentioned above are approximate values.

vii. AEML-D's 80 MW load fed through TPC network was restored till 16:00 hrs and remaining load was restored in stage manner in Malad, Kandivali, Versova, Chembur, Vikhroli and Ghatkopar area till 20:00 hrs of 12th October, 2020. The total load in Thane, Navi Mumbai and Raigad region was also restored by 01:00 hrs of 13th October, 2020.

viii. In view of the limitation of loading on 400 kV Talegaon(PG)–Kharghar S/C line, due to non-availability of TPC-G Unit 5 and 8, loads were directed to be shed on rotation basis in MMR region till the restoration of complete generation of TPC-G at 01:00 hrs of 13th October, 2020.

ix. Trombay unit 8 which was on the way to commence generation by 14:00 hrs, unfortunately tripped in the blackout and had to undergo the restart process from beginning and later on synchronized at 21:36 hrs on 12th October, 2020.

4.2 Analysis of restoration:

i. The restoration by extending available supply in the Grid (All India grid) was the correct option **exercised by the load dispatcher.**

ii. **Reason for delay in restoration of Hydro Plants** – Khopoli Unit No. 7 and Bhivpuri Unit No. 10 & 11 were started in black start mode and 110kV Bus was charged at 10:29 hrs and 10:31 hrs at Khopoli and Bhivpuri respectively. 110kV Khopoli – Karanjade line was charged from Khopoli at 10:39 hrs after clearance from Power System Control Centre (PSCC) of TPC. However, Khopoli Unit No. 7 tripped on overvoltage and Bhivpuri on ESD at 10:41 hrs immediately after 110KV Karanjde - Chembur line was charged resulting into shutdown to the stations.

iii. It was noted by the Committee that a section of 8.5 km was made Underground between Karanjade and Waghiwalli on the 110 kV Khopoli- Chembur line. (Karanjade station was introduced in March 2020 for converting overhead line into cable section at Navi Mumbai International Airport.) At the time of Charging the Cable section, the sending end voltage at Khopoli was 95 kV which rose to 140 kV at Karanjade end. It was also observed that Karanjade–Waghiwali UG Cabling scheme (approved in 2014-15 and commissioned in March 2020) was not informed in any WRPC forum or to the system operator for updation in the Black Start Procedures Document of WRLDC which is reviewed annually and such changes in the Black-start restoration process of Western region should be discussed at WRPC forum.

iv. It was also understood that earlier proposal for reactors (2*10 MVAR each for 110 kV Lines and 2*40 MVAR each for 400 kV Lines) on these lines was not approved by STU. With the cable section from lines emanating from hydro units, this overvoltage can cause serious issues in black starting. If the contingency of complete collapse occurs, then the Blackstart facility available

at hydro stations of TPC cannot be used till all the reactors at Karanjade are installed.

v. It was also understood that Municipal Development Authority and CIDCO in that area is planning to convert more overhead lines into underground cables. This will place a heavy stress on reactive power management. STU/TPC may therefore revisit the entire reactive compensation requirement in this area comprehensively now itself and the possibility of any further sections going UG should be identified instead of doing piece meal conversion. In the interim, there is a need to shift existing reactors available with MSETCL at Karanjade-Waghiwali area to be helpful for black-start and STU may look into the same.

vi. The responsibility of black starting and keeping it in full readiness is of the concerned utility, TPC in this case, and STU may ensure adequate reactive compensation on network side for successful black-start at the earliest.

vii. **Challenges faced in Restoration of 500 MW Trombay Unit 5**: Due to total black out, auxiliary power was not available, which was restored at 11:04 hrs. Subsequently switchyard was normalized, Station transformer charged, 6.6 kV& 415 Buses /switchgear supply normalized. Main LP turbine diaphragm got punctured due to pressurization of condenser. Condenser got suspected pressurized due to tripping of all condenser cooling water pumps. LP diaphragm replacement job was competed by 15:30 hrs. After the unit tripping, it was noticed that boiler both Regenerative Air Preheater (RAPH) got jammed due to no rotations & uneven expansion. RAPH was not coming on air motor as well as electric motor. After cooling, same were normalized and taken on electric motor by 16:15 hrs. After restoration of LP diaphragm & RAPH, Boiler start up activities were started, boiler was lit up at 17.30 hrs & unit was synchronized at 22:28 hrs.

viii. **Challenges faced in Restoration of Trombay 120 MW Unit 7A Gas Turbine**: Trombay Unit 7 GTG could not be started immediately due to non-availability of APM gas from GAIL/ONGC. At 11:02 hrs, it was intimated by GAIL that due to power failure at Uran GTPS their Gas Processing Plant at ONGC Uran(3x20 MW) had tripped and APM gas was not available. In

the Uran islanding scheme as a preparatory to Area islanding the isolation of 3x20MW generators (available at GAIL/ONGC) from the grid at 220kV ONGC(Uran) S/s is initiated at Base 48.5 Hz, df/dt 0.9 Hz/sec with time delay 66 ms OR Under freq. 47.7 Hz with time delay 250 ms, however due to the heavy rate of change of frequency these 3x20MW generators tripped thereby interrupting the supply to the gas pumping arrangement at ONGC.

ix. This failure resulted in delay in Black start activities due to non-availability of gas from ONGC. This reason also resulted in Non availability of gas at Trombay unit-7A too. There is a need to have a standby DG set arrangement at the Uran Gas Processing Unit of GAIL/ONGC, so that in case power is not available from the grid side and the 3x20MW generating units at Uran Gas Processing Plant fails, the gas availability to Uran generating station of MSPGCL & Trombay generating station of TPC, is not hampered. MSLDC may take up the matter of providing standby DG sets at Uran Gas Processing Plant, with GAIL/ONGC authorities. By 12:33 Hrs RLNG system was lined up from GAIL & Tata Power and Trombay Unit-7A Gas turbine was synchronized at 12:59 hrs on 12th October, 2020.

x. **Challenges faced in Restoration of Trombay 60 MW Unit 7B Steam Turbine**: At 12:11 hrs, it was noticed that Unit 7 Steam Turbine did not come on Turning gear. Speed gradually came down to zero, while coasting down. Steam turbine was left for cooling down with intermittent hand barring. On 13th October, 2020 at 4.45 hrs., turbine came on Turning gear and all the parameters of turbine were checked for healthiness on Turning gear. After Turbine on Turning gear, Boiler warm up activities started by 6.00 hrs and STG was synchronized at 09.51 hrs on 13th October, 2020.

xi. **Challenges faced in Restoration of Trombay 250 MW Unit 8**: Unit-8 was scheduled to come on bar from 14:00 hrs of 12.10.2020. The startup activities were in progress on 12.10.2020 morning to bring back the unit. It was a cold start up after reserve shutdown of 6 months but due to black out at 09:58 hrs, all auxiliaries tripped which was started earlier in morning. After restoration of power and normalization of switchgears, all auxiliaries were restarted and

finally boiler lit up at 13:37 hrs and unit was synchronized at 21:36 hrs. Boiler took additional time due to cold start up after period of 6 months it took around Half an hour for achieving steam quality parameters as it was a cold start up, around one hour soaking of turbine at 600 RPM and another 50 minutes soaking of turbine at 3000 RPM including AVR checks.

xii. **Some hindrances in evacuation power at Bhivpuri:** During the blackout Neral s/s had opened the Bhivpuri-Neral line resulting in delay of power evacuation from Bhivpuri. There was a need to co-ordinate between PSCC Tata-SLDC before this action was done. In general restoration within a state should be co-ordinated by MSLDC with concerned and all have to strictly adhere to the instructions of MSLDC. As such the committee felt it necessary that all the utilities of Mumbai to review the coordination needed in the restoration process and redevelop suitable Protocols for seamless operation of any restoration process in future.

xiii. It was intimated by AEML that restoration of certain loads in their system was not completed till about 20:00 hrs on 12.10.2020. However, the load in other DISCOMS area were restored much earlier. They requested for equitable consideration in the restoration process of loads in all the DISCOMS.

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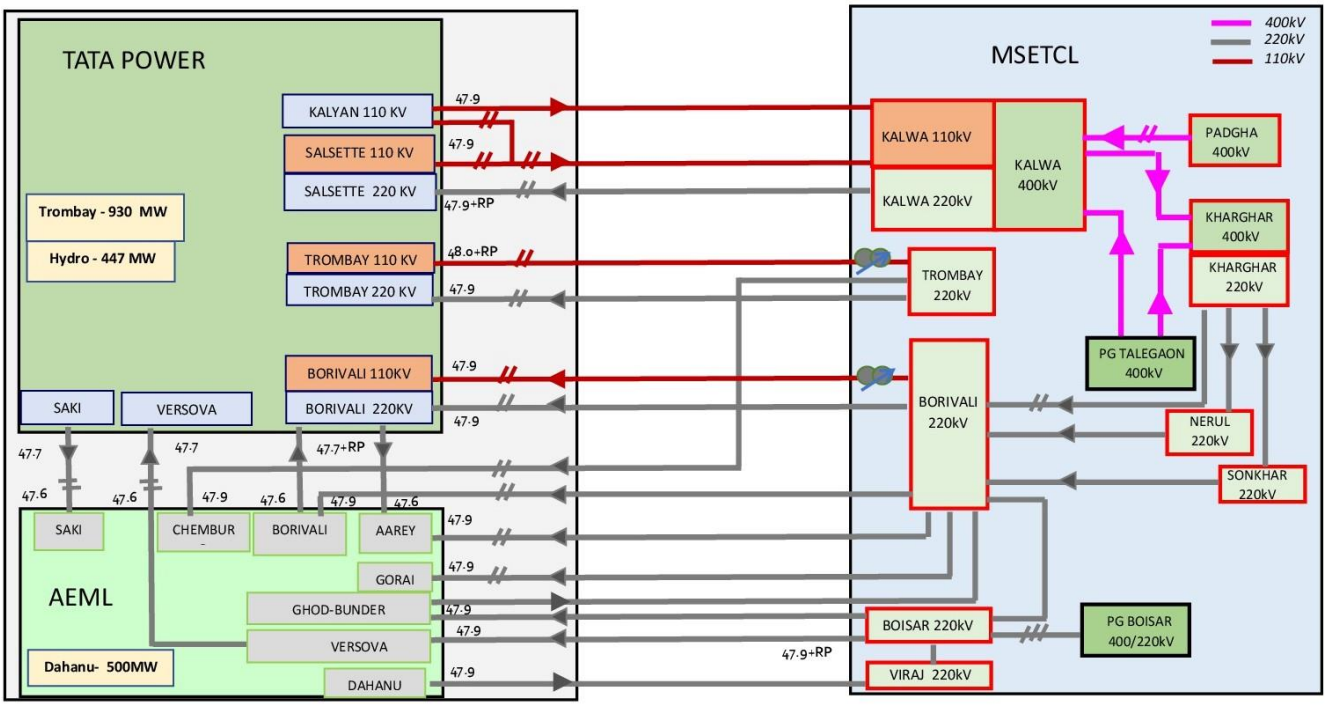
Chapter 5: Analysis and Review of Islanding Scheme

5.1 Islanding in power system is carried out to save a part of system from collapsing during a grid disturbance. Hence, the quantum of load which can be served during islanding should be commensurate with the local generation within the island. The essential load for general public safety like hospitals, railways, airports, firefighting stations, water pumping stations etc. should be selected for balancing with local generation on bars during islanding. However, all these as well as other important loads should also maintain their standby arrangements for reliability of power supply in the event of failure of islanding scheme. Mumbai Islanding Scheme was designed long back in the year 1981. Subsequently, the quantum and nature of load on various feeders in Mumbai system have undergone a change. Embedded generation plays a vital role in successful survival of Island and required to maintain load generation balance.

5.2 Mumbai Power System comprising of transmission network of Tata Power Co. Ltd. (TPC) and Adani Electricity Mumbai Ltd. (AEML) network is connected to State Transmission Grid of Maharashtra State Electricity Transmission Co. Ltd. (MSETCL) through 220kV / 110kV tie lines as shown in figure below:



5.3 The embedded generation capacity available in Mumbai system is 1877 MW out of which thermal/gas and hydro generation, available in TPC system is 1377 MW (Thermal-930 MW and Hydro - 447MW) and in AEML system 500 MW from Dahanu thermal power plant. The peak demand of Mumbai which is around 3800 MW and total embedded generation in Mumbai system is 1877 MW which is approximately 50% of the peak demand of Mumbai.

5.4 The Islanding scheme of the Mumbai is designed with Load Trimming scheme (to shed the load) in two stages. The brief on the existing Islanding scheme is as given below:

Stage I:

- Major disturbance is sensed by frequency decay. At **48.0 / 47.9 Hz** under-frequency load shedding takes place by way of opening designated feeders, **prior to islanding**, to ensure generation rich island.
  - **TATA System**:
    - SCADA system, depending on Generation of TATA and Interchanges with MSETCL & Adani, estimates the quantum of Load to be shed online dynamically through PLC.
    - Enables the identified feeders. Around 28 S/Ss have UFR relays installed.
    - Once the set frequency of 48 Hz is achieved the respective feeders are tripped.
    - The UFR takes its own time (sampling time) to ascertain the frequency is at/below 48 Hz. This time is around 150msec and breaker time is around 30-40msec. Therefore, total time for detection and load shed is around 180-190msec.
  - **Adani System:**
    - Load Shedding at 48 Hz or 49+0.5 Hz/Sec. with real time calculation of Load to be shed value based on net import on tie lines. Islanding with MSETCL-T Network at 47.9 Hz. Islanding with TPC-T Network at 47.6 Hz.

- Combination of under-frequency condition **(47.9 Hz)** and power flow (from Mumbai area) into the grid will **trigger islanding scheme**.
- Islanding scheme operation will result in tripping of all tie line breakers and Tata Power system along with Adani Dahanu system will be isolated from rest of the grid.

Stage II:

- Further, if frequency continues to sink, coupled with reversal of power (Power flow from Tata Power to Adani) then **Tata Power system gets isolated from Adani at 47.7Hz**.
- Redundancy is provided in the form of Main 1 & Main 2 islanding schemes.
- In case of failure or stuck breaker condition, at 47.0 Hz LBBU of that breaker operates and gets isolated from the network.
- Islanding signal from 220kV Trombay tie point provides trigger for Trombay Unit 5 & 8 to respond to frequency between 49.5 – 50 Hz by varying generation by 20 /10 MW for every 0.1 Hz variation

Hydro Islanding Scheme (For fast restoration):

- Bhivpuri 24MW 3 Units, Khopoli 24MW 1 unit & Bhira old 25MW, 5 units changes over to speed control mode at 47.9 Hz.
- Bhira has 2 stages for Islanding, Stage 1 operation is at 46.5 Hz (1 unit as per selection continues to feed house load after opening its 110 kV breaker). Stage 2 operation is at 45 HZ (All 110 KV line breakers open).
- 150 MW Bhira Pump Storage Unit changes over to speed control mode if df/dt is > 5Hz/sec.
- At 45.0 Hz, Khopoli & Bhivpuri Islanding scheme operates and trip all outgoing lines & transfer breaker and units remain online and available for building the network.

High Frequency Control in Islanded Mode:

- If frequency recovers to more than 50.2 HZ, auto restoration scheme at Borivali resumes 20 MW load in three stages at frequency settings of 50.3, 50.5 & 51.0 Hz respectively, which helps to stabilize islanded system frequency.
- At 51.5 Hz, high frequency anti acceleration protection on Trombay Unit 5 &8 will drop load with 5% droop.
- At 51.5 Hz, 30 sec time delay, Unit 7A class C trip & 56 Sec time delay – Class A. At 53.0 Hz - Instantaneous, Unit 7A – Class C trip & 0.6 sec time delay Class A trip.
- In case frequency does not recover after islanding,
  - At **47.5 Hz,30 sec time delay Unit 7A** Class C protection will operate and unit will continue to operate on house load.
  - At **47.0 Hz, 3 Sec time delay** for **Unit 5 and Unit 8** will open and Units will run on House load-Class C
  - At **46.0Hz, 0.6 Sec Delay** – Class C & 2 Sec – Class A for **Unit 5 & 8**
  - At **46.5 Hz, at Bhira, Set 2/5 gets isolated from the grid** and feeds station auxiliary.
  - **47.0 Hz, No Time delay Unit 7A** – GTG Trip (DCS Command).

In 2018, the Islanding scheme was revised by considering the following;

- Total generation normally in operation in the Island is around 1880MW without Unit 6 at TATA Trombay. (TATA Trombay = 500MW+250MW+180MW = **930MW**, TATA Hydro= **447MW** & AEML Dahanu = 250MW+250MW = **500MW**)
- Total Maximum Demand met in the Island in recent past =3825 MW.
- Import from Maharashtra System is around 2200 MW.

Load details & Quantum of Load Shedding identified in 2018 and subsequently implemented.

5.5 **Towards Islanding of the separated Mumbai System**: In continuation with the Analysis of the grid disturbance given in Chapter No. 3, the sequence of events of islanding and its analysis is given below.

i) **Separated Mumbai System**: After separation from the grid the separated Mumbai system now comprised of TPC, AEML systems and from MSETCL system the 220 kV nodes at Borivali, Kalwa, Kharghar, Apta, Uran, Trombay, Temghar areas and Generation of TPC, AEML and Uran.

ii) **Tata Islanding:** From 10:05:07.760 hrs, in the separated Mumbai power system, the frequency decayed rapidly. It touched 48 Hz, the starting point of UFLS for islanding at 10:05:08.000 hrs. The drop is about 1.4 Hz in 0.4 seconds and the df/dt is 3.75 Hz/s (as seen from Kalwa PMU).

iii) From 48 Hz, UFLS for islanding operated in TPC system and completed in 0.18 seconds, when the frequency dropped to 47.22 Hz. This is a drop rate of 4.33 Hz/s. It is noteworthy, that the frequency has dipped below AEML tie-line isolation at 47.6 Hz, while the Tata System automatic load shedding was in progress. *(Note: Dahanu machine inertia is not available now for TPC system, as it separated at 47.6 Hz)*

iv) The RPUF setting is analog measured and takes a measurement time of about 100-110 milliseconds. By the time Trombay and Salsette RPUF operated the frequency touched a low 46.87 Hz. The system isolated from MSETCL system in 0.337 seconds.

v) Trombay Unit 7A has an under-frequency mechanical trip of 47 Hz. Since the frequency dipped below 47 Hz, the mechanical trip activated and tripped the machine. (Unit 5 of Trombay have some time delay before machine trips on turbine low speed, hence it survived for a bit longer). As soon as unit-7 tripped, the TPC Island had less generation and more load. The frequency decayed and at 46.5 Hz Bhira Unit 2 went on house load, but could not survive. Frequency continued to drop and Unit 5 tripped at 46 Hz after 0.6 seconds from 10:05:07.800 hrs. Hydro islanding relay operated at 45 Hz and tripped all the line breakers as frequency continued to drop. With this, the TPC system collapsed.

vi) **AEML Islanding**: AEML load shedding started at 48 Hz with AEML-T network separation from MSETCL-T network at 47.9 Hz & TPC-T network at 47.6 Hz, plain frequency. It survived successfully with both generating units at Dahanu running.

vii) **Collapse of MSETCL system**: After the separation from TPC system, the MSETCL system was having the units at Uran and feeding loads at Borivali, Kalwa, Kharghar pockets of MSETCL network. The data from Uran and the DRs suggest one unit tripped very early when the frequency was high. The other two machines experienced turbine reverse power protection. This may be due to swings in the islanded system. It was informed by MSPGCL that Islanding scheme at Uran GTPS is kept out of service since 2017 due to addition of Network and enhancement of the load in Island. With loss of Uran, this part of MSETCL went dark.

5.6 **Analysis of the separation and Mumbai islanding Scheme:** The Committee discussed and examined various aspects of the Islanding scheme with reference to the disturbance of 12.10.2020 in the Mumbai system.

From the analysis of the disturbance during islanding following was observed:

(i) **Islanding Philosophy & the conditions of 12-10-2020:** The TPC and AEML power systems, island themselves from the Grid when the WR Grid is likely to fail. But the Grid was healthy and operating around the normative frequency of 50Hz on 12.10.2020. The relay-logic to estimate that the grid is undergoing serious trouble is captured as (a) Under Frequency 47.9 Hz in the Grid & Mumbai System, (b) Reverse power on two tie-lines to MSETCL grid at Trombay and Salsette. These two tie-lines never export power to Grid, under normal operating conditions and are generally import lines for TATA system from the MSETCL Grid.

While the above two relay-logic conditions are met on 12-10-2020, the main assumption that the WR Grid is undergoing serious trouble however was not true. Hence the basic philosophy which has islanded the Mumbai System successfully for the last three to four decades (during all these occasions the Western Maharashtra system collapsed), was not applicable this time as the Western Maharashtra system was not under any threat of collapsing at any point of time

during this failure. Hence the blackout of 12-10-2020 was contingency caused islanding. The Khaparde Committee blackout of 2010 was also contingency caused, where AEML(then REL) had collapsed. The blackout of 25th and 28th February, 2007 (Santosh Kumar Committee) was caused due to grid side problems, and West Maharashtra grid collapsed but TPC and REL island survived.

The Mumbai islanding settings have primarily been evolved to adapt to the relatively slow frequency collapse when a large part of the grid is involved in the separation. For contingency based situations, the challenge is higher and if islanding settings are back-fitted to face these contingency, then the performance when the islanding is initiated by grid side is likely to suffer seriously.

The Committee has the opinion that the contingency based situations should be addressed by SPS/LTS. If one has to raise main islanding settings, all the associated settings like beginning of UFLS, separation set points etc., have to be properly studied by experts using transient stability simulations and then only a final decision is to be taken. Hence for contingency based situations following is suggested-

(a) Whenever due to power diversion, 220 kV flow gates in Mumbai MSETCL system gets overloaded, SPS may be formulated to address such contingencies. An LTS for 220 kV Boisar gates exists. Similar LTS may be formulated for Kalwa/Kharghar/Padghe gates. The tripping of 220 kV Boisar(M)-Borivali(M) line in Boisar LTS may be removed, and all lines trippings on overcurrent may be coordinated.

(b) Till such time the above SPS/LTS is formulated and implemented, the UFLS preparatory to islanding currently raised to 48.4 Hz may be maintained. As soon as all the SPSs are activated, the UFLS preparatory load shed settings of 48.4 Hz may be reviewed by requisite study.

(c) The Main islanding settings (for grid initiated blackouts) may be revised only after transient stability studies to be done by experts for both grid initiated islanding cases, or contingency related islanding cases.

(d) Measurement cycle reduction of UFLS, as described below, is useful for both contingency and grid initiated islanding and can be implemented immediately.

(e) In the future, WAMS based Wide Area Control can be used for better dynamic performance and is described below.

(Note: Transient Study case of Feb,2007 incident is available at WRPC Secretariat and can be shared with stakeholders, if required.)

(ii) A detailed analysis of TPC system was done by TPC and perused by the Committee and the same is enclosed at **Annexure 5.1**.

(iii) **Very high df/dt experienced during separation**: During this sudden separation, ~~as~~ the Mumbai system was importing power, therefore the df/dt experienced was of the order of 3.75 Hz/s at separation.

(iv) **RPUF needs to be revisited:** The logic of RPUF is indeed very ingenious. However, there was no RPUF operation at Trombay or Salsette till the frequency touched 46.6 Hz or so and took almost 0.335 seconds (since there was no reverse power flow till then) from 48 Hz. It is to be noted that load shedding completed in 0.18 seconds (from zero time at 48 Hz). Since in the past TPC and AEML systems have survived in an islanded mode, it implies that RPUF scheme worked satisfactorily when there was a bigger part of West Maharashtra system connected. Perhaps this was not the case in this blackout, Since, at 47.6 Hz, almost all isolation of TPC system is completed, there is no reason why one should wait for final confirmation of islanding from RPUF. It may be explored to see the performance of ORing the RPUF by plain under frequency trip (at 47.6 Hz). Also, why the frequency did not recover here is not clear, as the load shed during preparatory islanding is always an estimated surplus by about 20 MW. This is probably due to large frequency decay, and hence when df/dt is high there may be a need to shed more. It is only after the RPUF feeders at Trombay and Salsette tripped, that frequency recovery started taking place. These aspects may be explored by transient stability studies by experts.

(v) **Quicker UFLS needed:** Regarding the plain under frequency relays for pre Islanding preparatory load shedding scheme, there is a scope to reduce the measurement time around 3-5 cycles so that the operation of load shedding is

completed in about 5-7 cycles. The UFRs for pre Island preparatory scheme (which gets triggered at 48Hz) could not provide fast relief during the steep fall of the frequency within a very short time to raise the frequency of Island, The Mumbai system frequency on separation from the Grid fell sharply. The fall of frequency from 47.9Hz (frequency at which the Mumbai Island comprising of TPC & AEML systems forms) to 47.6Hz (frequency at which TPC system & AEML system separates) was within 80msecs. The TPC system took about 180 milliseconds to trip loads. There is a scope to reduce the measurement time of UFR relays to 3 to 5 cycles so that the operation of load shedding is completed in about 100 milliseconds or so. Inherent measurement time of relay operation is unavoidable. However, no external time delay shall be provided for Load shedding or Islanding frequency settings. This is a benign change and can be done immediately and is helpful for both contingency initiated and grid initiated islanding incidents.

(vi) **Wide Area Control (WAC) for Mumbai**: Since Mumbai is a high priority load of Maharashtra, of commercial and international reputation, there is a need to have Wide Area Management System (WAMS) based WAC systems for the future. Such WAC systems have the added advantage of being very near optimal performance. The potential of WAMS and WAC is given in a practical application example in the South Korean system (Paper in CIGRE conference 2014 -***PMU Applications in the Korean Power System: Wide-Area Monitoring And Control (WAMAC) System by S.Han and others***).

With 40 PMUs in 28 substations the PMU data in the Korean system, the data which comes to a Regional Control Center and a Global control center in South Korea KEPCO system – and using dynamically computed Wide Area Voltage index and Wide Area Flow-Voltage index, the South Korean system sheds load now in two stages of 1000 MW and if required up to 500 MW more. The earlier traditional load dispatch SPS had 1500 MW at one go. But with WAC they are able to manage with 1000 MW load dispatching using real time PMU measurement. Not only are they shedding fewer loads, but also they are taking machine based actions in real time using PMU data. This is the potential of the

PMUs and the same can be realized in the country and to begin with, in WR/Mumbai. It is suggested that MSLDC, STU, TPC and AEML may jointly explore this application for Mumbai system accordingly. With a full deployment of PMUs in Central grid, and a full visibility of PMUs from States of WR grid, we see a possibility to take control action automatically and control the power system in an optimal self-healing way and also minimize or eliminate the blackouts.

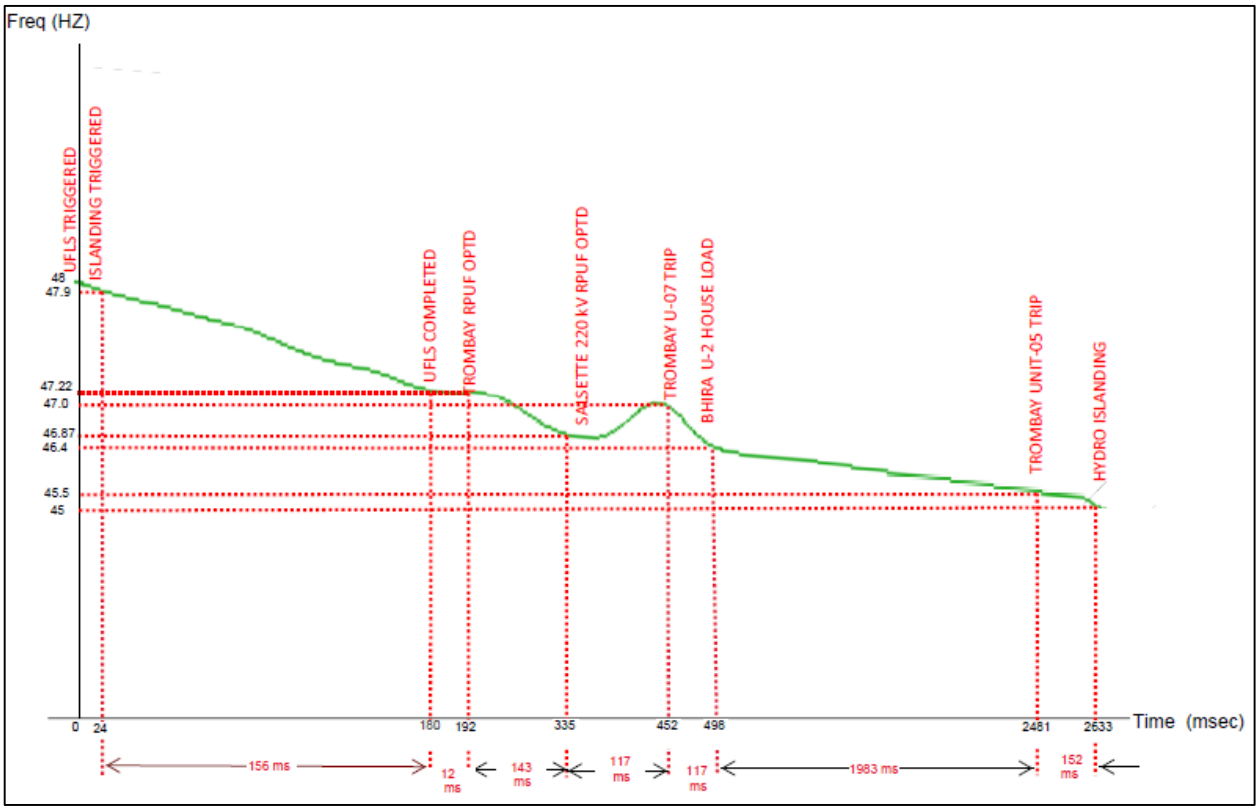


Figure: Frequency plot from Trombay 110KV Islanding relay showing various events during System disturbance

(vii) **Trombay Unit 7 under frequency trip:** Unit 7 tripped on under-frequency. TPC engineers informed that this is the first time this unit has tripped on under frequency during islanding separation. The trip is recommended by the manufacturers. TPC may explore if this trip can be lowered. If not, then there is a need to handle this contingency by tripping loads equal to generation of Unit 7, maybe using a high speed detection of frequency at 47 Hz. The Expert may review this suggestion based on transient stability studies.

(viii) **Addressing the df/dt challenge:** The maximum rate of change of frequency, df/dt, occurs at the start of the separation. For a First-order Load modelling, this is given by

$$df/dt = \frac{-\Delta PL}{2H}$$

Here ΔPL is an indication of the loss of import, in pu. H is the inertia of the system. Till such time connectivity to Mumbai is not increased from the main Grid, there is a need to maximize internal generation, and accommodate them either as must run or some form of ancillary services may be introduced. As connectivity to Mumbai improves, there must be a plan as to how much the embedded generation shall be kept and how much import is required considering the load growth aspect. These aspects may be looked after by the State planners accordingly.

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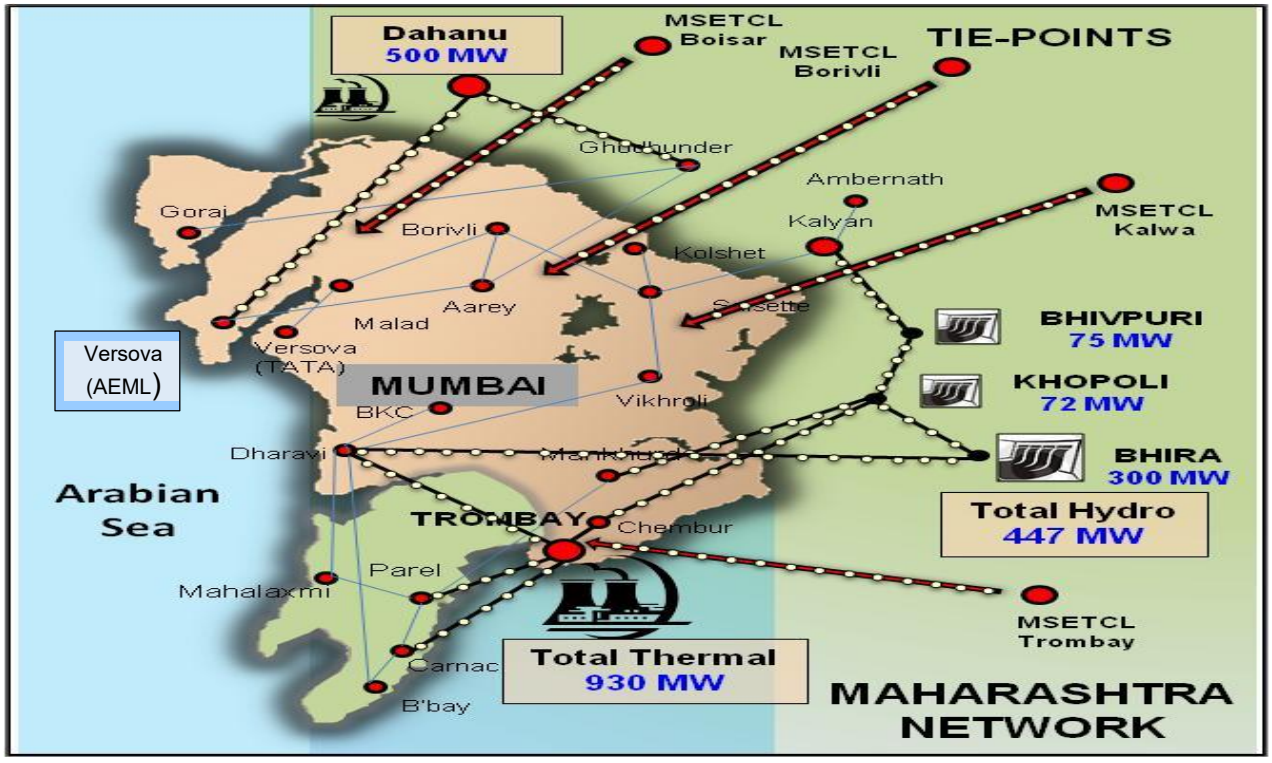
Chapter 6: Required System Strengthening in Mumbai Grid

6.1 Introduction to Mumbai System:

6.1.1 Mumbai Power Generation:

Mumbai has total generation installed capacity of 1877 MW. Out of this 930 MW of thermal generation and 447 MW of hydro generation is owned and operated by TATA Power and the remaining 500 MW of thermal generation is owned and operated by M/s Adani Electricity Mumbai Limited (AEML). The breakup of the Mumbai generation is given below:

Particular	Generating Plant	Installed Capacity (MW)
Tata Power (Thermal)	Trombay unit-5	500
	Trombay units-7A & 7B	180
	Trombay unit-8	250
Tata Power (Hydro)	Bhira, Bhivpuri & Khopoli	447
Tata Power Total		1377
AEML	Dahanu units 1&2	500
AEML Total		500
Mumbai Total Installed Capacity		**1877**



6.1.2 Load profile of Mumbai:

The peak demand of Mumbai for the previous years is shown in the table below:

Year	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21 (Upto Oct,2020)
Mumbai Load (MW)	3153	3217	3365	3416	3581	3592	3670	3744	2854

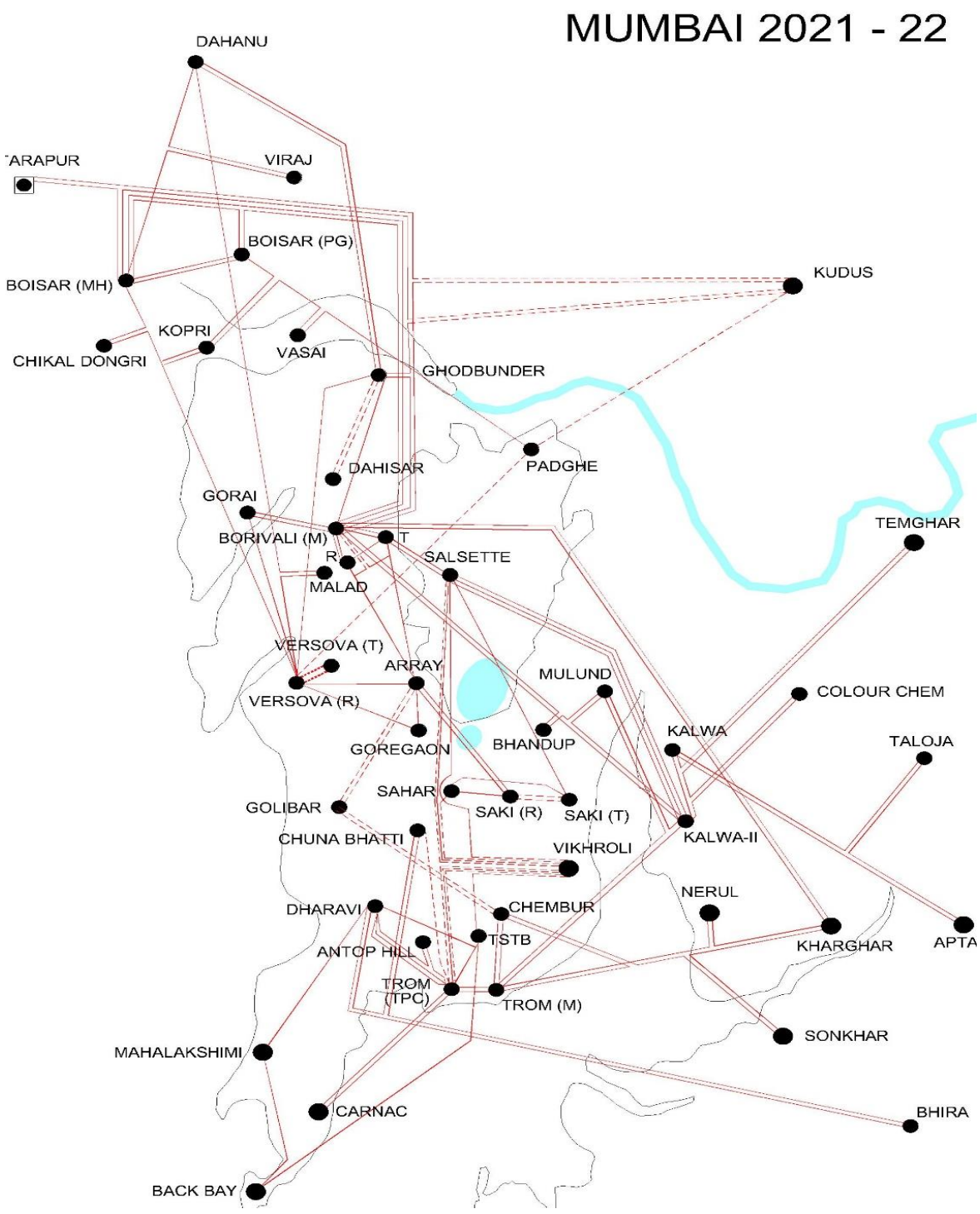
The peak demand of Mumbai (as well as All India) is drastically reduced in FY 2020-21 due to Nationwide lockdown imposed to contain spread of Covid-19 pandemic in India. The load is likely to pick up after unlocking, which started from 1st June, 2020 in stages.

6.1.3 Future demand of MMR:

As per the 19th Electric Power Survey of India by Central Electricity Authority, the expected Peak Demand of Mumbai upto 2024-25 is shown below:

FY	2020-21	2021-22	2022-23	2023-24	2024-25
Mumbai Load (MW)	3809	3910	4015	4123	4234

Transmission map of Mumbai (internal):



6.1.4 Mumbai Power Transmission:

The transmission system of Mumbai area is collectively handled by three transmission licensees namely Maharashtra State Electricity Transmission Limited (MSETCL), Tata Power Company (TPC) Limited and Adani Electricity Mumbai Limited (AEML). The import point of Mumbai system are as follows:

I. 220 kV Boisar(M) S/s
II. 400 kV Kalwa(M) S/s
III. 400 kV Kharghar (M) SS
IV. 220 kV Borivali(M) S/s
V. 220 kV Trombay(M) S/s

Incoming lines from these S/s:

	220 kV Transmission Lines Feeding to Mumbai
S. No.	**Transmission Lines**
1	220 kV Kalwa-Salsette D/c line
2	220 kV Sonkher-Trombay S/c line
3	220 kV Nerul-Trombay S/c line
4	220 kV Mulund-Trombay S/c line
5	220 kV Kalwa-Trombay S/c line
6	220 kV Kalwa-Borivali S/c line
7	220 kV Kharghar-Borivali D/c line
8	220 kV Bhandup-Borivali S/c line
9	220 kV Boisar-Borivali S/c line
10	220 kV Boisar PG-Borivali S/c line
11	220 kV Tarapur - Borivali S/c line
12	220 kV Boisar-AEML Versova S/c line
13	220 kV Boisar-AEML Ghodbunder S/c line
14	220 kV Viraj-AEML Dahanu S/c line
15	220 kV Borivali-AEML Ghodbunder S/c line

Further, the feeding points to above sub-stations are given below:

i. **Talegaon (Pune) 400 kV S/s:** Talegaon – Kalwa/Kharghar 400 kV D/c line
ii. **Padghe (M) 400 kV S/s:** Padghe (M) – Kalwa 400 kV D/c line
iii. **Tarapur 220 kV S/s:** Tarapur – Borivali/Boisar(M) 220 kV D/c line
iv. **Boisar(PG) 400 kV S/s:** Boisar(PG) – Boisar(M)- 3 Nos of 220 kV Circuits
v. **Kharghar 400 kV S/s:** Kharghar – Borivali 220 kV D/c line & Kharghar – Nerul/Sonkhar/Trombay 220 kV D/C line

6.1.5 Mumbai Power Distribution:

The distribution of Mumbai is collectively catered by Tata Power Distribution (TPC-D), BEST, Maharashtra State Electricity Distribution Company Limited (MSEDCL) and Adani Electricity Mumbai Limited (AEML).

6.1.6 Substation wise load in MMR:

The average loading of Mumbai as observed in the current FY i.e. 2019-20 is tabulated below:

Tata Power 220kV Network loading (MW)		
	220kV Receiving Stations	**Average Loading (MW)**
1	Trombay	193
2	Borivali	196
3	Carnac	141
4	Salsette	153
5	Dharavi	344
6	Backbay	112
7	Saki	127
8	Mahalaxmi	135
9	Sahar	21
10	Versova	45
		1274 MW
	220kV Gen Stations	**Average Generation (MW)**
1	Trombay	862
2	Bhira - Gen	142
	AEML 220kV Substation load (MW)	
1	Aarey	229
2	Versova	231
3	Ghodbunder	189
4	Gorai	81
5	Goregaon	98

6	Chembur	86
7	Borivali	61
8	Saki	154
		1129 MW

Other than this, the average load of S/s feed by MSETCL network around Mumbai is tabulated below:

	MSETCL 220kV Network loading (MW)	
1	220KV AKP	73.33
2	220KV NERUL	118.22
3	220KV SONKHAR	101.92
4	220KV COLOURCHEM	180.28
5	220KV KOLSHET	123.04
6	220KV GIS BHANDUP	118.5
7	220KV MULUND	111.01
8	100KV VASHI	74.32
9	100KV NOCIL	70.42
10	220KV KALWA	311
11	220KV MAHAPE	135
12	220KV BOISAR 2	390
		1806

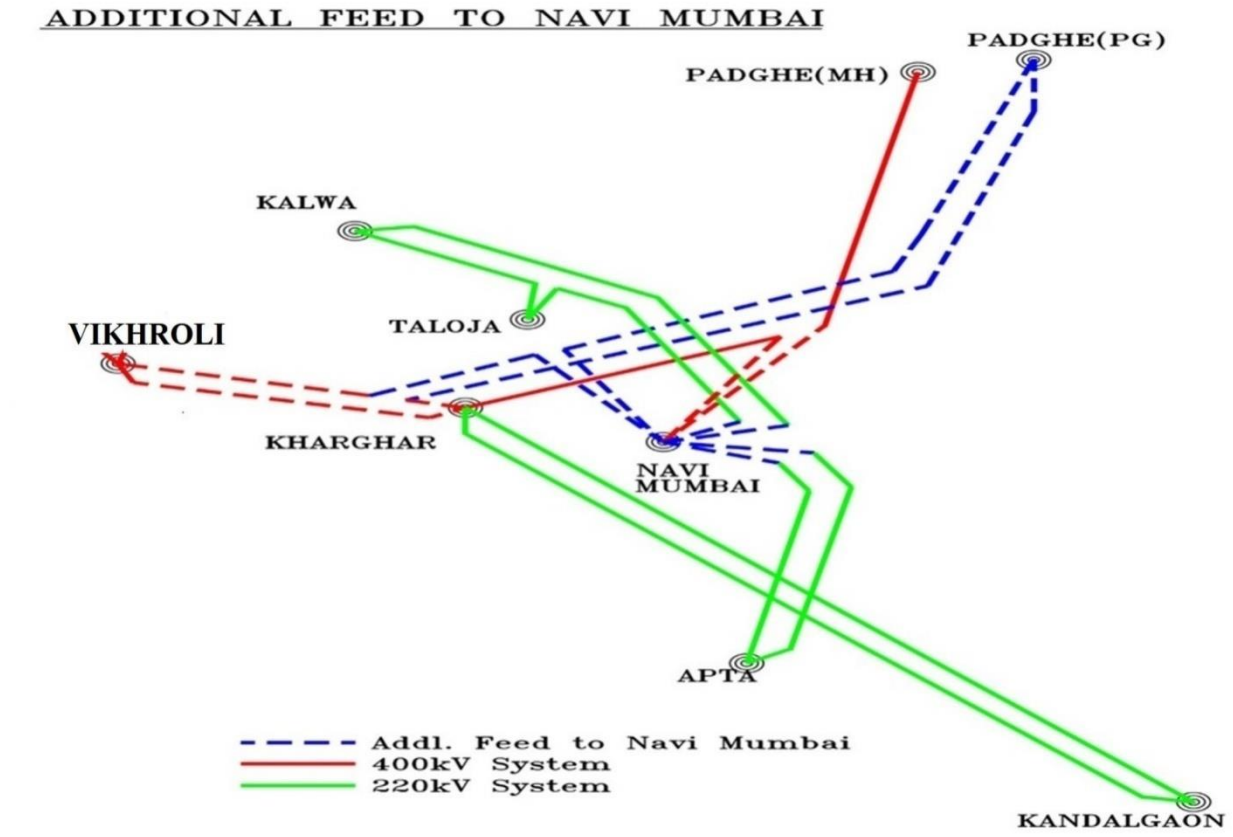
6.2 Criticality of Transmission system in the Mumbai under Present scenario:

Presently 400 kV Kalwa S/s is the main feeding source of Mumbai. Other feeding S/s to Mumbai being Kharghar S/s, Boisar(M), Boisar (PG), Phadge(M) & Borivali (M) S/s. The 400 kV Kalwa S/s gets their feed from 400 kV Phadge (M) through Kalwa- Phadge(M) 400 kV D/C line. Beside this, other feed comes from 400 kV Talegaon S/s through Talegaon-Kalwa 400 kV line and Talegaon–Kharghar-Kalwa 400 kV line. The other feeds from 400 kV Boisar(PG) are to 220 kV Borivili (M), Kharghar to 220 kV Borivali (M) and Padghe(M) to Temghar D/C line. Due to non-availability of schedule most of the time, TPC generation is mostly limited to around 800-850 MW and hydro generation about 150 MW. With the generation available in Mumbai, TPC (Thermal+ Hydro) and AEML Dahanu, more than 50% load of Mumbai is met through import of power through the above 400 kV lines. In the event of outage of any of the above 400 kV feed to Mumbai, the other lines are constrained. Under that condition any N-2 outage of 400 kV feed may prove disastrous for Mumbai system. Mumbai transmission system expansion has so far been badly affected due to non-

availability of adequate ROW through the city. Due to that reason 400 kV Kharghar – Vikhroli D/C could not be implemented so far. Besides this, due to ageing of TPC generations and environmental issues, the existing generation in Mumbai is likely to deplete further. Under these circumstances inadequacy of transmission network is likely to hamper the security of the Mumbai grid in future and it would be difficult to meet the Mumbai demand reliably. If some problem arises at 400 kV Padghe (M) S/S heavy load shedding have to be carried out to save the Mumbai grid. Same condition also applies with Boisar (PG) S/s. Similar situation had arisen in the morning of 12th October, 2020 when 2 nos. of 400 kV line (out of 4) incoming lines were under shutdown (one line Talegaon – Kalwa line was out due to snapping of conductor) and the 2nd line from Padghe to Kalwa also tripped due to snapping of R Phase. This was also brought out by WRLDC that tripping on these lines are quite frequent in the past also. Therefore, the committee is of the opinion that MSETCL need to look into the tripping of these lines urgently and take actions accordingly. Due to the above tripping there was heavy flow from Boisar(M) to Borivali(M) which led to its tripping. Subsequently, the remaining line from Talegaon – Kharghar – Kalwa line also tripped leading to major power outage in Mumbai the details of which have been mentioned at Chapter 3 above.

To avoid the above conditions, there is a need to have separate source of supply for Mumbai with multiple feeding point. One scheme under ISTS namely WRSS-XIX is currently under implementation through TBCB route, which would provide additional feed to Mumbai and is expected by 2022-23 timeframe is as under.

- Padghe (PG)- Kharghar 400 kV D/C quad line to terminated into one circuit of Kharghar – Ghatkopar/Vikhroli 400 kV D/c line, thus forming Padghe (PG)- Kharghar 400 kV S/C quad line, and Padghe (PG)- Ghatkopar/Vikhroli 400 kV S/C line.
- LILO of Padghe (PG)- Ghatkopar/Vikhroli 400 kV line at 400/220 kV Navi Mumbai S/S of PG.
- LILO of Apta – Taloja and Apta – Kalwa Section of Apta – Taloja /Kalwa 220 D/C line at Navi Mumbai.



There is need to commission this scheme as early as possible to increase a ISTS source to Mumbai. The scheme is likely to be commissioned by 2022-23 time frame. For absorption of power from the above ISTS system which is under construction through TBCB, MSETCL has also planned matching scheme and also bid out the system with the proposal for completion by 2023 timeframe. The transmission elements covered under the above scheme are as under:

Voltage Level	Type of Element	Proposed Network Element	Agency
400kV	New sub-station	**400 kV Vikhroli S/s**	ATL
400kV	New Line	400 KV Kharghar-Vikhroli D/C line with bays at Kharghar S/s	ATL
400kV		LILO of 400 kV Talegaon (PG) – Kalwa Line at 400 kV Vikhroli S/s	ATL
400kV	New ICTs	3 x 500 MVA, 400/220/33 kV ICTs at Vikhroli S/s	ATL
220kV	New Line	LILO of existing and proposed 220kV Trombay-Salsette and proposed 220kV Trombay-Saki lines	TPC

		at 220kV Vikhroli S/s	
400 kV	New Line	LILO of Tarapur-Padghe 400 kV D/c line at Kudus(M) S/s	STU
220kV	New Line	LILO of 220 kV Boisar (M) - Ghodbunder (AEML) (Twin AAAC) S/c Line at 400 kV Kudus (M) S/s	STU
220kV	New Line	LILO of 220 kV Tarapur – Borivali (M) S/c Line at 400 kV Kudus (M) Line (Twin AAAC)	STU

(ATL: Adani Transmission Limited, STU: State Transmission Utility, TPC: Tata Power)

With the avalibility of the system by 2022-23 there would be two additional feed from Phadge (PG) into Mumbai system and one to New Mumbai, which is very important considering the upcoming new airport in that area. Powergrid New Mumbai S/s which was to have feed from Padghe (M) could not be connected so far due to ROW issues and MSETCL not agreeing for repeated LILO of the line. The S/s even though has already been commissioned but is laying unused for nearly last five years. The above ISTS system is also going to be connected to Kharghar and Vikhroli MSETCL, there by bringing additional feed to these S/s in addition to the existing feed.

6.3 System Study for the 2023-24 condition:

The maximum demand of Maharashtra as per the 19th EPS is 32717 MW for the peak conditions of 2023-24 and the peak demand of Mumbai is likely to be around 4125 MW by 2023-24. The system studies carried out by CEA under the condition very low generation inside the Mumbai area, considering availability of New Mumbai S/S and interconnection of Padghe(PG) with New Mumbai and Kharghar/Vikhroli substation shows difficulty in meeting N-1 Compliance at some 400 kV as well as 220 kV system inside Mumbai.

Since, there is likelihood that Mumbai generation is to come down further by 2023-24, so under that condition with increased power demand of Mumbai area, the existing 220 kV network of Mumbai would be further stressed, with the result some of the important lines would not be N-1 compliant. So as to cope up with the deficit in the embedded generation, Mumbai area has to depend mainly on the external source to meet its requirement of supply of power.

It has been observed that the incoming sources to MMR would be very critical. Any failures in these incoming supply could lead to complete or partial failure of power. Keeping this in view and the difficulty faced for implementing EHV overhead lines inside Mumbai area following suggestions were given to MSETCL for urgent implementation:

- The underground feeding lines to feed the Mumbai areas to enhance the reliability of system i.e. Establishment of Kudus-Array VSC based HVDC line. The line would be 1000 MW VSC based HVDC Cable Connected with symmetrical monopole for immediate implementation along with provision for addition of 1000 MW in future. The proposal would solve many problems. It would bring 1000 MW power directly in the heart of the city without bothering for ROW. This would act like additional availability of 1000 MW in the heart of the city. AEML has intimated that they have adequate land at both Kudus and Array S/S for installation of VSC module, commenced preparatory actions on the Project and are waiting for approval.
- Effort should be made to commission the transmission scheme “WRSS-XIS” which is under implementation through TBCB route and the Intra-state transmission scheme for establishment of Kharghar/Vikroli S/s system at the earliest possible time.
- The study result also shows that short circuit levels some of the substations in MMR are higher than the design ratings. It is important to note that with additional augmentation in transmission system of Mumbai Region, the fault level of these S/S is going to increase further. Therefore, mitigation measures to limit the fault current need to be evolved along with the proposal for augmentation in transmission system.

MSETCL is coordinating with CEA in the process of development of the MMR system beyond 2025 time frame. The exercise in already on for development of robust transmission network for Mumbai which can reliably cater the requirement of the area atleast for the next 10 to 15 years time frame. However, to ensure the immediate need of safety of Mumbai system, MSETCL need to expedite all the transmission proposal discussed above so that Mumbai system is strengthen to take the future load demand of Mumbai for atleast next five years timeframe.

****

Chapter 7: Recommendations of the Committee

7.1 Based on the analysis of the Mumbai grid disturbance and review of the Mumbai system, the recommendations of the Committee are given in the following categories.

a) Related to Improving SLDC Infrastructure / Operation
b) Related to Mumbai Islanding
c) Related to Power System Protection.
d) Related to Planning of Transmission and Generation
e) Others

7.2 **Recommendations related to Improving SLDC Infrastructure / Operation:**

a) Mandatory need for MSLDC permission to switch on or off equipments in field: A protocol that requires the MSLDC permission /code to hand trip lines or other equipments in MSLDC control area under normal circumstances must be incorporated. Similarly, during restoration, all field utilities should do sub-station operations in MSLDC control area in consultation with MSLDC only. Further, provisions of clause 5.2 of IEGC Regulations shall strictly be followed.

b) Ensuring reliable backup power supply for the communication systems to have uninterrupted data and speech communication at SLDC/RLDC during blackout.

During the incident on 12th Oct 2020, data transmission to WRLDC was interrupted soon after the blackout at Kalwa, Kharghar, Trombay and Uran causing loss of visibility to the system operator. This may be rectified immediately, and for future the healthiness of reliable back up power supply for communication systems at all stations may be ensured.

c) Evaluating Best options for possible scenarios in Real time Operation by Load Dispatcher: In this incident, when the major lines were tripping on over current, efforts were taken to maximize the internal generation to improve the frequency, immediate manual load shedding in MMR/Mumbai area was a better option rather than waiting for the LTS to cut load. Accordingly, there is a need to evaluate best options available to the load dispatcher, as per the system conditions, and accordingly handle the various scenarios faced in real time, and MSLDC should be empowered to shed loads in MMR/Mumbai region as a last resort thereby preventing Mumbai from entering into an islanding state to the

extent possible. There is also a need to handle the Unit 7 under frequency trip, by additional load shedding as well as possibility to form df/dt based signals to initiate load shedding to handle very high df/dt. The same may be studied by the stakeholders for further necessary action.

d) **Enhancing full visibility of 220 kV RTU data in SCADA:** MSETCL had already installed some PMUs in their system, however they are non-functional due to lack of communication network issues. It is understood that the 220 kV SCADA visibility of Maharashtra network in MSLDC is only about fifty percent. Further in Mumbai area there are important 110/100 kV network in tandem to the 220 kV network. In particular, Mumbai system should also have PMU placements to move towards WAMS and WAC systems for the future. The PMU project can also be very useful for state estimation in Maharashtra network. The PMU data available at WRLDC was very useful in the analysis of the sequence of blackout. The Committee recommends that MSLDC/ MSETCL may plan RTUs/PMUs so that full visibility of 220 kV network of Mumbai as well as Maharashtra grid is available in real time at MSLDC.

e) **Building reliable communication backbone:** If the visibility by RTU/PMU data to MSLDC is to be enhanced, it is very important to have a strong and reliable communication backbone. Accordingly, MSETCL may plan for a strong and reliable communication infrastructure required to be in place, both for Maharashtra as well as Mumbai as per Central Electricity Authority (Technical Standards for Communication System in Power System Operations), Regulations, 2020.

7.3 **Recommendations related to Mumbai Islanding:**

a) **Formation of a Special group on Mumbai islanding:** The Committee recommends the formation of a special group for addressing short term operation issues and implementation of recommendations pertaining to Mumbai Islanding and restorative aspects of Mumbai portion with Maharashtra grid. The special group would periodically discuss all aspects pertaining to implementation of various recommendations of WRPC (regarding the islanding scheme) any short term changes within the Island, load generation balance of the Mumbai Islanding, including, reactive compensation, updating load connectivity for UFLS for islanding and any other related aspects. MSLDC can be the convener of the

Group involving the power utilities of Mumbai as members. The group shall meet a minimum of twice a year, and as frequently as need arises.

b) Comprehensive study of islanding settings. Till such time the SPS/LTS is formulated to handle power diversion in 220 kV Mumbai network (like Padghe gate diversion, Kalwa and Kharghar gate diversion, Boisar LTS is already available), the UFLS preparatory for islanding, currently raised to 48.4 Hz, may be maintained. As soon as all the SPSs are activated, the UFLS preparatory load shed settings of 48.4 Hz may be reviewed by requisite study by the Special group on Mumbai Islanding. Certain ideas like replacing RPUF with plain under frequency at 47.6 Hz (almost tie-lines are by then disconnected) has been suggested in the report and the same must also be verified for agreement from the simulations. There is also a need to handle the Unit 7 under frequency trip, by additional load shedding as well as possibility to form df/dt based signals to initiate load shedding to handle very high df/dt. All the settings to be chosen for the islanding should be verified by performing transient simulations and other required studies, under a variety of conditions, both for contingency based and grid initiated scenarios and the same may be studied by the Special group on Mumbai Islanding.

c) **Reduction in Measuring cycle of plain Under frequency preparatory load shedding during islanding:** The reduction of measurement time to 3-5 cycles for UFR during islanding should be done immediately. Inherent measurement time of relay operation is unavoidable. However, no external time delay shall be provided for Load shedding or Islanding frequency settings. All Mumbai loads, except very critical Mumbai loads (to be decided by MSLDC as per guidelines of MERC and technical constraints as applicable) shall be wired up for UFLS and available for islanding.

7.4 **Pertaining to Power System Protection:**

a) **Formulation of LTS / SPS for Mumbai system:** The Committee recommends that over-current (phase over load) function of 220 kV MSETCL network around Mumbai which has resulted in tripping of the lines shall be mitigated through LTS / SPS to handle contingencies of power diversion on Padghe, Kalwa and Kharghar gates, as well as any other power flow constraints in Mumbai system, may be framed by MSLDC.

b) **Restoration of load in equitable manner:** MSLDC may form protocols for load restoration after islanding, so that the same is done in an equitable manner for all DISCOMS loads in Mumbai, subject to technical constraints, if any.

7.5 **Related to Planning of Transmission and Generation:**

a) **Reactive Planning to control high voltages:** Reactors may be planned to ensure success of black start operation through hydro stations of TPC. STU should immediately arrange for reactors or may also divert an already available reactor as interim measure at Karanjade/Waghiwali so that black start operation at TPC Hydro can be successful. The STU, may plan for conversion overhead lines into underground cables in line with the Municipal Corporation and address the reactive requirement in a comprehensive manner to contain over-voltages in Mumbai System.

b) **Enhancing Embedded Generation and planning for import of power:** Considering the importance of Mumbai system, STU in line with the future scenario, may suitably plan to maximise embedded generation (including exploring of R&M of generating plants, power from Solar energy and Waste to energy plants and Battery energy storage) and also plan to import power from grid as a part of long term plan, ensuring the system security. Till such time, strong interconnections with the main grid are established, there is a need to maximise the embedded generation in MMR and adjoining region supplying power to Mumbai, so that the chances of survival during islanded mode is enhanced. This may require the possibility of making the embedded generation in Mumbai and adjoining areas supplying power to Mumbai as must-run available generation sources in Mumbai and MSLDC/MSETCL may accordingly do the needful. Alternatively, similar frameworks like Ancillary services available at Centre can be introduced for Mumbai.

c) **Strengthening the incoming lines to Mumbai area:** In view of existing constraints in transmission capacity, depleted embedded generation in Mumbai and increase in demand the Committee recommends additional feed from other 400/765KV S/S or strong HVDC source. The strengthening of transmission system for importing power in Mumbai from other parts of the grid should be taken up at the earliest. An additional HVDC VSC link of Kudus – Aarey as proposed by CEA may be taken up by STU at the earliest. This would strengthen the supply of

power in the heart of Mumbai grid without facing the problem of ROW within Mumbai.

7.6 **Others:**

a) The non-operation of Uran islanding scheme shall be investigated by MSLDC with measures to take the scheme in service at the earliest and to be reviewed for long term measures with suitable load control methods.

b) The Committee recommends the operation of Bhira Pumped Storage plant in Pumping mode shall be made operational at the earliest.

c) Due to a number of incidents of conductor/jumper snapping, the system was exposed to faults, aggravating the stability problems. The Committee, therefore recommends that MSETCL shall Review the preventive maintenance works at all the 400 kV ,220 kV, 110 kV substations in Mumbai and Mumbai outskirts on priority and at regular intervals.

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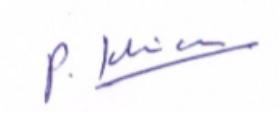
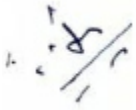


(Prakash Khichi)
Member Secretary

(Pallikuth Devanand)
Member

(Arvind Kumar Sharma)
Member

(Ashok Pal)
Member



(Sanjay Taksande)
Member

(V.K. Shrivastava)
Member

(Hemant Jain)
Member

(Satyanarayan S.)
Member

(Goutam Roy)
Chairman of the Committee

420023/2021/OPERATION AND MONITORING SECTION

Annexure 1.1

सत्यमेव जयते

भारत सरकार
Government of India
विद्युत मंत्रालय
Ministry of Power
केन्द्रीय विद्युत प्राधिकरण
Central Electricity Authority
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सं. 2/ए.आई/जी.आर.डी./ग्रि.प्र/2020/336 - 338 **दिनांक: 12.10.2020**

OFFICE MEMORANDUM

विषय: 12 अक्टूबर,2020 को मुम्बई में हुई ग्रिड बाधा की जांच के लिए एक समिति का गठन

Subject: Constitution of a Committee to enquire into the Grid Disturbance which occurred in Mumbai on 12th October,2020 – reg.

It has been decided by the competent authority to constitute a Committee under the chairmanship of Chief Engineer (Power System Planning & Appraisal-I),CEA, to enquire into the Grid Disturbance which occurred in Mumbai system on 12th October,2020, affecting the power supply in Mumbai.

2. The composition of the Committee will be as under:

(i)	Shri Goutam Roy, Chief Engineer (PSPA-I), CEA	- Chairman
(ii)	Shr Satyanarayan. S, Member Secretary, WRPC	- Member
(iii)	Shri Ashok Pal, CGM, CTU	- Member
(iv)	Shri V.K. Srivastava, ED, WRLDC	- Member
(v)	Representative of Maharashtra State Electricity Transmission Company Limited (MSETCL)	- Member
(vi)	Representative of Tata Power Limited	- Member
(vii)	Representative of Adani Electricity Mumbai Limited	- Member
(viii)	Director (Grid Management), CEA	- Member Secretary

The Committee may co-opt any other members as it may deem necessary.

3. The Terms of Reference of the Committee are as under:

(i) To analyse the causes and circumstances leading to the grid disturbance affecting power supply in the Mumbai system;
(ii) To suggest remedial measures to avoid recurrence of such disturbance in future;
(iii) To review the restoration of system following the disturbance and suggest measures for improvement in this regard, if any;
(iv) Requirement of system strengthening in Mumbai area

420023/2021/OPERATION AND MONITORING SECTION

(v) Other relevant issues concerned with the safe and secured operation of the Mumbai system.

4. The Committee shall submit its Report in a month's time.

12/10/2020

(प्रकाश खीची)
निदेशक (ग्रिड प्रबंधन)

Distribution:
Chairman and Head of Organizations represented in the Committee

Copy for kind information to:

1. **Chairperson, CEA**
2. **Member (GO&D), CEA**
3. **Joint Secretary (OM), MoP**

420023/2021/OPERATION AND MONITORING SECTION

Annexure 1.2

सत्यमेव जयते

भारत सरकार
Government of India
विद्युत मंत्रालय
Ministry of Power
केन्द्रीय विद्युत प्राधिकरण
Central Electricity Authority
****

सं. 2/ए.आई/जी.आर.डी./ग्रि.प्र/2020/339 - 340 **दिनांक: 12.10.2020**

Subject: First Meeting of the Committee constituted to enquire into the Grid Disturbance which occurred in Mumbai on 12th October,2020 – reg.

A Committee to enquire into the Grid Disturbance which occurred in Mumbai on 12th October, 2020 has been constituted vide CEA OM of even No. dated 12.10.2020. It has been decided that the first meeting of the Committee would be held at 3:00 PM on 13.10.2020 under the Chairmanship of Chief Engineer (Power System Planning & Appraisal-I),CEA, at WRPC, Mumbai.

2. It is requested to kindly attend the meeting or nominate your representative at appropriate level with relevant data/ information. The undersigned may be contacted on email prakashkhichi@nic.in or on mobile No. 9212092617 for any information.

12/10/2020

(प्रकाश खीची)
निदेशक (ग्रिड प्रबंधन)

Distribution:
Chairman and Head of Organizations represented in the Committee

Copy for kind information to:
1. **Chairperson, CEA**
2. **Member (GO&D), CEA**

List of Participants attended First meeting of the Committee held on 13.10.2020 at Mumbai to enquire into Grid disturbance which occurred in Mumbai on 12th October, 2020

Sr. No.	Name (Shri)	Designation
CEA		
1.	Goutam Roy	Chief Engineer (PSPA-1) & Chairman of the Committee
2.	Awdhesh Kumar Yadav	Dir.(PSPA-1)
3.	Prakash Khichi	Dir.(GM) & Member Secretary to the Committee
WRPC		
4.	Satyanarayan S.	Member Secretary, WRPC
5.	P. D. Lone	SE (Coml.)
6.	J. K. Rathod	SE (P)
POWERGRID		
7.	Ashok Pal	CGM (CTU)
WRLDC, POSOCO		
8.	V. K. Shrivastava	Executive Director
MSETCL / MSEDCL		
9.	Sanjay Taksande	Dir(O), MSETCL
10.	Peeyush Sharma	CE(SLDC), MSETCL/MSLDC
11.	Shashank Jewalikar	CE(STU), MSETCL
12.	Paresh Bhagwat	CE(PP), MSEDCL
13.	S.S. Patil	SE (LM), MSEDCL
14.	Kishor B. Garud	EE(Tr. O&M), MSETCL
Tata Power Co. Ltd.		
15.	P. Devanand	Head – PSCC
16.	Milind Gole	Head – Grid Operation
17.	T.K. Bhaskaran	Consultant
Adani Electricity Mumbai Ltd.		
18.	Arvind Kumar Sharma	COO (Transmission)
19.	Rajendra Nandi	COO, AEML-G
20.	Mahesh Bhadoria	Sr. V.P. (CES), AEML-G
21.	Suraj Phalak	V.P. (Distribution)
22.	D.M. Devasthale	Addl.V.P.(Transmission)
23.	Shrikant Yeole	Addl.V.P.(Distribution)
24.	Sonu Karekar	Asst. V.P.(Network)

List of Participants attended Second meeting of the Committee held on 14.10.2020 at Mumbai to enquire into Grid disturbance which occurred in Mumbai on 12th October, 2020

Sr. No.	Name (Shri)	Designation
CEA		
1.	Goutam Roy	Chief Engineer (PSPA-1) & Chairman of the Committee
2.	Awdhesh Kumar Yadav	Dir.(PSPA-1)
3.	Prakash Khichi	Dir.(GM) & Member Secretary to the Committee
WRPC		
4.	Satyanarayan S.	Member Secretary, WRPC
5.	P. D. Lone	SE (Coml.)
6.	J. K. Rathod	SE (P)
7.	Sachin K. Bhise	EE (P)
8.	P. Peddi Reddy	EE (O)
POWERGRID		
9.	Ashok Pal	CGM (CTU)
WRLDC, POSOCO		
10.	V. K. Shrivastava	Executive Director
MSETCL / MSEDCL		
11.	Peeyush Sharma	CE(SLDC), MSETCL/MSLDC
12.	Paresh Bhagwat	CE(PP), MSEDCL
13.	S.S. Patil	SE (LM), MSEDCL
Tata Power Co. Ltd.		
14.	Sanjay Banga	President (T&D)
15.	P. Devanand	Head – PSCC
16.	Milind Gole	Head – Grid Operation
Adani Electricity Mumbai Ltd.		
17.	Arvind Kumar Sharma	COO (Transmission)
18.	Mahesh S. Ambardekar	Sr. V.P. (Transmission)
19.	D.M Devasthale	Addl.V.P.(Transmission)
20.	Shrikant Yeole	Addl.V.P.(Transmission)
21.	Jafar Khan	Dy. G.M. (Transmission)
22.	Sonu Karekar	Asst. V.P.(Network)

420023/2021/OPERATION AND MONITORING SECTION

सत्यमेव जयते

भारत सरकार
Government of India
विद्युत मंत्रालय
Ministry of Power
केन्द्रीय विद्युत प्राधिकरण
Central Electricity Authority
****

सं. 2/ए.आई./जी.आर.डी./ग्रि.प्र./2020/३५१ **दिनांक: 19.10.2020**

विषय : 12 अक्टूबर, 2020 को मुंबई में हुई ग्रिड बाधा की जांच के लिए गठित समिति में नये सदस्य को सहयोजित करने के सम्बन्ध में।

Subject: To co-opt a member in the Committee constituted to enquire into the Grid Disturbance which occurred in Mumbai on 12th October,2020-reg.

CEA vide its letter No. 2/AI/GRD/GM/2020/336-338 dated 12th Oct,2020 has constituted a Committee under the Chairmanship of Chief Engineer (Power System Planning & Appraisal-I), CEA to enquire into the Grid Disturbance which occurred in Mumbai on 12th October,2020. It has been decided by the Chairman of the Committee to co-opt Shri Hemant Jain, Chief Engineer (Grid Management), CEA as one of the Member of this Committee.

19/10/2020

(प्रकाश खीची)
निदेशक (ग्रिड प्रबंधन)

Distribution by email:

To all Members of the Committee

Copy for kind information to:

1. PPS to Chairperson, CEA
2. PPS to Member (GO&D), CEA

Annexure 3.1

Load Trimming Scheme for 400KV Talegaon-Kharghar Line at Kharghar SS.

Sr. No.	Name of the Scheme	Status	Measurement point and quantity	Sertting adopted (Current and time)	Actions at locations	Load Relief Expected (MW)	Remarks
10	LTS Scheme for 400KV Talegaon-Kharghar Line at Kharghar SS.	In Service	400KV Talegaon-Kharghar Line at Kharghar SS.	CT Ratio 2000/1A, Alarm 1300A, 2 sec delay. Stage I/II 1300 Amp, 3 sec delay.	**Stage I** **220kV Nerul s/s: (23.99MW)** 1. 22kV CBD Sec 11 & KB= 0.76MW 2. 22kV Shirwanegaon =1.37MW 3. 22kVNerul MIDC = 8.32MW 4. 22kV Turbhe MIDC = 5.73MW 5. 22kV Nerul LP Naka = 5.35MW **220kV Sonkar s/s: (28.73MW)** 1. 33kV Feeder 9 =13.71MW 2. 33kV Feeder 11 =3.65MW 3. 33kV Feeder 14 =3.26MW 4. 33kV Feeder 17 =8.11MW **220kV Dharavi TATA s/s: (120MW)** **Stage II** 400kV Kharghar S/S (40MW) 33kV CBD I= 7MW 33kV Kamothe = 18MW, 33kV sector 29 = 15MW **220kV Sonkar s/s: (27.89MW)** 1. 33kV Feeder 1 = 5.2MW 2. 33kV Feeder 16 = 4.8MW 3. 33kV Feeder 3 =3.66MW 4. 33kV Feeder 8 =4.171MW 5. 33kV Feeder 4 =3.83MW 6. 33kV Feeder 10 =6.23MW **220kV Nerul /S (101.54MW)** 1. 33kV CPWD = 8.12MW 2. 33kV NRI = 1.83MW 3. 33kV Ulwe I = 6.23MW 4. 33kV RLW II = 8.41MW 5. 33kV RLW I = 10.92MW 6. 33kV Sanpada = 17.49MW 7. 33kV SBI Colony = 10.17MW 8. 33kV IDBI = 2.46MW 9. 33kV Nerul SDn. = 11.84MW 10. 33kV Ulwa II = 7.26MW 11. 22kV Nerul I = 8.31MW 12. 22kV New Found = 0.49MW 13. 22kV Kukshet II = 8.01MW	Stage I = 172.72MW Stage II = 169.43MW	Both stage I and II load relief for ICT is connected for Line LTS. TRIP Commands from Kharghar are send to Nerul, Trombay MSETCL, TATA Dharavi and Sonkhar ss Via PLCC and On OFC to TATA. Scheme is taken in service on 17/10/2020 with mock trials in presence of MSETCL and TATA testing Team and in coordination with SLDC Kalwa and TATA LD.

Testing of LTS at Khargar: While investigating the regions for non operation of LTS at Khargar on 12.10.2020, MSLDC informed that trip commands from Khargar is sent via PLCC to Nerul, Trombay (M), Sonkhar and Dharavi (Tata). The PLCC communication link between Khargar and Sonkhar was not in service due to the reorientation of 220 kV Khargar-Trombay by LILO at 220 kV Sonkhar SS. Further, at Nerul and Trombay the links were not kept open due to reorientaion work. The link was restored on 17.10.2020 and mock trials were taken in the presence of MSETCL and Tata testing team.

420023/2021/OPERATION AND MONITORING SECTION

Gmail

Satyanarayan S <satyaguru100@gmail.com>

Re: Submission of data required to Member secretory WRPC for further submission to CEA committee

4 messages

Moreshwar Dhore(Charge) <SE7500@mahatransco.in> Wed, Nov 4, 2020 at 5:30 PM
To: "ms-wrpc@nic.in" <ms-wrpc@nic.in>, "satyaguru100@gmail.com" <satyaguru100@gmail.com>
Cc: Nasir Quadri <CEVASHI@mahatransco.in>, Peeyush Sharma <SEOPR8000@mahatransco.in>

Dear Sir,

With reference to the above subject matter, the pointwise information as under -

1) Probable tripping sequence of lines in excel sheet, tripping details with line ends, loading on the lines which tripped prior to the occurrence (10.00 hrs reading)
- **Enclosed separately**

2) Viraj- Boisar line tripping and after outage analysis

- **On dtd. 12102020 during Grid Disturbance, 220kV Viraj - Boisar2 Line tripped on Y ph line differential protection from 220kV Boisar 2 substation and at Viraj end line differential protection didn't operate. Hence on dtd. 31102020 suspected Y ph CT with R and B Ph CTs at Viraj end are tested for the following tests.**
1. knee point voltage test
2. Ratio test with core confirmation.
3. CT secondary circuit checked and insulation resistance up to Relay panel measured.
For all the above tests, results found in order.
Also at both ends Line differential relays (Make: ABB, RED 670) is tested for line differential protection. During the testing, Viraj end relay operations found delayed which is not desirable for proper operation.
Now the differential relay (Make: ABB, RED 670) issue is discussed with M/s ABB and M/s Adani for further investigation and corrective action.

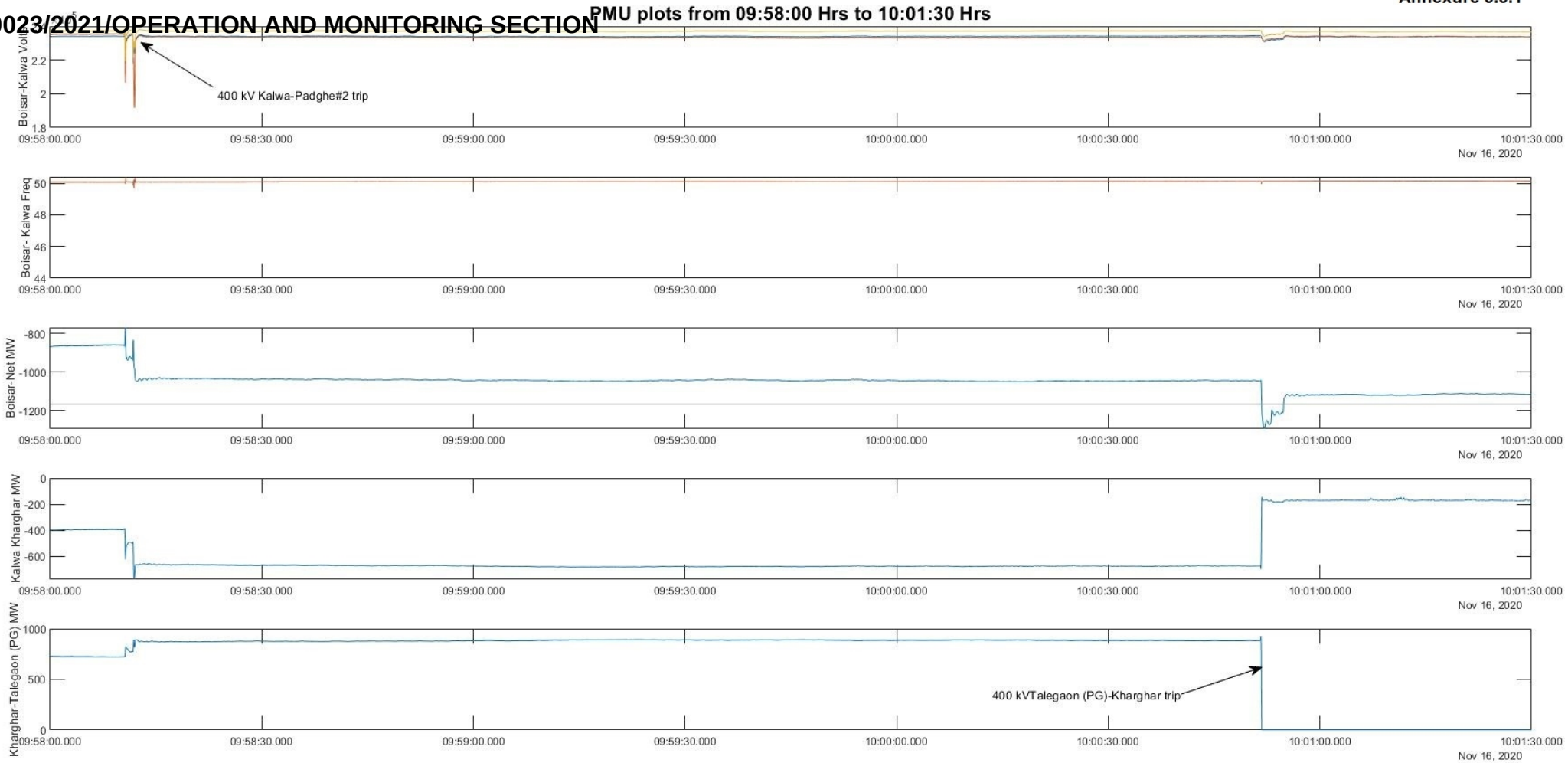
3) Scheme of LTS operation-
a) Kharghar-Talegaon LTS - **Enclosed separately**
b) Boisar LTs - **Enclosed separately**
c) Kalwa ICT with Interconnection operation -
i) There was no LTS operation of Kalwa ICT.
ii) However special-purpose scheme is implemented to closed interconnector breaker between 220KV Kalwa - I and Kalwa - II in the event of loading of 220KV AKP, Panchanand, Apta & Temghar lines beyond the set values with a time delay of 1.2sec. The same is operated correctly on 12.10.2020 grid disturbance.

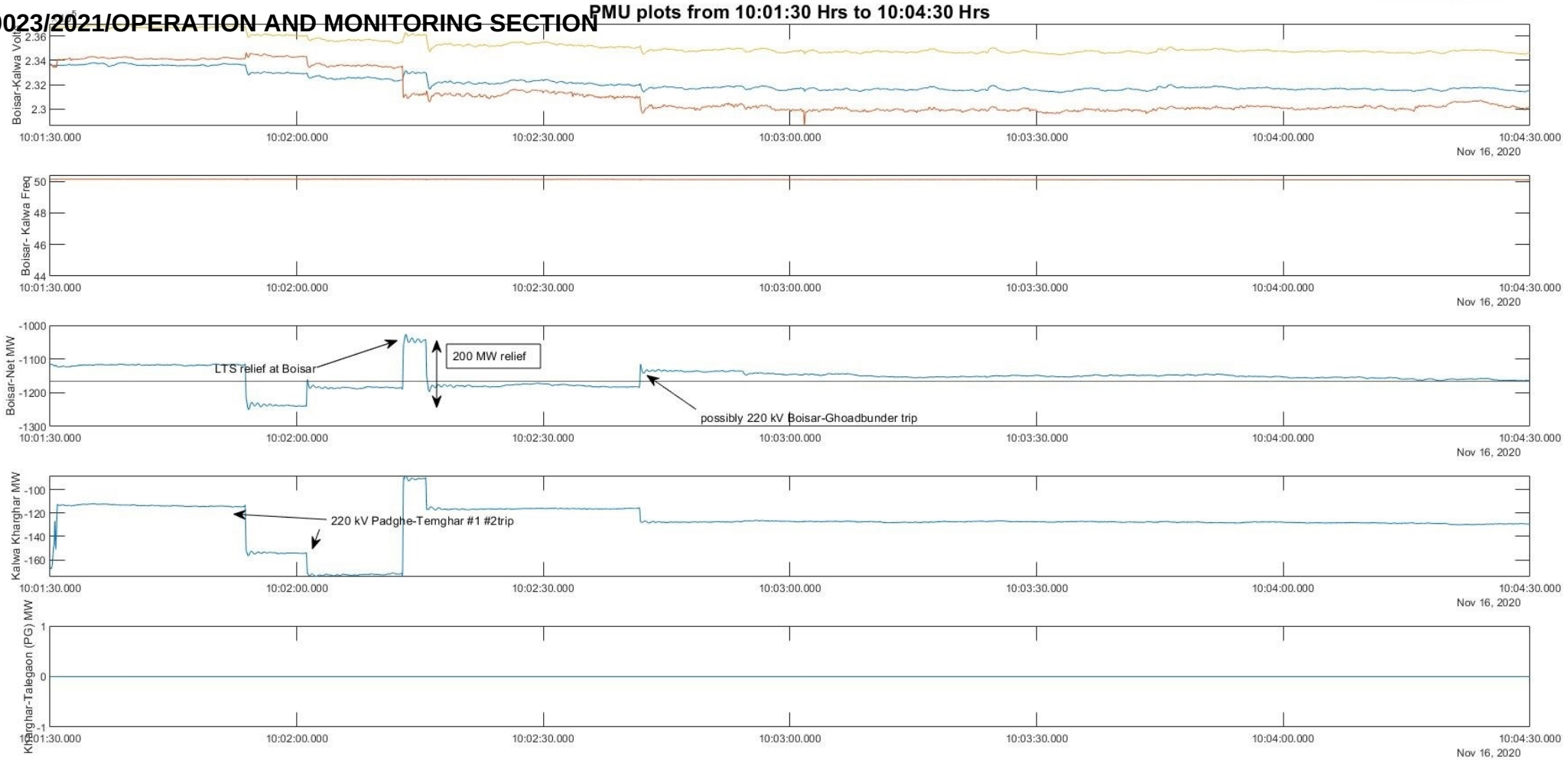
4) DRs of Boisar-Ghodbunder at Boisar end.

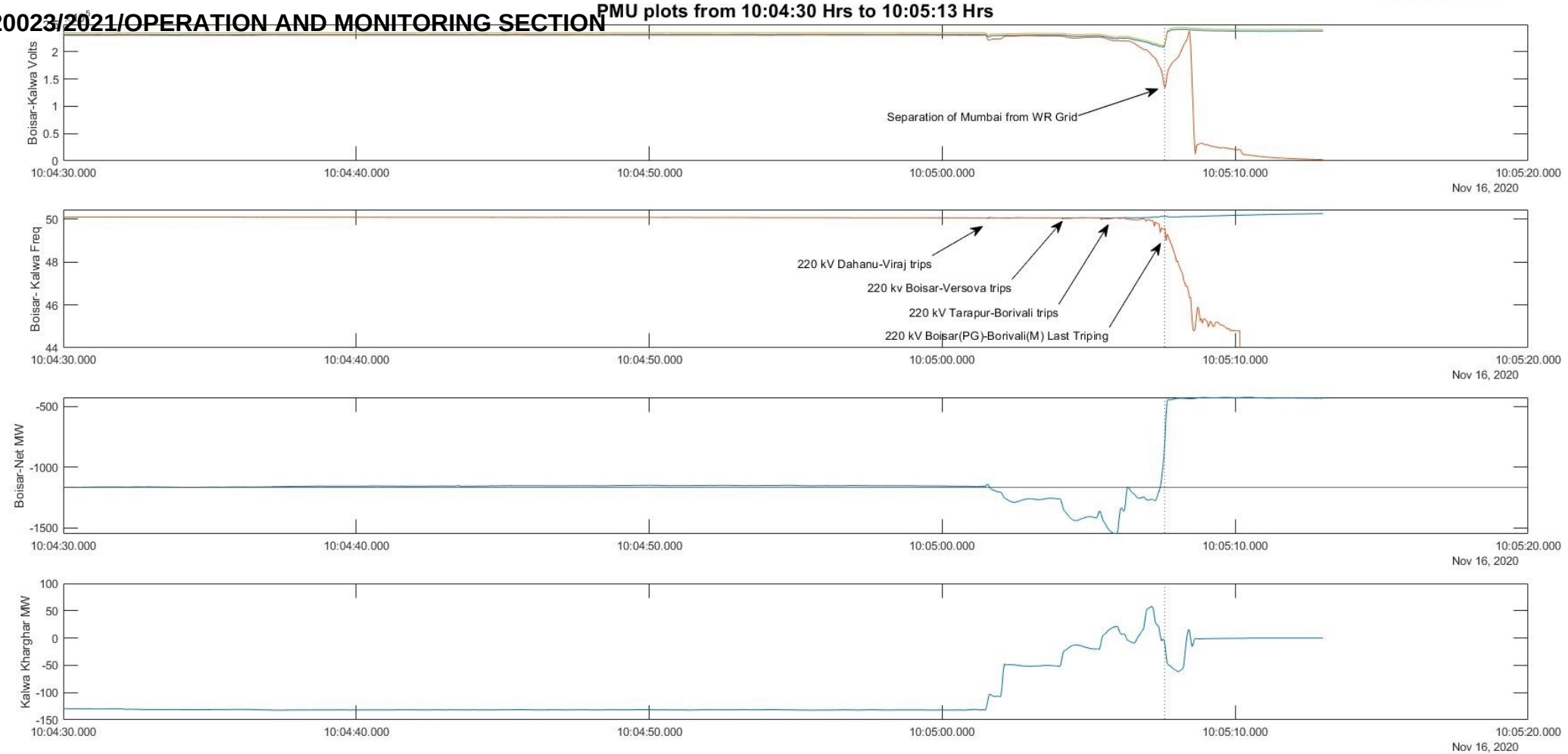
- **220 kV Boisar-Ghodbunder line tripped on Directional O/C at Boisar(M) end. Since DR could not be retrieved due to relay communication problems. However, the event list is enclosed herewith.**

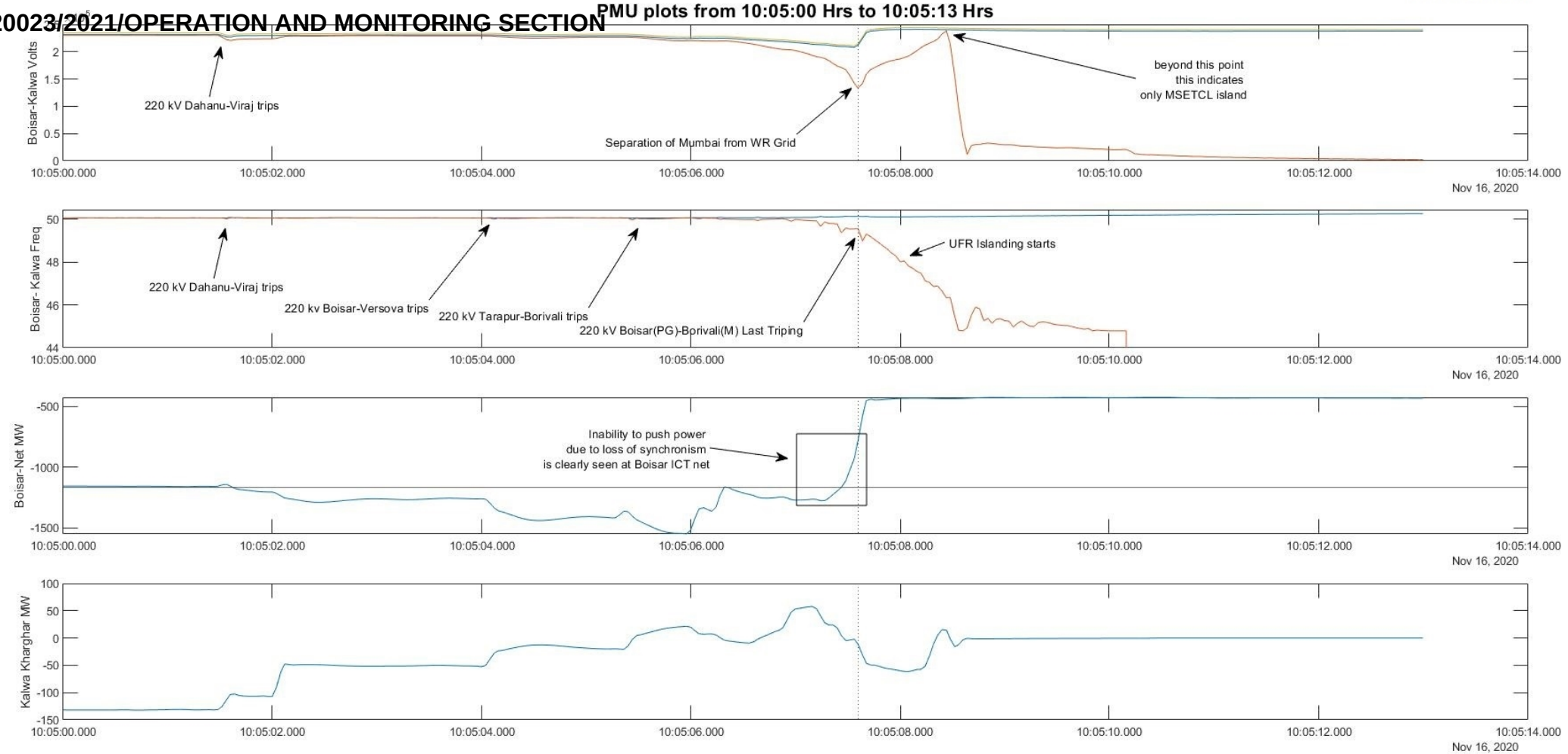
Thanks & Regards,

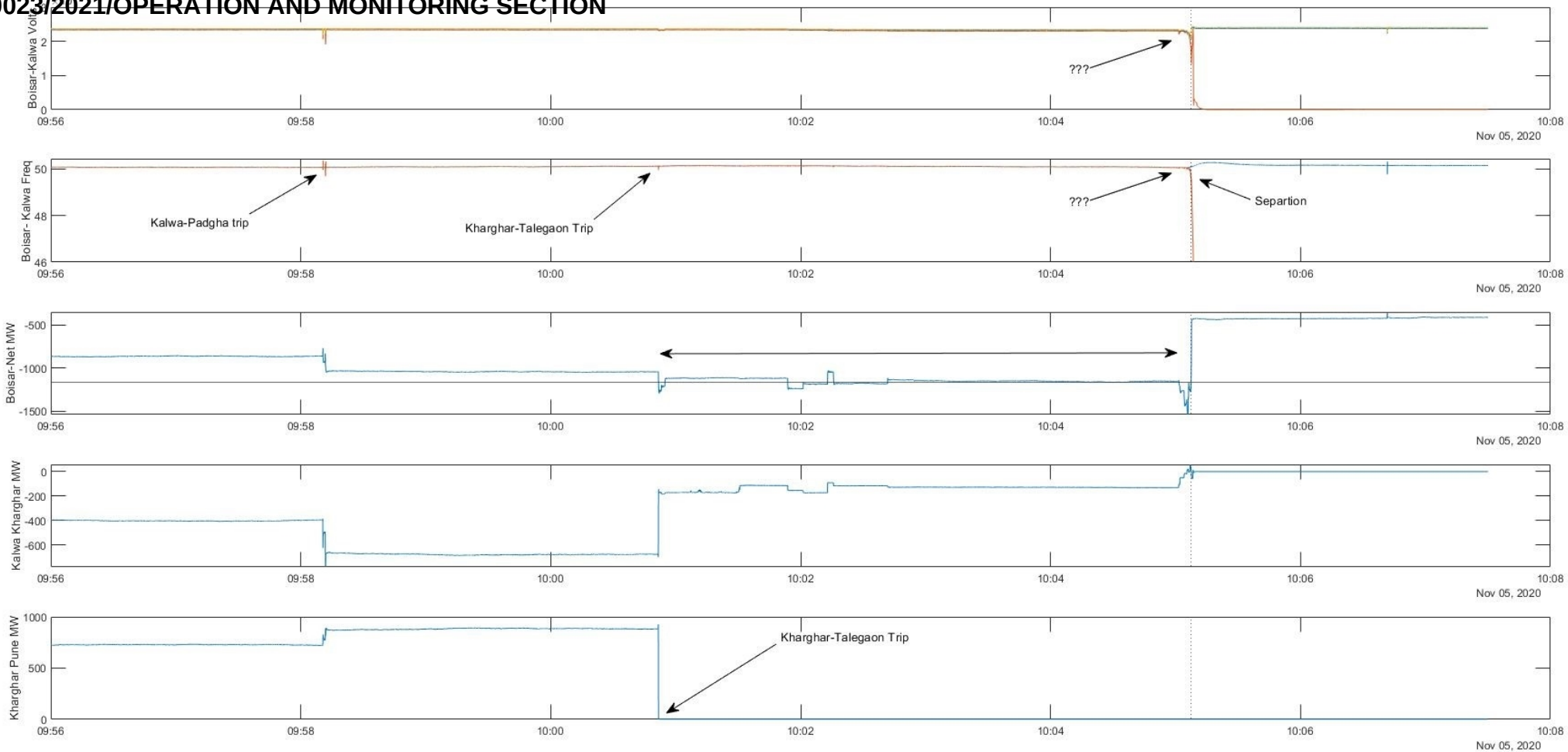
(Moreshwar Dhore)
Superintending Engineer(I/C)
Testing & Communication Circle,

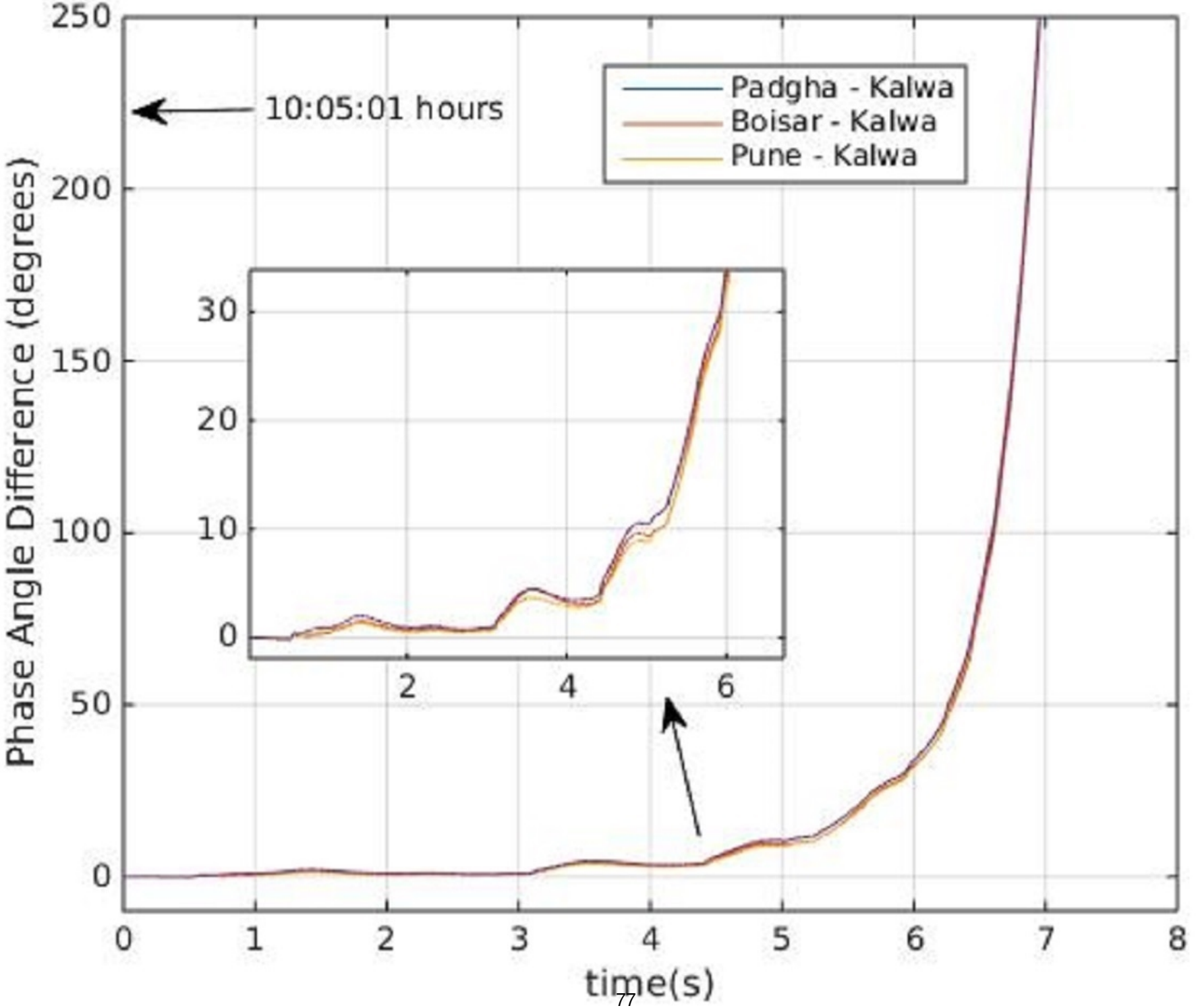

PMU plots from 09:58:00 Hrs to 10:01:30 Hrs
Boisar-Kalwa Volt
400 kV Kalwa-Padghe#2 trip
Boisar- Kalwa Freq
Boisar-Net MW
Kalwa Kharghar MW
Kharghar-Talegaon (PG) MW
400 kVTalegaon (PG)-Kharghar trip
09:58:00.000
09:58:30.000
09:59:00.000
09:59:30.000
10:00:00.000
10:00:30.000
10:01:00.000
10:01:30.000
Nov 16, 2020


PMU plots from 10:01:30 Hrs to 10:04:30 Hrs
Boisar-Kalwa Volt
Boisar- Kalwa Freq
Boisar-Net MW
LTS relief at Boisar
200 MW relief
possibly 220 kV Boisar-Ghoadbunder trip
Kalwa Kharghar MW
220 kV Padghe-Temghar #1 #2trip
Kharghar-Talegaon (PG) MW
10:01:30.000
10:02:00.000
10:02:30.000
10:03:00.000
10:03:30.000
10:04:00.000
10:04:30.000
Nov 16, 2020


PMU plots from 10:04:30 Hrs to 10:05:13 Hrs
Boisar-Kalwa Volts
Separation of Mumbai from WR Grid
Boisar- Kalwa Freq
220 kV Dahanu-Viraj trips
220 kv Boisar-Versova trips
220 kV Tarapur-Borivali trips
220 kV Boisar(PG)-Borivali(M) Last Triping
Boisar-Net MW
Kalwa Kharghar MW
10:04:30.000
10:04:40.000
10:04:50.000
10:05:00.000
10:05:10.000
10:05:20.000
Nov 16, 2020


PMU plots from 10:05:00 Hrs to 10:05:13 Hrs
Boisar-Kalwa Volts
220 kV Dahanu-Viraj trips
Separation of Mumbai from WR Grid
beyond this point
this indicates
only MSETCL island
Boisar- Kalwa Freq
220 kV Dahanu-Viraj trips
220 kv Boisar-Versova trips
220 kV Tarapur-Borivali trips
220 kV Boisar(PG)-Borivali(M) Last Triping
UFR Islanding starts
Boisar-Net MW
Inability to push power
due to loss of synchronism
is clearly seen at Boisar ICT net
Kalwa Kharghar MW
10:05:00.000
10:05:02.000
10:05:04.000
10:05:06.000
10:05:08.000
10:05:10.000
10:05:12.000
10:05:14.000
Nov 16, 2020

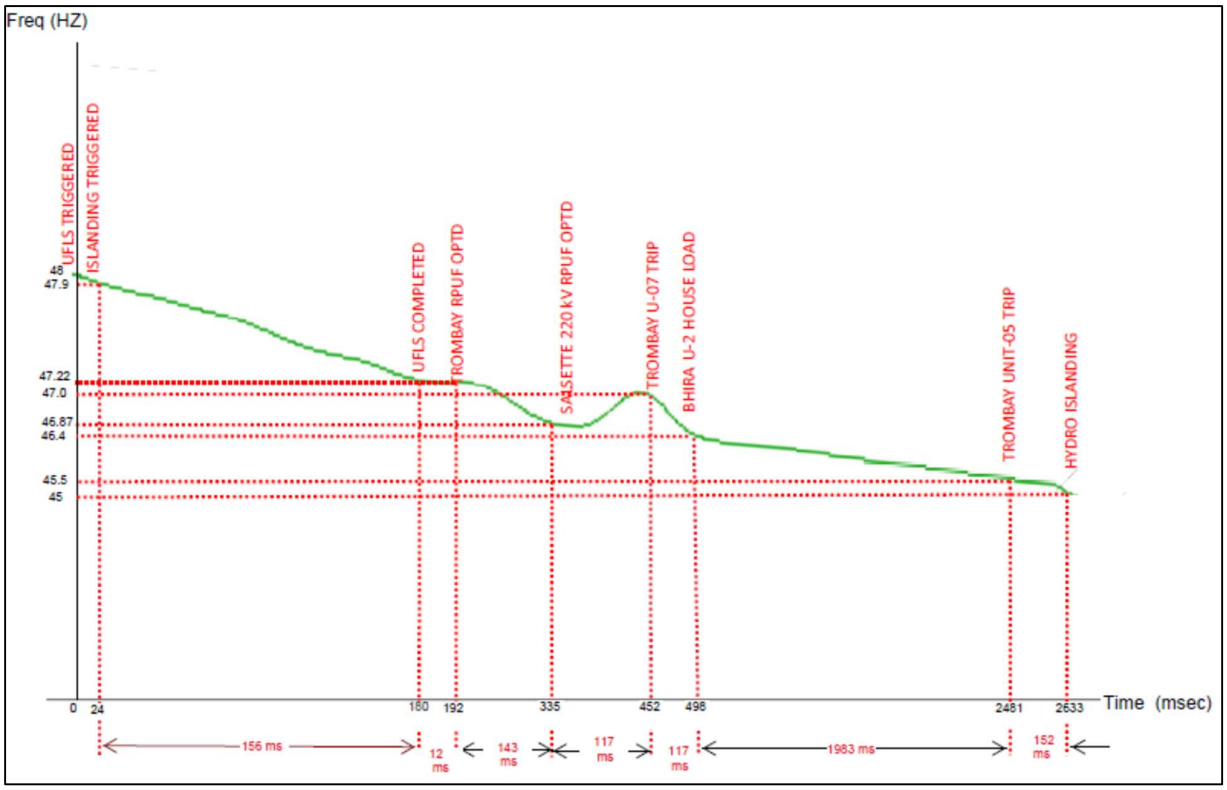

Boisar-Kalwa Volt
???
09:56
09:58
10:00
10:02
10:04
10:06
10:08
Nov 05, 2020
Boisar- Kalwa Freq
Kalwa-Padgha trip
Kharghar-Talegaon Trip
???
Separtion
Boisar-Net MW
Kalwa Kharghar MW
Kharghar Pune MW
Kharghar-Talegaon Trip


10:05:01 hours
Padgha - Kalwa
Boisar - Kalwa
Pune - Kalwa
Phase Angle Difference (degrees)
time(s)
250
200
150
100
50
0
0
1
2
3
4
5
6
7
8
30
20
10
0
2
4
6

TPC ANALYSIS OF EVENTS DURING ISLANDING

Mumbai Shutdown – 12.10.20

Frequency plot from Trombay 110KV Islanding relay showing various events during System disturbance:



In the frequency plot, U/F setting 48.0 Hz is taken as zero reference at 10:05:09 hrs.

At 48.0 Hz UFLS relay sensed low frequency condition and UFR load shedding lock out operated at receiving stations as per the automatic UFLS scheme based on Tie line interchange (256 no of feeders 881 MW).

At 47.9Hz, Islanding relays set at interchange points of Salsette, Trombay, Borivli and Kalyan initiated trip command to tie line breakers. Under frequency load shedding was completed after 180 mSec. (the time required for initiation of relay, operation of lockout relay and actual breaker opening). By that time frequency dropped to 47.22Hz.

Tie line breakers tripped after 168 mSec. This resulted in to reverse power towards MSETCL at Trombay 110KV and Salsette 220KV after which, all the remaining tie lines at Trombay and Kalwa tripped after 168 & 311 mSec respectively. TPC network got isolated from MSETCL at all tie points and islanded within 335 mSec with a frequency of 46.87 Hz. System frequency started recovering due to @ 18 MW surplus power in the Island.

However, the frequency again started dropping due to shortfall in the island due to Unit 7A trip, which was initiated at 47.0 Hz as per design trip setting, corresponding to 46.4 Hz. Bhira Unit 2 went on house load at 46.5 Hz but could not survive. Frequency continued to drop and Unit 5 tripped at 46 Hz after 600 msec as per design settings. Hydro islanding relay operated at 45 Hz and tripped all the line breakers as frequency continued to drop.

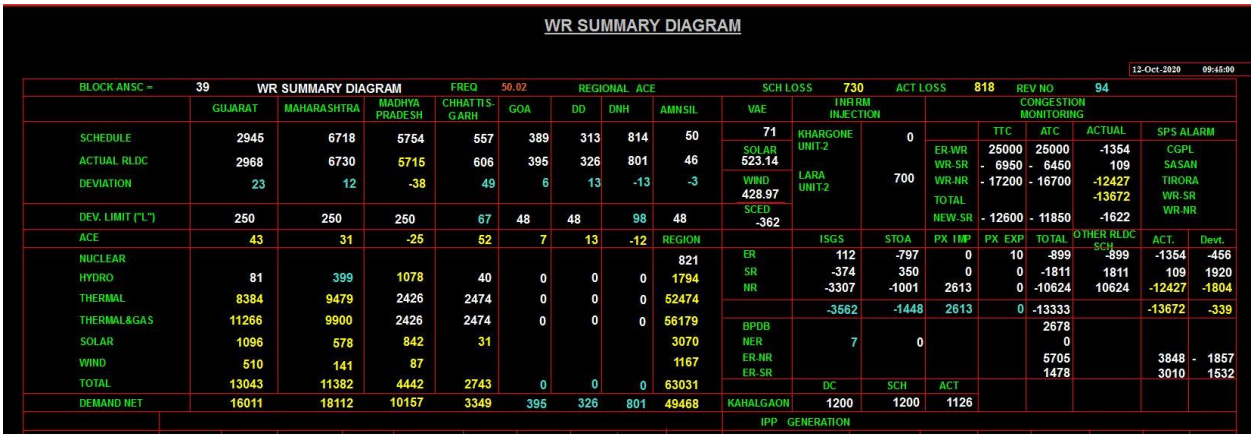
AEML system isolated from TPC system at 47.0 Hz.

Hydro Islanding operation was as per design, however all the Generating Units tripped on Over speed / Under speed.

Bhira has two stages for Islanding, Stage 1 Operation at 46.5 Hz (One Unit as per selection continues to feed house load after opening its 110KV breaker) and Stage 2 Operation at 45 Hz (all 110KV lines open).

Khopoli and Bhivpuri has Islanding scheme set at 45 Hz (All 110 KV lines open).

09.45-WR Demand Summary-IR Summary



WR SUMMARY DIAGRAM

12-Oct-2020 09:45:00

BLOCK ANSC = 39 WR SUMMARY DIAGRAM FREQ 50.02 REGIONAL ACE SCH LOSS 730 ACT LOSS 818 REV NO 94

	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	2945	6718	5754	557	389	313	814	50
ACTUAL RLDC	2968	6730	5715	606	395	326	801	46
DEVIATION	23	12	-38	49	6	13	-13	-3
DEV. LIMIT ("L")	250	250	250	67	48	48	98	48
ACE	43	31	-25	52	7	13	-12	REGION
NUCLEAR								821
HYDRO	81	399	1078	40	0	0	0	1794
THERMAL	8384	9479	2426	2474	0	0	0	52474
THERMAL&GAS	11266	9900	2426	2474	0	0	0	56179
SOLAR	1096	578	842	31				3070
WIND	510	141	87					1167
TOTAL	13043	11382	4442	2743	0	0	0	63031
DEMAND NET	16011	18112	10157	3349	395	326	801	49468

VAE 71

SOLAR 523.14

WIND 428.97

SCED -362

INFIRM INJECTION

KHARGONE UNIT-2 0

LARA UNIT-2 700

CONGESTION MONITORING

	TTC	ATC	ACTUAL	SPS ALARM
ER-WR	25000	25000	-1354	CGPL
WR-SR	- 6950	- 6450	109	SASAN
WR-NR	- 17200	- 16700	-12427	TIRORA
TOTAL			-13672	WR-SR
NEW-SR	- 12600	- 11850	-1622	WR-NR

	ISGS	STOA	PX IMP	PX EXP	TOTAL	OTHER RLDC SCH	ACT.	Devt.
ER	112	-797	0	10	-899	-899	-1354	-456
SR	-374	350	0	0	-1811	1811	109	1920
NR	-3307	-1001	2613	0	-10624	10624	-12427	-1804
	-3562	-1448	2613	0	-13333		-13672	-339
BPDB					2678			
NER	7	0			0			
ER-NR					5705		3848	- 1857
ER-SR					1478		3010	1532

	DC	SCH	ACT
KAHALGAON	1200	1200	1126

IPP GENERATION

09.58-WR Demand Summary

BLOCK ANSC = 39	WR SUMMARY DIAGRAM		FREQ 50.07		REGIONAL ACE		
	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	2945	6718	5754	557	389	313	814	50
ACTUAL RLDC	3093	6583	5673	619	401	323	802	0
DEVIATION	130	-209	-14	48	12	10	29	-50
DEV. LIMIT ("L")	250	250	250	68	48	48	93	48
ACE	179	-164	32	28	12	12	31	REGION
NUCLEAR								827
HYDRO	81	346	1082	39	0	0	0	1745
THERMAL	8306	9543	2437	2454	0	0	0	52459
THERMAL&GAS	11148	9963	2437	2454	0	0	0	56126
SOLAR	1154	596	879	37				3211
WIND	525	127	99					1147
TOTAL	12995	11383	4504	2722	0	0	0	63056
DEMAND NET	16088	17965	10176	3341	401	323	802	49368

420023/2021/OPERATION AND MONITORING SECTION

10.02-WR Demand Summary

BLOCK ANSC =	39	WR SUMMARY DIAGRAM		FREQ 50.14		REGIONAL ACE	
	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	2945	6718	5754	557	389	313	814	50
ACTUAL RLDC	3088	6189	5645	672	404	325	800	44
DEVIATION	145	-447	35	91	9	6	6	-5
DEV. LIMIT ("L")	250	250	250	70	48	48	95	48
ACE	236	-347	91	111	12	8	10	REGION
NUCLEAR								822
HYDRO	81	351	1075	40	0	0	0	1742
THERMAL	8309	9521	2424	2434	0	0	0	52174
THERMAL&GAS	11141	9944	2424	2434	0	0	0	55849
SOLAR	1173	611	890	40				3261
WIND	526	134	106					1158
TOTAL	13011	11384	4504	2720	0	0	0	62832
DEMAND NET	16099	17573	10148	3392	404	325	800	49057

10.10-WR Demand Summary-IR Summary

BLOCK ANSC =	39	WR SUMMARY DIAGRAM		FREQ G 47.97		REGIONAL ACE		SCH LOSS 729	ACT LOSS 966	REV NO 94
	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	2945	6718	5754	557	389	313	814	50
ACTUAL RLDC	2844	4019	5667	651	406	325	801	135
DEVIATION	-99	-2617	58	70	12	6	6	86
DEV. LIMIT ("L")	250	250	250	70	48	48	95	48
ACE	59	-446	102	79	4	5	6	REGION
NUCLEAR								822
HYDRO	81	411	1062	39	0	0	0	1790
THERMAL	8120	9401	2406	2438	0	0	0	51215
THERMAL&GAS	10906	9823	2406	2438	0	0	0	54808
SOLAR	1220	636	925	38				3378
WIND	521	142	122					1174
TOTAL	12823	11365	4523	2710	0	0	0	61972
DEMAND NET	15667	15383	10191	3361	406	325	801	46540

VAE	
	71
SOLAR	559.49
WIND	388.54
SCED	-362

INFRM INJECTION	
KHARGONE UNIT-2	0
LARA UNIT-2	795

CONGESTION MONITORING				
	TTC	ATC	ACTUAL	SPS ALARM
ER-WR	25000	25000	-2010	CGPL
WR-SR	- 6950	- 6450	127	SASAN
WR-NR	- 17200	- 16700	-13527	TIRORA
TOTAL			-15410	WR-SR
NEW-SR	- 12600	- 11850	-1610	WR-NR

	ISGS	STOA	PX IMP	PX EXP	TOTAL	OTHER RLDC SCH	ACT.	Devt.
ER	112	-797	0	10	-899	-845	-2010	-1166
SR	-374	350	0	0	-1811	1618	127	1745
NR	-3307	-1001	2613	0	-10624	10901	-13527	-2625
	-3549	-1402	2747	0	-13364		-15410	-2046
BPDB					2678			
NER	7	0			0			
ER-NR					5761		3362 -	2399
ER-SR					1270		2780	1510

	DC	SCH	ACT
KAHALGAON	1200	1200	1122

11.00-WR Demand Summary

BLOCK ANSC =	43	WR SUMMARY DIAGRAM		FREQ 50.13		REGIONAL ACE	
	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	2843	6766	5570	578	401	320	807	50
ACTUAL RLDC	2833	4792	5481	652	405	327	802	-51
DEVIATION	-9	-2019	-97	92	0	7	-3	-100
DEV. LIMIT ("L")	250	250	250	67	48	48	97	48
ACE	80	-1945	-44	110	2	9	2	REGION
NUCLEAR								834
HYDRO	81	411	965	39	0	0	0	1691
THERMAL	8244	8865	2318	2462	0	0	0	50790
THERMAL&GAS	10935	9046	2318	2462	0	0	0	54026
SOLAR	1406	726	1028	46				3819
WIND	654	108	205					1345
TOTAL	13155	10652	4524	2723	0	0	0	61715
DEMAND NET	15988	15444	10005	3375	405	327	802	46568

12.00-WR Demand Summary

BLOCK ANSC =	47	WR SUMMARY DIAGRAM		FREQ 50.12		REGIONAL ACE	
	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	2839	6530	5473	598	405	320	805	50
ACTUAL RLDC	3067	5203	5147	503	398	327	798	-137
DEVIATION	290	-1363	-245	-85	-16	-3	-20	-187
DEV. LIMIT ("L")	250	250	250	71	48	48	98	48
ACE	368	-1297	-201	-69	-14	-2	-16	REGION
NUCLEAR								817
HYDRO	81	253	899	40	0	0	0	1468
THERMAL	8235	8146	2252	2451	0	0	0	49773
THERMAL&GAS	11104	8145	2252	2451	0	0	0	52952
SOLAR	1502	748	1058	45				3970
WIND	689	62	186					1388
TOTAL	13459	9587	4402	2751	0	0	0	60596
DEMAND NET	16526	14790	9548	3254	398	327	798	45776

13.00-WR Demand Summary

BLOCK ANSC =	51	WR SUMMARY DIAGRAM		FREQ 50.09	REGIONAL ACE		
	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	2670	5193	5340	574	418	313	792	50
ACTUAL RLDC	2787	5513	5652	376	396	312	783	-30
DEVIATION	117	374	241	-167	-16	0	-3	-80
DEV. LIMIT ("L")	250	250	250	65	48	48	94	48
ACE	208	427	279	-153	-14	1	0	REGION
NUCLEAR								825
HYDRO	81	1067	643	40	0	0	0	1977
THERMAL	8462	8424	2284	2484	0	0	0	50952
THERMAL&GAS	11364	8423	2284	2484	0	0	0	54174
SOLAR	1481	773	1032	33				3848
WIND	568	70	143					1060
TOTAL	13584	10708	4108	2750	0	0	0	61883
DEMAND NET	16371	16221	9760	3126	396	312	783	47210

14.00-WR Demand Summary

BLOCK ANSC =	55	WR SUMMARY DIAGRAM		FREQ 50.12	REGIONAL ACE		
	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	3290	5266	5704	471	395	310	783	50
ACTUAL RLDC	3119	5725	5785	366	371	322	792	-77
DEVIATION	-81	-282	91	-104	-27	8	7	-127
DEV. LIMIT ("L")	250	250	250	56	48	48	94	48
ACE	-42	-241	118	-97	-26	8	9	REGION
NUCLEAR								828
HYDRO	81	459	644	41	0	0	0	1373
THERMAL	8602	8920	2454	2481	0	0	0	51878
THERMAL&GAS	11534	9020	2454	2481	0	0	0	55332
SOLAR	1394	681	934	36				3370
WIND	474	65	86					803
TOTAL	13570	10587	4127	2710	0	0	0	61706
DEMAND NET	16689	16312	9912	3076	371	322	792	47669

15.00-WR Demand Summary

BLOCK ANSC =	59	WR SUMMARY DIAGRAM		FREQ	50.03	REGIONAL ACE	
	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	3547	6264	5882	334	370	322	802	50
ACTUAL RLDC	3804	6151	5966	444	374	331	797	86
DEVIATION	114	-183	80	94	3	-4	-10	36
DEV. LIMIT ("L")	250	250	250	42	48	48	97	48
ACE	-12	-248	177	123	-5	-5	-15	REGION
NUCLEAR								834
HYDRO	81	699	771	40	0	0	0	1738
THERMAL	8497	8820	2506	2456	0	0	0	52074
THERMAL&GAS	11504	8983	2506	2456	0	0	0	55663
SOLAR	1161	610	726	12				2830
WIND	471	71	66					700
TOTAL	13309	10728	4077	2689	0	0	0	61765
DEMAND NET	17112	16879	10043	3134	374	331	797	49029

16.00-WR Demand Summary

BLOCK ANSC =	63	WR SUMMARY DIAGRAM		FREQ	50.08	REGIONAL ACE	
	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	3610	6052	6100	425	365	316	788	50
ACTUAL RLDC	3740	6496	6179	567	356	324	810	-53
DEVIATION	86	526	98	129	-8	8	21	-102
DEV. LIMIT ("L")	250	250	250	53	48	48	95	48
ACE	112	539	124	139	-9	9	23	REGION
NUCLEAR								839
HYDRO	81	948	829	40	0	0	0	2044
THERMAL	8576	8911	2486	2468	0	0	0	52327
THERMAL&GAS	11663	9089	2486	2468	0	0	0	55997
SOLAR	839	352	454	7				1812
WIND	537	66	60					724
TOTAL	13217	10854	3835	2674	0	0	0	61417
DEMAND NET	16957	17350	10014	3241	356	324	810	49271

17.00-WR Demand Summary

BLOCK ANSC =	67	WR SUMMARY DIAGRAM		FREQ	50.03	REGIONAL ACE		
	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	3754	5709	6384	615	377	315	785	50
ACTUAL RLDC	3833	5518	6408	670	363	329	811	199
DEVIATION	15	-107	15	39	-16	13	22	149
DEV. LIMIT ("L")	250	250	250	76	48	48	95	48
ACE	20	-110	6	44	-18	15	24	REGION
NUCLEAR								843
HYDRO	81	1052	803	79	0	0	0	2161
THERMAL	8681	9453	2500	2491	0	0	0	53575
THERMAL&GAS	11804	9632	2500	2491	0	0	0	57276
SOLAR	442	236	151	2				856
WIND	470	89	52					673
TOTAL	12898	11444	3511	2727	0	0	0	61809
DEMAND NET	16731	16962	9919	3398	363	329	811	48983

18.00-WR Demand Summary

BLOCK ANSC =	71	WR SUMMARY DIAGRAM		FREQ	50.07	REGIONAL ACE		
	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	4105	5412	6328	810	379	294	785	50
ACTUAL RLDC	3813	5751	5980	948	392	326	816	85
DEVIATION	-51	387	-114	29	7	8	11	35
DEV. LIMIT ("L")	250	250	250	110	48	48	97	48
ACE	5	455	-95	40	7	9	13	REGION
NUCLEAR								842
HYDRO	81	855	632	80	0	0	0	1793
THERMAL	8751	9941	2499	2494	0	0	0	55800
THERMAL&GAS	12143	10120	2499	2494	0	0	0	59789
SOLAR	89	155	0	0				243
WIND	418	87	99					672
TOTAL	12839	11682	3240	2671	0	0	0	63338
DEMAND NET	16652	17433	9220	3618	392	326	816	48813

19.00-WR Demand Summary

BLOCK ANSC =	75	WR SUMMARY DIAGRAM		FREQ	50.07	REGIONAL ACE	
	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	3610	5698	6281	1127	426	325	799	50
ACTUAL RLDC	3893	5548	6018	1000	430	322	817	-55
DEVIATION	384	-145	-273	-76	-18	-3	23	-105
DEV. LIMIT ("L")	250	250	250	129	48	48	95	48
ACE	445	-89	-257	-71	-16	-2	25	REGION
NUCLEAR								841
HYDRO	81	1918	720	80	0	0	0	2945
THERMAL	8768	9805	2518	2378	0	0	0	55983
THERMAL&GAS	12225	9985	2518	2378	0	0	0	60026
SOLAR	5	150	0	0				153
WIND	322	140	210					697
TOTAL	12731	12666	3460	2567	0	0	0	64662
DEMAND NET	16624	18214	9478	3567	430	322	817	49667

20.00-WR Demand Summary

BLOCK ANSC =	79	WR SUMMARY DIAGRAM		FREQ	50.05	REGIONAL ACE	
	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	2835	5662	5783	965	465	318	794	50
ACTUAL RLDC	2783	5403	5546	914	416	298	784	-43
DEVIATION	165	-253	-124	-30	-36	-1	-2	-92
DEV. LIMIT ("L")	250	250	250	113	48	48	94	48
ACE	197	-223	-105	-23	-35	0	0	REGION
NUCLEAR								846
HYDRO	81	753	618	79	0	0	0	1677
THERMAL	8853	10067	2506	2425	0	0	0	55907
THERMAL&GAS	12321	10246	2506	2425	0	0	0	59946
SOLAR	4	149	0	0				152
WIND	312	275	376					962
TOTAL	12818	11903	3511	2603	0	0	0	63583
DEMAND NET	15602	17307	9057	3518	416	298	784	47209

21.00-WR Demand Summary

BLOCK ANSC =	83	WR SUMMARY DIAGRAM		FREQ	50.11	REGIONAL ACE		
	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	2887	5698	5543	846	433	306	824	50
ACTUAL RLDC	2916	5411	5655	859	388	302	787	-26
DEVIATION	15	-285	116	33	-44	-4	-38	-76
DEV. LIMIT ("L")	250	250	250	99	48	48	99	48
ACE	78	-200	153	38	-43	-3	-35	REGION
NUCLEAR								851
HYDRO	81	650	421	80	0	0	0	1379
THERMAL	8843	9913	2331	2496	0	0	0	55238
THERMAL&GAS	11970	10094	2331	2496	0	0	0	58914
SOLAR	4	62	0	0				65
WIND	338	282	426					1039
TOTAL	12487	11560	3189	2679	0	0	0	62248
DEMAND NET	15403	16971	8843	3539	388	302	787	46478

22.00-WR Demand Summary

BLOCK ANSC =	87	WR SUMMARY DIAGRAM		FREQ	50.12	REGIONAL ACE		
	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	3055	5197	5549	798	405	307	828	50
ACTUAL RLDC	2970	5173	5676	842	374	302	799	-18
DEVIATION	-108	104	111	44	-41	-4	-29	-68
DEV. LIMIT ("L")	250	250	250	96	48	48	99	48
ACE	-47	196	156	60	-39	-3	-26	REGION
NUCLEAR								848
HYDRO	81	635	483	40	0	0	0	1386
THERMAL	8761	9889	2313	2479	0	0	0	53872
THERMAL&GAS	11681	10068	2313	2479	0	0	0	57334
SOLAR	4	62	0	0				65
WIND	364	222	423					1003
TOTAL	12226	11469	3231	2618	0	0	0	60635
DEMAND NET	15196	16642	8907	3460	374	302	799	45934

23.00-WR Demand Summary

BLOCK ANSC =	91	WR SUMMARY DIAGRAM		FREQ 50.00		REGIONAL ACE	
	GUJARAT	MAHARASHTRA	MADHYA PRADESH	CHHATTIS-GARH	GOA	DD	DNH	AMNSIL
SCHEDULE	3235	5339	6175	833	376	300	773	50
ACTUAL RLDC	3495	5106	6471	772	348	302	785	-91
DEVIATION	254	-264	284	-49	-25	2	-5	-140
DEV. LIMIT ("L")	250	250	250	99	48	48	95	48
ACE	254	-245	285	-51	-25	2	-5	REGION
NUCLEAR								847
HYDRO	81	517	685	40	0	0	0	1469
THERMAL	8749	9990	2461	2514	0	0	0	54097
THERMAL&GAS	11375	10169	2461	2514	0	0	0	57278
SOLAR	4	62	0	0				65
WIND	447	205	402					1079
TOTAL	12003	11429	3555	2677	0	0	0	60738
DEMAND NET	15498	16534	10026	3449	348	302	785	47124

09.45 hrs_MSEB

MSEB SYSYTEM OVERVIEW

13-Oct-2020 09:45:00

FREQUENCY 50.02 | GENERATION 11382 | DEMAND CATERED 18112 | MUMBAI DEMAND 2538

KALWA SYSTEM

HYDRO	EFF CAPACITY	MW	MVAR
KOYNA I & II POPHALE			
UNIT 1	70	5	11
UNIT 2	70	5	11
UNIT 3	70	4	14
UNIT 4	70	5	15
UNIT 5	80	4	16
UNIT 6	80	7	16
UNIT 7	80	7	R 0
UNIT 8	80	5	14
TOTAL :	600	42	
KOYNA - III PEDAMBE			
UNIT 1	80	79	-9
UNIT 2	80	0	0
UNIT 3	80	0	0
UNIT 4	80	0	0
TOTAL :	320	79	
KOYNA - IV			
UNIT 1	250	0	-1
UNIT 2	250	0	-1
UNIT 3	250	0	-1
UNIT 4	250	0	-1
TOTAL :	1000	-1	
KOYNA DPH	36	0	
VAITARNA	60	0	
TILLARY	66	0	
BHATGAR	20		
ELDARY	22.5		
SMALL HYD	350	0	
GHATGHAR	250	0	
GHATGR PSP	250		
BHIRA TR	80		
MAH IPP GEN		4928	

THERMAL /GAS	EFF CAPACITY	MW	MVAR
URAN			
UNIT 5	108	88	-6
UNIT 6	108	61	7
UNIT 7	108	0	0
UNIT 8	108	0	0
WHR-I(A0)	120	89	G
WHR - II(B0)	120	0	0
TOTAL :	672	239	
IB AMRAWATI			
UNIT 1	270	0	0
UNIT 2	270	0	0
UNIT 3	270	0	0
UNIT 4	270	0	0
UNIT 5	270	0	0
TOTAL :	1350	0	0
DHARIWAL			
UNIT 1	300	194	-26
JAIGAD			
UNIT 1	300	277	S 19
UNIT 2	300	196	S -1
UNIT 3	300	195	S -11
UNIT 4	300	204	S 0
TOTAL :	1200	872	
WPCL (WARDHA)			
UNIT 1	135	-3	0
UNIT 2	135	86	-4
UNIT 3	135	93	-8
UNIT 4	135	85	-6
TOTAL :	540	262	-17
APML TIRORA			
UNIT 1	660	542	- 66
UNIT 2	660	298	- 22
UNIT 3	660	574	- 80
UNIT 4	660	524	11
UNIT 5	660	571	-9
TOTAL :	3300	2518	-166
IEPL			
UNIT 1	270	0	S 0
UNIT 2	270	0	G
TOTAL :	540	0	S 0

AMBAZARI ALDC SYSTEM TATA SYSTEM

THERMAL /GAS	EFF CAPACITY	MW	MVAR
BHUSAWAL			
UNIT 3	210	0	0
UNIT 4	500	336	-19
UNIT 5	500	342	-46
TOTAL :	1210	677	
KORADI			
UNIT 6	210	0	0
UNIT 7	210	0	0
UNIT 8	660	0	S -47
UNIT 9	660	0	S -47
UNIT 10	660	360	21
TOTAL :	2400	360	
PARLI			
UNIT 6	250	191	R 0
UNIT 7	250	172	S 0
UNIT 8	250	220	S 0
TOTAL :	750	583	
PARAS			
UNIT 3	250	215	
UNIT 4	250	239	
TOTAL :	500	452	
KHAPERKHEDA			
UNIT 1	210	143	11
UNIT 2	210	179	8
UNIT 3	210	161	5
UNIT 4	210	167	-15
UNIT 5	500	386	-89
TOTAL :	1340	1037	
NASIK			
UNIT 3	210	0	0
UNIT 4	210	0	0
UNIT 5	210	0	0
TOTAL :	630	0	

THERMAL /GAS	EFF CAPACITY	MW	MVAR
CHANDRAPUR			
UNIT 3	210	0	0
UNIT 4	210	125	-22
UNIT 5	500	370	-41
UNIT 6	500	0	0
UNIT 7	500	0	0
UNIT 8	500	376	- 109
UNIT 9	500	339	- 44
TOTAL :	2920	1217	

TATA SYSTEM

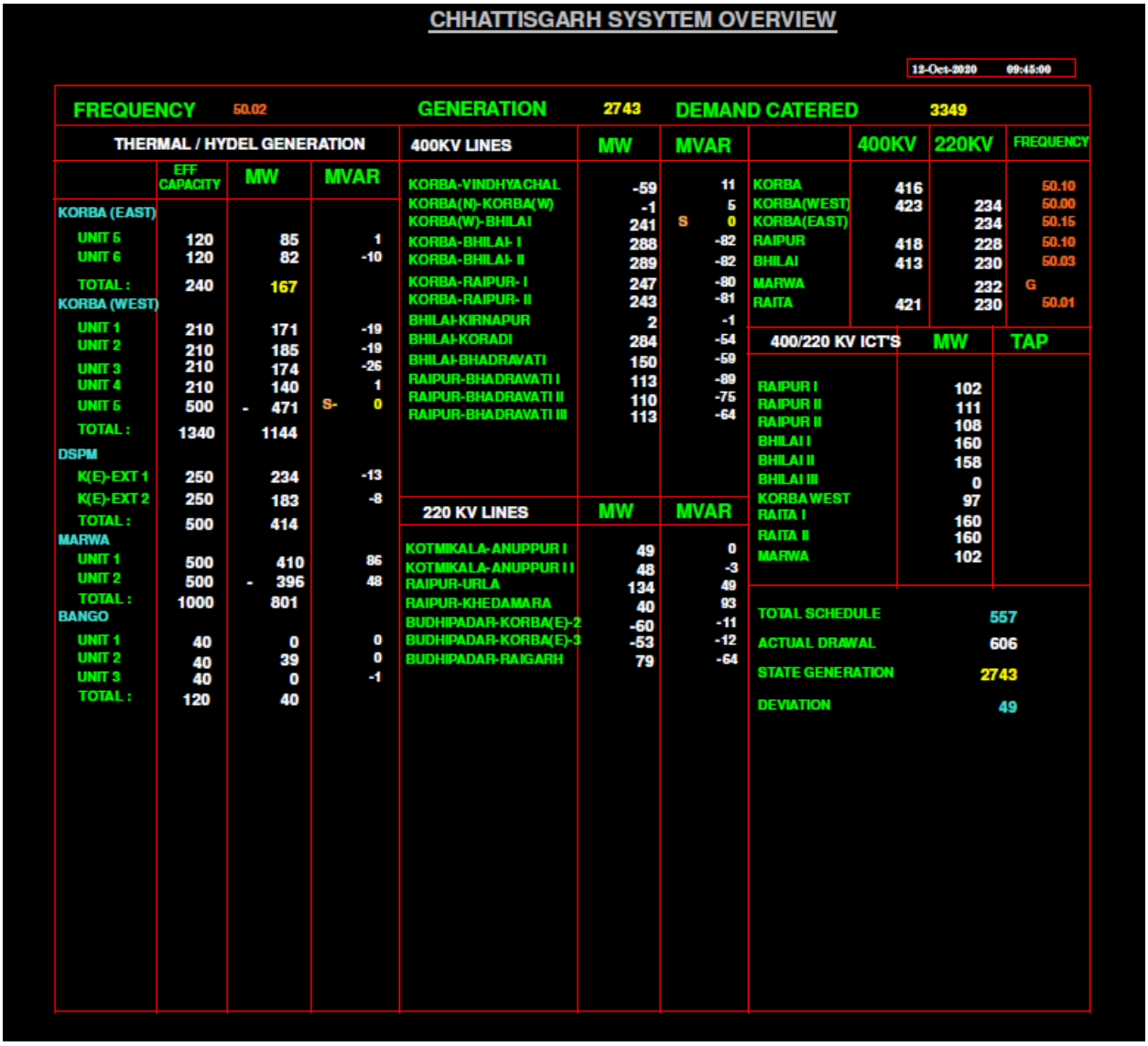
TATA			
UNIT 4	150	0	
UNIT 5	500	464	
UNIT 7A	120	116	
UNIT 7B	60	66	
UNIT 8	250	0	
TOTAL :	1080	645	

HYDRO SYSTEM

TATA BHIRA + BHIRA PSS	150	111	
	150	163	
TATA BHIVPURI	75	0	
TATA KHOPOLI	72	5	
TATA HYDRO TOT	447		
DAHANU			
UNIT 1	250	251	G
UNIT 2	250	246	G
TOTAL :	500	497	
VIPL			
UNIT 1	300	0	G
UNIT 2	300	0	G
TOTAL :	600	0	

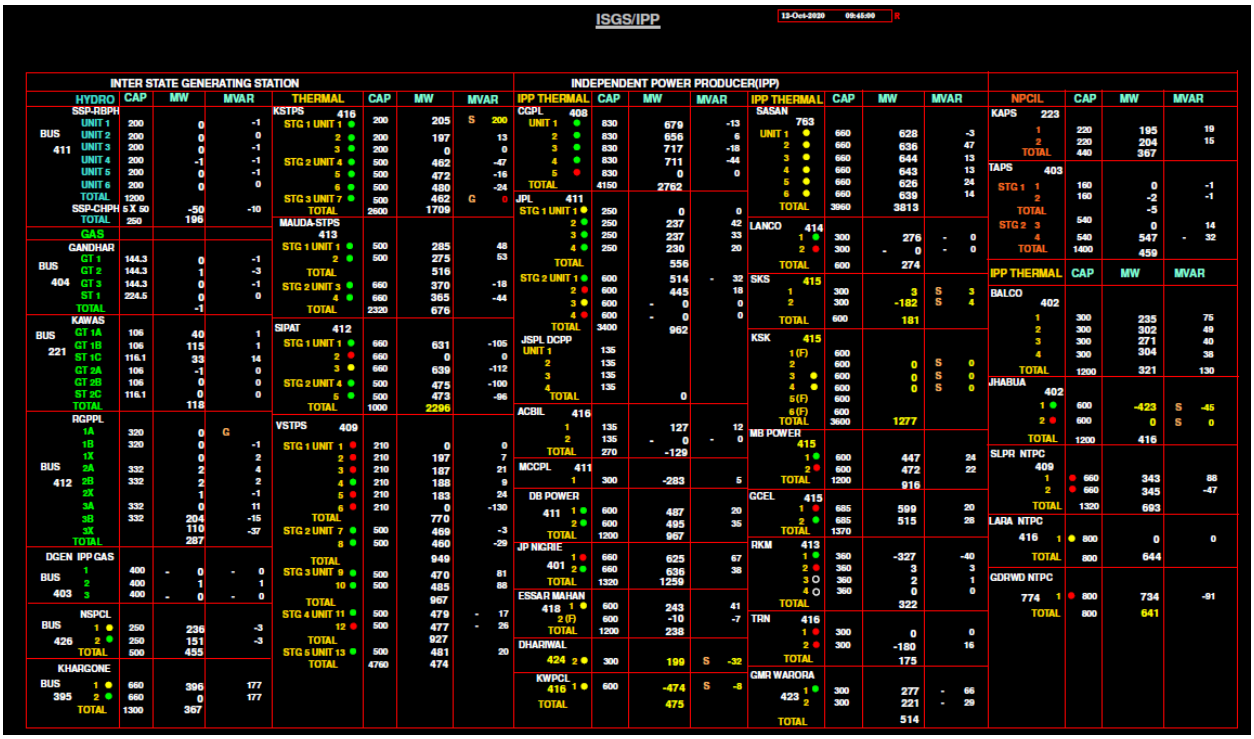
420023/2021/OPERATION AND MONITORING SECTION

09.45 hrs_Chhattisgarh



420023/2021/OPERATION AND MONITORING SECTION

09.45 hrs_IPP



ISGS/IPP

13-Oct-2020 09:45:00

INTER STATE GENERATING STATION

HYDRO	CAP	MW	MVAR
SSP-RBPH			
UNIT 1	200	0	-1
BUS UNIT 2	200	0	0
411 UNIT 3	200	0	-1
UNIT 4	200	-1	-1
UNIT 5	200	0	-1
UNIT 6	200	0	0
TOTAL	1200		
SSP-CHPH	5 X 50	-50	-10
TOTAL	250	196	

GAS			
GANDHAR			
BUS GT 1	144.3	0	-1
GT 2	144.3	1	-3
404 GT 3	144.3	0	-1
ST 1	224.5	0	0
TOTAL		-1	
KAWAS			
BUS GT 1A	106	40	1
221 GT 1B	106	115	1
ST 1C	116.1	33	14
GT 2A	106	-1	0
GT 2B	106	0	0
ST 2C	116.1	0	0
TOTAL		118	
RGPPL			
1A	320	0	G
1B	320	0	-1
1X		0	2
BUS 2A	332	2	4
412 2B	332	2	2
2X		1	-1
3A	332	0	11
3B	332	204	-15
3X		110	-37
TOTAL		287	
DGEN IPP GAS			
BUS 1	400	- 0	- 0
2	400	1	1
403 3	400	- 0	- 0
NSPCL			
BUS 1	250	236	-3
426 2	250	151	-3
TOTAL	500	455	
KHARGONE			
BUS 1	660	396	177
395 2	660	0	177
TOTAL	1300	367	

THERMAL	CAP	MW	MVAR
KSTPS 416			
STG 1 UNIT 1	200	205	S 200
2	200	197	13
3	200	0	0
STG 2 UNIT 4	500	462	-47
5	500	472	-16
6	500	480	-24
STG 3 UNIT 7	500	462	G 0
TOTAL	2600	1709	
MAUDA-STPS 413			
STG 1 UNIT 1	500	285	48
2	500	275	53
TOTAL		516	
STG 2 UNIT 3	660	370	-18
4	660	365	-44
TOTAL	2320	676	
SIPAT 412			
STG 1 UNIT 1	660	631	-105
2	660	0	0
3	660	639	-112
STG 2 UNIT 4	500	475	-100
5	500	473	-96
TOTAL	1000	2296	
VSTPS 409			
STG 1 UNIT 1	210	0	0
2	210	197	7
3	210	187	21
4	210	188	9
5	210	183	24
6	210	0	-130
TOTAL		770	
STG 2 UNIT 7	500	469	-3
8	500	460	-29
TOTAL		949	
STG 3 UNIT 9	500	470	81
10	500	485	88
TOTAL		967	
STG 4 UNIT 11	500	479	- 17
12	500	477	- 26
TOTAL		927	
STG 5 UNIT 13	500	481	20
TOTAL	4760	474	

INDEPENDENT POWER PRODUCER(IPP)

IPP THERMAL	CAP	MW	MVAR
CGPL 408			
UNIT 1	830	679	-13
2	830	656	6
3	830	717	-18
4	830	711	-44
5	830	0	0
TOTAL	4150	2762	
JPL 411			
STG 1 UNIT 1	250	0	0
2	250	237	42
3	250	237	33
4	250	230	20
TOTAL		556	
STG 2 UNIT 1	600	514	- 32
2	600	445	18
3	600	- 0	0
4	600	- 0	0
TOTAL	3400	962	
JSPL DCPP			
UNIT 1	135		
2	135		
3	135		
4	135		
TOTAL		0	
ACBIL 416			
1	135	127	- 12
2	135	- 0	- 0
TOTAL	270	-129	
MCCPL 411			
1	300	-283	5
DB POWER			
411 1	600	487	20
2	600	495	35
TOTAL	1200	967	
JP NIGRIE			
1	660	625	67
401 2	660	636	38
TOTAL	1320	1259	
ESSAR MAHAN			
418 1	600	243	41
2 (F)	600	-10	-7
TOTAL	1200	238	
DHARIWAL			
424 2	300	199	S -32
KWPCL			
416 1	600	-474	S -8
TOTAL		475	

IPP THERMAL	CAP	MW	MVAR
SASAN 763			
UNIT 1	660	628	-3
2	660	636	47
3	660	644	13
4	660	643	13
5	660	626	24
6	660	639	14
TOTAL	3960	3813	
LANCO 414			
1	300	276	- 0
2	300	- 0	- 0
TOTAL	600	274	
SKS 415			
1	300	3	S 3
2	300	-182	S 4
TOTAL	600	181	
KSK 415			
1 (F)	600		
2	600	0	S 0
3	600	0	S 0
4	600	0	S 0
5 (F)	600		
6 (F)	600		
TOTAL	3600	1277	
MB POWER 415			
1	600	447	24
2	600	472	22
TOTAL	1200	916	
GCEL 415			
1	685	599	20
2	685	515	28
TOTAL	1370		
RKM 413			
1	360	-327	-40
2	360	3	3
3	360	2	1
4	360	0	0
TOTAL		322	
TRN 416			
1	300	0	0
2	300	-180	16
TOTAL		175	
GMR WARORA			
423 1	300	277	- 66
2	300	221	- 29
TOTAL		514	

NPCIL	CAP	MW	MVAR
KAPS 223			
1	220	195	19
2	220	204	15
TOTAL	440	367	
TAPS 403			
STG 1 1	160	0	-1
2	160	-2	-1
TOTAL		-5	
STG 2 3	540	0	14
4	540	547	- 32
TOTAL	1400	459	

IPP THERMAL	CAP	MW	MVAR
BALCO 402			
1	300	235	75
2	300	302	49
3	300	271	40
4	300	304	38
TOTAL	1200	321	130
JHABUA 402			
1	600	-423	S -45
2	600	0	S 0
TOTAL	1200	416	
SLPR NTPC 409			
1	660	343	88
2	660	345	-47
TOTAL	1320	693	
LARA NTPC 416 1	800	0	0
TOTAL	800	644	
GDRWD NTPC 774 1	800	734	-91
TOTAL	800	641	

09.45 hrs_MP

MPSEB SYSTEM OVERVIEW

12-Oct-2020 09:45:00 R

FREQUENCY	50.02	GENERATION	3357	DEMAND CATERED	10157

THERMAL GENERATION

S/S	EFF CAPACITY	MW	MVAR
SATPURA			
UNIT 6	200	0	0
UNIT 7	210	0	0
UNIT 8	210	-3	-2
UNIT 9	210	-2	-4
UNIT 10	250	255	46
UNIT 11	250	252	32
TOTAL :	1330	500	
SGTPS			
UNIT 1	210	167	-27
UNIT 2	210	162	-25
UNIT 3	210	0	0
UNIT 4	210	188	3
UNIT 5	500	492	-70
TOTAL :	1340	1045	
AMARKANTAK			
UNIT 5	210	212	21
TOTAL :	210	213	
SINGHAJI			
UNIT 1	600	486	29
UNIT 2	600	0	0
UNIT 3	660	0	0
UNIT 4	660	0	0
TOTAL :	2520	490	29
JP BINA			
UNIT 1	250	145	24
UNIT 2	250	148	35
TOTAL :	500	148	
BLA THERMAL			
UNIT 1	45	20	6
UNIT 2	45	20	6
TOTAL :	90		

HYDRO GENERATION

S/S	EFF CAPACITY	MW	MVAR
I'SAGAR			
UNIT 1	125	0	0
UNIT 2	125	0	0
UNIT 3	125	0	0
UNIT 4	125	0	0
UNIT 5	125	119	18
UNIT 6	125	122	19
UNIT 7	125	123	12
UNIT 8	125	0	0
TOTAL :	1000	368	
BARGI			
UNIT 1	45	0	S -1
UNIT 2	45	45	S -6
TOTAL :	90	45	S -6
PENCH			
UNIT 1	80	77	-13
UNIT 2	80	79	-14
TOTAL :	160	156	
TONS			
UNIT 1	105	98	-7
UNIT 2	105	99	3
UNIT 3	105	0	0
TOTAL :	315	198	
SILPARA (BANS)			
UNIT 1	15	-9	-2
UNIT 2	15	-10	1
TOTAL :	30	-19	
DEOLONE			
UNIT 1	20	0	S 0
UNIT 2	20	0	S 0
UNIT 3	20	0	S 0
TOTAL :	60		

THERMAL /GAS	EFF CAPACITY	MW	MVAR
ZINNA (BANS 4)			
UNIT 1	10	0	S 0
UNIT 2	10	0	S 0
TOTAL :			
RAJGHAT			
UNIT 1	15	0	0
UNIT 2	15	0	0
UNIT 3	15	0	0
TOTAL :	45	0	0
G'SAGAR			
UNIT 1	23	0	S 0
UNIT 2	23	0	S 0
UNIT 3	23	0	S 0
UNIT 4	23	0	S 0
UNIT 5	23	0	S 0
TOTAL :	115	1	
OMKAR'R			
UNIT 1	65	0	0
UNIT 2	65	0	0
UNIT 3	65	0	0
UNIT 4	65	0	0
UNIT 5	65	65	-2
UNIT 6	65	65	-2
UNIT 7	65	0	0
UNIT 8	65	0	0
TOTAL :	520	130	
MADIKHEDA			
UNIT 1	20	20	-2
UNIT 2	20	20	0
UNIT 3	20	20	0

09.45 hrs_Gujarat

GUJRAT SYSYTEM OVERVIEW

12-Oct-2020 09:45:00

FREQUENCY 50.02 **GENERATION** 13043 **DEMAND CATERED** 16011

THERMAL / GAS GENERATION

S/S	EFF CAPACITY	MW	MVAR
ALTPS (AKRIMOTA)			
UNIT 1	125	29	-3
UNIT 2	125	28	-7
TOTAL :	250	57	
DGBP (DHUVRAN)			
GT 1	68	5	13
ST	39	16	S 0
GT 2	72	17	P 13
ST	40	17	8
GT 3	246	- 0	11
ST	130		
TOTAL :	219	438	
UTPS			
UNIT 3	200	121	25
UNIT 4	200	181	0
UNIT 5	210	148	28
UNIT 6	500	368	55
TOTAL :	1110	813	
WTPS			
UNIT 1	210	3	0
UNIT 2	210	0	0
UNIT 3	210	163	44
UNIT 4	210	0	0
UNIT 5	210	0	0
UNIT 6	210	0	0
UNIT 7	210	0	0
UNIT 8	800	727	174
TOTAL :	1470	881	
GTPS (GANDHINAGAR)			0
UNIT 3	210	0	0
UNIT 4	210	0	35
UNIT 5	210	170	
TOTAL :	630	169	
BECL (BHAVNAGAR)			1
UNIT 1	250	0	10
UNIT 2 (F)	250	129	
TOTAL :	500	128	

S/S	CAP	MW	MVAR
STPS (SIKKA)			
UNIT 3	250	177	-19
UNIT 4	250	175	-9
TOTAL :	500	355	
KLTPS (PANANDRO)			
UNIT 1	70	0	0
UNIT 2	70	0	0
UNIT 3	75	71	2
UNIT 4	75	0	S 0
TOTAL :	290	72	
SLPP (SURAT LIGNITE)			
UNIT 1	125	103	-150
UNIT 2	125	109	19
UNIT 3	125	0	-1
UNIT 4	125	123	31
TOTAL :	500	335	
GSEC			
UNIT 1	52	29	8
UNIT 2	52	29	12
UNIT 3	52	42	22
GSEC STG II			
UNIT 1	222	176	18
STG	129	112	14
TOTAL :	507	387	
UGPP STG I			
UNIT 1	30	0	S 0
UNIT 2	30	0	S 0
UNIT 3	30	0	0
UNIT 4	45	0	S 0
TOTAL :	135	0	0
UTRAN STG-II			
GT	228	221	S 14
ST	147	136	S 5
TOTAL :	375	-333	
OPGS			
UNIT 1	150	111	-13
UNIT 2	150	78	-14
TOTAL :	300	-190	

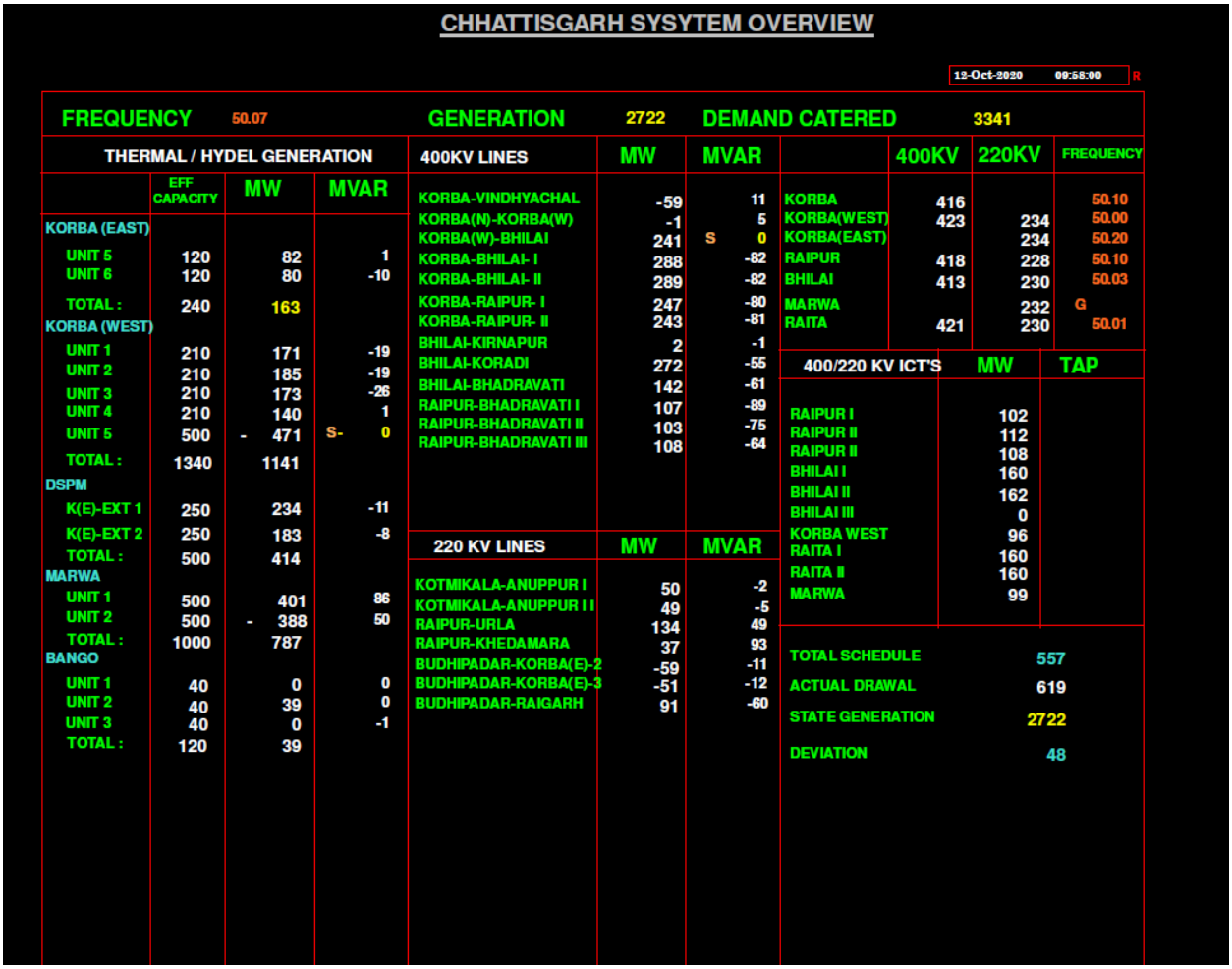
IPPS GENERATION

S/S	EFF CAPACITY	MW	MVAR
AECO			
UNIT C	60	0	0
UNIT D	120	111	29
UNIT E	121	0	S 0
UNIT F	121	0	S 0
GT1	32.5	0	S 0
GT2	32.5	0	S 0
STG	35	0	S 0
TOTAL :	522	330	
GIPCL			
UNIT 1	32	0	0
UNIT 2	32	27	11
UNIT 3	32	25	7
UNIT 4	49	29	11
STG 1 TOTAL :	145	81	
UNIT 5	111	0	0
UNIT 6	54	0	0
STG 2 TOTAL :	165	0	
GPEC (CLPI)			
UNIT 1	138	0	-3
UNIT 2	138	0	-3
UNIT 3	138	0	-3
ST	241	0	-1
TOTAL :	655		
GPPC (PIPAVAV)			
GT 1	351	- 215	29
ST		- 146	11
GT 2	351	- 119	2
ST		- 96	- 6
TOTAL :	702	-535	
ESSAR IPP			
GT 1	110	0	S 0
GT 2	110	0	S 0
GT 3	110	0	S 0
STG	185	0	S 0
TOTAL :	440	0	

HYDRO GENERATION

S/S	CAP	MW	MVAR
KHPS (KADANA)			
UNIT 1	60	0	0
UNIT 2	60	0	0
UNIT 3	60	0	0
UNIT 4	60	0	0
TOTAL :	240	0	
UHPS			
UNIT 1	75	0	0
UNIT 2	75	0	0
UNIT 3	75	81	1
UNIT 4	75	0	0
TOTAL :	300	81	
APL MUNDRA			
UNIT 1	330	305	35
UNIT 2	330	311	11
UNIT 3	330	307	29
UNIT 4	330	316	25
UNIT 5	660	600	71
UNIT 6	660	603	66
UNIT 7	660	565	-94
UNIT 8	660	566	-67
UNIT 9	660	616	-46
TOTAL :	4620	4472	
SUGEN			
UNIT 1	382.5	329	118
UNIT 2	382.5	218	120
UNIT 3	382.5	218	38
TOTAL :	1147.5	770	
ESSAR VADINAR (EPGL)			
UNIT 1	600	508	20
UNIT 2	600	0	3
TOTAL :	1200	515	
UNOSUGEN			
UNIT 1	382.5		-11

09.58 hrs_CHHATTISGARH



CHHATTISGARH SYSYTEM OVERVIEW

12-Oct-2020 09:58:00 R

FREQUENCY 50.07 **GENERATION** 2722 **DEMAND CATERED** 3341

THERMAL / HYDEL GENERATION

	EFF CAPACITY	MW	MVAR
KORBA (EAST)			
UNIT 5	120	82	1
UNIT 6	120	80	-10
TOTAL :	240	163	
KORBA (WEST)			
UNIT 1	210	171	-19
UNIT 2	210	185	-19
UNIT 3	210	173	-26
UNIT 4	210	140	1
UNIT 5	500	- 471	S- 0
TOTAL :	1340	1141	
DSPM			
K(E)-EXT 1	250	234	-11
K(E)-EXT 2	250	183	-8
TOTAL :	500	414	
MARWA			
UNIT 1	500	401	86
UNIT 2	500	- 388	50
TOTAL :	1000	787	
BANGO			
UNIT 1	40	0	0
UNIT 2	40	39	0
UNIT 3	40	0	-1
TOTAL :	120	39	

400KV LINES

	MW	MVAR
KORBA-VINDHYACHAL	-59	11
KORBA(N)-KORBA(W)	-1	5
KORBA(W)-BHILAI	241	S 0
KORBA-BHILAI- I	288	-82
KORBA-BHILAI- II	289	-82
KORBA-RAIPUR- I	247	-80
KORBA-RAIPUR- II	243	-81
BHILAI-KIRNAPUR	2	-1
BHILAI-KORADI	272	-55
BHILAI-BHADRAVATI	142	-61
RAIPUR-BHADRAVATI I	107	-89
RAIPUR-BHADRAVATI II	103	-75
RAIPUR-BHADRAVATI III	108	-64

220 KV LINES

	MW	MVAR
KOTMIKALA-ANUPPUR I	50	-2
KOTMIKALA-ANUPPUR I I	49	-5
RAIPUR-URLA	134	49
RAIPUR-KHEDAMARA	37	93
BUDHIPADAR-KORBA(E)-2	-59	-11
BUDHIPADAR-KORBA(E)-3	-51	-12
BUDHIPADAR-RAIGARH	91	-60

	400KV	220KV	FREQUENCY
KORBA	416		50.10
KORBA(WEST)	423	234	50.00
KORBA(EAST)		234	50.20
RAIPUR	418	228	50.10
BHILAI	413	230	50.03
MARWA		232	G
RAITA	421	230	50.01

400/220 KV ICT'S

	MW	TAP
RAIPUR I	102	
RAIPUR II	112	
RAIPUR II	108	
BHILAI I	160	
BHILAI II	162	
BHILAI III	0	
KORBA WEST	96	
RAITA I	160	
RAITA II	160	
MARWA	99	

TOTAL SCHEDULE	557
ACTUAL DRAWAL	619
STATE GENERATION	2722
DEVIATION	48

09.58 hrs_Gujarat

GUJRAT SYSYTEM OVERVIEW

12-Oct-2020 09:58:00

FREQUENCY 50.07 | GENERATION 12995 | DEMAND CATERED 16088

THERMAL / GAS GENERATION

S/S	EFF CAPACITY	MW	MVAR
ALTPS (AKRIMOTA)			
UNIT 1	125	29	-3
UNIT 2	125	28	-7
TOTAL :	250	57	
DGBP (DHUVRAN)			
GT 1	68	5	12
ST	39	16	S 0
GT 2	72	17	P 13
ST	40	17	8
GT 3	246	- 0	15
ST	130		
TOTAL :	219	422	
UTPS			
UNIT 3	200	132	23
UNIT 4	200	177	0
UNIT 5	210	146	29
UNIT 6	500	368	54
TOTAL :	1110	813	
WTPS			
UNIT 1	210	3	0
UNIT 2	210	0	0
UNIT 3	210	163	36
UNIT 4	210	0	0
UNIT 5	210	0	0
UNIT 6	210	0	0
UNIT 7	210	0	0
UNIT 8	800	681	167
TOTAL :	1470	836	
GTPS (GANDHINAGAR)			0
UNIT 3	210	0	0
UNIT 4	210	0	34
UNIT 5	210	171	
TOTAL :	630	170	
BECL (BHAVNAGAR)			1
UNIT 1	250	0	10
UNIT 2 (F)	250	97	
TOTAL :	500	96	

S/S	CAP	MW	MVAR
STPS (SIKKA)			
UNIT 3	250	181	-21
UNIT 4	250	178	-11
TOTAL :	500	358	
KLTPS (PANANDRO)			
UNIT 1	70	0	0
UNIT 2	70	0	0
UNIT 3	75	71	2
UNIT 4	75	0	S 0
TOTAL :	290	71	
SLPP (SURAT LIGNITE)			
UNIT 1	125	101	-150
UNIT 2	125	109	19
UNIT 3	125	0	-1
UNIT 4	125	121	31
TOTAL :	500	328	
GSEC			
UNIT 1	52	29	8
UNIT 2	52	29	12
UNIT 3	52	41	23
GSEC STG II			
UNIT 1	222	176	18
STG	129	112	15
TOTAL :	507	384	
UGPP STG I			
UNIT 1	30	0	S 0
UNIT 2	30	0	S 0
UNIT 3	30	0	0
UNIT 4	45	0	S 0
TOTAL :	135	0	0
UTRAN STG-II			
GT	228	221	S 14
ST	147	136	S 5
TOTAL :	375	-333	
OPGS			
UNIT 1	150	108	-14
UNIT 2	150	78	-14
TOTAL :	300	-185	

IPP'S GENERATION

S/S	EFF CAPACITY	MW	MVAR
AECO			
UNIT C	60	0	0
UNIT D	120	111	29
UNIT E	121	0	S 0
UNIT F	121	0	S 0
GT1	32.5	0	S 0
GT2	32.5	0	S 0
STG	35	0	S 0
TOTAL :	522	338	
GIPCL			
UNIT 1	32	0	0
UNIT 2	32	27	11
UNIT 3	32	24	7
UNIT 4	49	29	10
STG 1 TOTAL :	145	81	
UNIT 5	111	0	0
UNIT 6	54	0	0
STG 2 TOTAL :	165	0	
GPEC (CLPI)			
UNIT 1	138	0	-3
UNIT 2	138	0	-3
UNIT 3	138	0	-3
ST	241	0	-1
TOTAL :	655		
GPPC (PIPAVAV)			
GT 1	351	- 215	28
ST		- 147	12
GT 2	351	- 119	2
ST		- 96	- 5
TOTAL :	702	-536	
ESSAR IPP			
GT 1	110	0	S 0
GT 2	110	0	S 0
GT 3	110	0	S 0
STG	185	0	S 0
TOTAL :	440	0	

HYDRO GENERATION

S/S	CAP	MW	MVAR
KHPS (KADANA)			
UNIT 1	60	0	0
UNIT 2	60	0	0
UNIT 3	60	0	0
UNIT 4	60	0	0
TOTAL :	240	0	
UHPS			
UNIT 1	75	0	0
UNIT 2	75	0	0
UNIT 3	75	81	1
UNIT 4	75	0	0
TOTAL :	300	81	
APL MUNDRA			
UNIT 1	330	305	35
UNIT 2	330	311	11
UNIT 3	330	307	29
UNIT 4	330	316	25
UNIT 5	660	600	73
UNIT 6	660	590	64
UNIT 7	660	565	-96
UNIT 8	660	566	-66
UNIT 9	660	616	-47
TOTAL :	4620	4479	
SUGEN			
UNIT 1	382.5	325	118
UNIT 2	382.5	215	120
UNIT 3	382.5	213	39
TOTAL :	1147.5	747	
ESSAR VADINAR (EPGL)			
UNIT 1	600	508	21
UNIT 2	600	0	4
TOTAL :	1200	508	
UNOSUGEN			
UNIT 1	382.5		-11

09.58 hrs_MSEB

MSEB SYSYTEM OVERVIEW

12-Oct-2020 09:58:00 R

FREQUENCY 50.07 **GENERATION** 11383 **DEMAND CATERED** 17965 **MUMBAI DEMAND** 2543

KALWA SYSTEM

HYDRO	EFF CAPACITY	MW	MVAR
KOYNA I & II POPHALE			
UNIT 1	70	5	8
UNIT 2	70	5	8
UNIT 3	70	4	11
UNIT 4	70	5	12
UNIT 5	80	5	12
UNIT 6	80	8	13
UNIT 7	80	7 R	0
UNIT 8	80	5	11
TOTAL :	600	42	
KOYNA - III PEDAMBE			
UNIT 1	80	79	-9
UNIT 2	80	0	0
UNIT 3	80	0	0
UNIT 4	80	0	0
TOTAL :	320	79	
KOYNA - IV			
UNIT 1	250	0	-1
UNIT 2	250	0	-1
UNIT 3	250	0	-1
UNIT 4	250	0	-1
TOTAL :	1000	-1	
KOYNA DPH	36	0	
VAITARNA	60	0	
TILLARY	66	0	
BHATGAR	20		
ELDARY	22.5		
SMALL HYD	350	0	
GHATGHAR	250	0	
GHATGR PSP	250		
BHIRA TR	80		
MAH IPP GEN		4952	

THERMAL /GAS	EFF CAPACITY	MW	MVAR
URAN			
UNIT 5	108	88	-6
UNIT 6	108	61	6
UNIT 7	108	0	0
UNIT 8	108	0	0
WHR -I(A0)	120	89 G	
WHR -II(B0)	120	0	0
TOTAL :	672	239	
IB AMRAWATI			
UNIT 1	270	0	0
UNIT 2	270	0	0
UNIT 3	270	0	0
UNIT 4	270	0	0
UNIT 5	270	0	0
TOTAL :	1350	0	0
DHARIWAL			
UNIT 1	300	194	-28
JAIGAD			
UNIT 1	300	277 S	19
UNIT 2	300	196 S	-1
UNIT 3	300	195 S	-11
UNIT 4	300	204 S	0
TOTAL :	1200	872	
WPCL (WARDHA)			
UNIT 1	135	-3	0
UNIT 2	135	86	-5
UNIT 3	135	93	-10
UNIT 4	135	85	-7
TOTAL :	540	263	-22
APML TIRORA			
UNIT 1	660	542	- 70
UNIT 2	660	324	- 25
UNIT 3	660	574	- 80
UNIT 4	660	524	9
UNIT 5	660	571	-11
TOTAL :	3300	2550	-177
IEPL			
UNIT 1	270	0 S	0
UNIT 2	270	0 G	
TOTAL :	540	0 S	0

AMBAZARI ALDC SYSTEM TATA SYSTEM

THERMAL /GAS	EFF CAPACITY	MW	MVAR
BHUSAWAL			
UNIT 3	210	0	0
UNIT 4	500	336	-21
UNIT 5	500	342	-47
TOTAL :	1210	684	
KORADI			
UNIT 6	210	0	0
UNIT 7	210	0	0
UNIT 8	660	0 S	-47
UNIT 9	660	0 S	-47
UNIT 10	660	360	21
TOTAL :	2400	360	
PARLI			
UNIT 6	250	191 R	0
UNIT 7	250	172 S	0
UNIT 8	250	220 S	0
TOTAL :	750	583	
PARAS			
UNIT 3	250	215	
UNIT 4	250	241	
TOTAL :	500	457	
KHAPERKHEDA			
UNIT 1	210	143	11
UNIT 2	210	179	7
UNIT 3	210	165	5
UNIT 4	210	164	-15
UNIT 5	500	395	-94
TOTAL :	1340	1051	
NASIK			
UNIT 3	210	0	0
UNIT 4	210	0	0
UNIT 5	210	0	0
TOTAL :	630	0	

THERMAL /GAS	EFF CAPACITY	MW	MVAR
CHANDRAPUR			
UNIT 3	210	0	0
UNIT 4	210	127	-24
UNIT 5	500	376	-46
UNIT 6	500	0	0
UNIT 7	500	0	0
UNIT 8	500	376	- 114
UNIT 9	500	339	- 47
TOTAL :	2920	1223	

TATA SYSTEM

TATA			
UNIT 4	150	0	
UNIT 5	500	459	
UNIT 7A	120	115	
UNIT 7B	60	66	
UNIT 8	250	0	
TOTAL :	1080	640	

HYDRO SYSTEM

TATA BHIRA + BHIRA PSS	150 150	151 0	
TATA BHIVPURI	75	70	
TATA KHOPOLI	72	5	
TATA HYDRO TOT	447		
DAHANU			
UNIT 1	250	251	G
UNIT 2	250	246	G
TOTAL :	500	497	
VIPL			
UNIT 1	300	0	G
UNIT 2	300	0	G
TOTAL :	600	0	

09.58 hrs_MP

MPSEB SYSTEM OVERVIEW

12-Oct-2020 09:58:00

FREQUENCY	50.07	GENERATION	3372	DEMAND CATERED	10176

THERMAL GENERATION

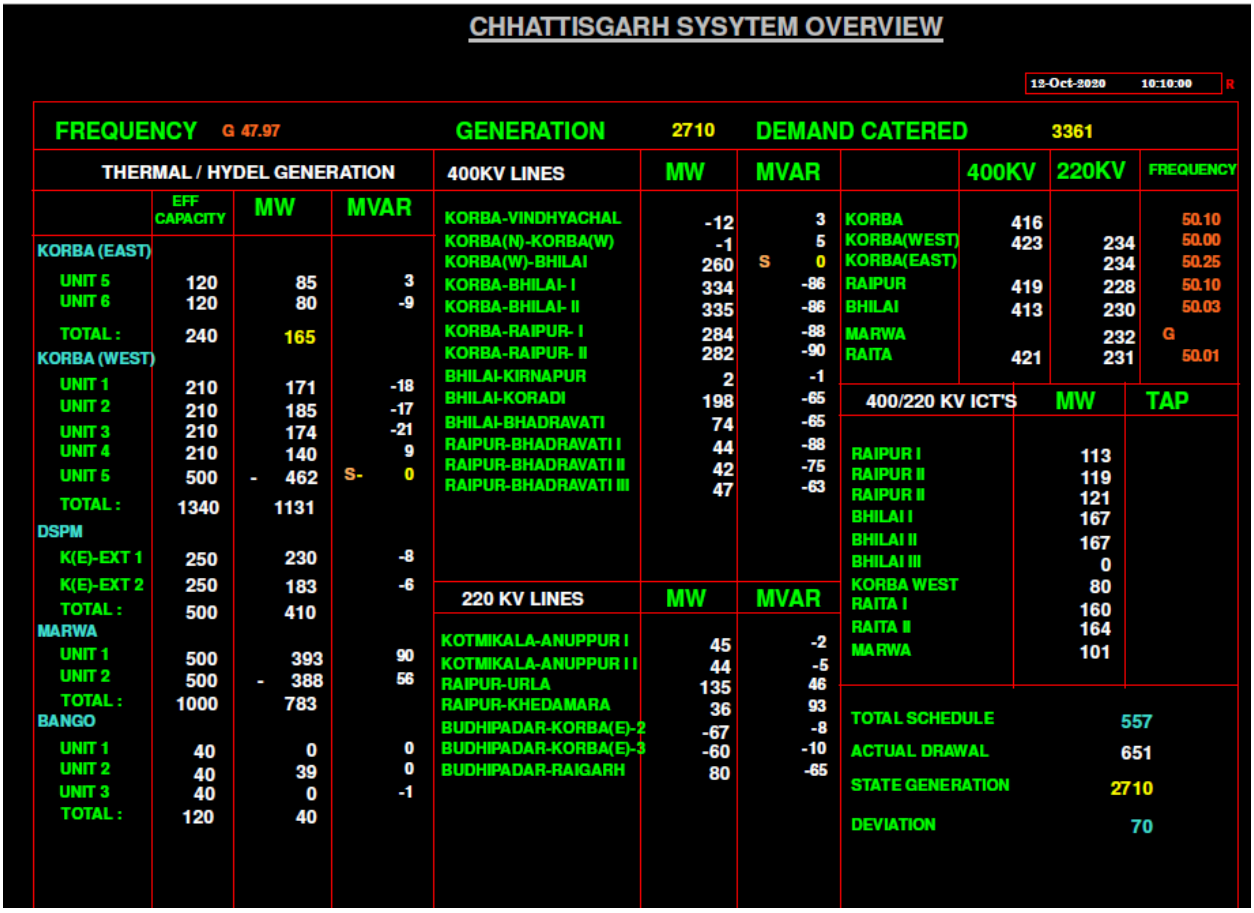
S/S	EFF CAPACITY	MW	MVAR
SATPURA			
UNIT 6	200	0	0
UNIT 7	210	0	0
UNIT 8	210	-3	-2
UNIT 9	210	-2	-4
UNIT 10	250	255	46
UNIT 11	250	252	30
TOTAL :	1330	500	
SGTPS			
UNIT 1	210	167	-28
UNIT 2	210	162	-25
UNIT 3	210	0	0
UNIT 4	210	188	3
UNIT 5	500	503	-67
TOTAL :	1340	1063	
AMARKANTAK			
UNIT 5	210	213	20
TOTAL :	210	212	
SINGHAJI			
UNIT 1	600	475	29
UNIT 2	600	0	0
UNIT 3	660	0	0
UNIT 4	660	0	0
TOTAL :	2520	483	29
JP BINA			
UNIT 1	250	145	21
UNIT 2	250	148	31
TOTAL :	500	148	
BLA THERMAL			
UNIT 1	45	20	6
UNIT 2	45	20	6
TOTAL :	90		

HYDRO GENERATION

S/S	EFF CAPACITY	MW	MVAR
I'SAGAR			
UNIT 1	125	0	0
UNIT 2	125	0	0
UNIT 3	125	0	0
UNIT 4	125	0	0
UNIT 5	125	119	18
UNIT 6	125	122	18
UNIT 7	125	123	12
UNIT 8	125	0	0
TOTAL :	1000	367	
BARGI			
UNIT 1	45	0	S -1
UNIT 2	45	45	S -6
TOTAL :	90	45	S -6
PENCH			
UNIT 1	80	79	-14
UNIT 2	80	79	-15
TOTAL :	160	158	
TONS			
UNIT 1	105	98	-7
UNIT 2	105	99	3
UNIT 3	105	0	0
TOTAL :	315	197	
SILPARA (BANS)			
UNIT 1	15	-9	-2
UNIT 2	15	-10	1
TOTAL :	30	-19	
DEOLONE			
UNIT 1	20	0	S 0
UNIT 2	20	0	S 0
UNIT 3	20	0	S 0
TOTAL :	60		

THERMAL /GAS	EFF CAPACITY	MW	MVAR
ZINNA (BANS 4)			
UNIT 1	10	0	S 0
UNIT 2	10	0	S 0
TOTAL :			
RAJGHAT			
UNIT 1	15	0	0
UNIT 2	15	0	0
UNIT 3	15	0	0
TOTAL :	45	0	0
G'SAGAR			
UNIT 1	23	0	S 0
UNIT 2	23	0	S 0
UNIT 3	23	0	S 0
UNIT 4	23	0	S 0
UNIT 5	23	0	S 0
TOTAL :	115	1	
OMKAR'R			
UNIT 1	65	0	0
UNIT 2	65	0	0
UNIT 3	65	0	0
UNIT 4	65	0	0
UNIT 5	65	65	-2
UNIT 6	65	65	-2
UNIT 7	65	0	0
UNIT 8	65	0	0
TOTAL :	520	130	
MADIKHEDA			
UNIT 1	20	20	-2
UNIT 2	20	20	0
UNIT 3	20	20	0

10.10 hrs_CHHATTISGARH



CHHATTISGARH SYSYTEM OVERVIEW

19-Oct-2020 10:10:00 R

FREQUENCY G 47.97 **GENERATION** 2710 **DEMAND CATERED** 3361

THERMAL / HYDEL GENERATION

	EFF CAPACITY	MW	MVAR
KORBA (EAST)			
UNIT 5	120	85	3
UNIT 6	120	80	-9
TOTAL :	240	165	
KORBA (WEST)			
UNIT 1	210	171	-18
UNIT 2	210	185	-17
UNIT 3	210	174	-21
UNIT 4	210	140	9
UNIT 5	500	- 462	S- 0
TOTAL :	1340	1131	
DSPM			
K(E)-EXT 1	250	230	-8
K(E)-EXT 2	250	183	-6
TOTAL :	500	410	
MARWA			
UNIT 1	500	393	90
UNIT 2	500	- 388	56
TOTAL :	1000	783	
BANGO			
UNIT 1	40	0	0
UNIT 2	40	39	0
UNIT 3	40	0	-1
TOTAL :	120	40	

400KV LINES

	MW	MVAR
KORBA-VINDHYACHAL	-12	3
KORBA(N)-KORBA(W)	-1	5
KORBA(W)-BHILAI	260	S 0
KORBA-BHILAI- I	334	-86
KORBA-BHILAI- II	335	-86
KORBA-RAIPUR- I	284	-88
KORBA-RAIPUR- II	282	-90
BHILAI-KIRNAPUR	2	-1
BHILAI-KORADI	198	-65
BHILAI-BHADRAVATI	74	-65
RAIPUR-BHADRAVATI I	44	-88
RAIPUR-BHADRAVATI II	42	-75
RAIPUR-BHADRAVATI III	47	-63

220 KV LINES

	MW	MVAR
KOTMIKALA-ANUPPUR I	45	-2
KOTMIKALA-ANUPPUR I I	44	-5
RAIPUR-URLA	135	46
RAIPUR-KHEDAMARA	36	93
BUDHIPADAR-KORBA(E)-2	-67	-8
BUDHIPADAR-KORBA(E)-3	-60	-10
BUDHIPADAR-RAIGARH	80	-65

	400KV	220KV	FREQUENCY
KORBA	416		50.10
KORBA(WEST)	423	234	50.00
KORBA(EAST)		234	50.25
RAIPUR	419	228	50.10
BHILAI	413	230	50.03
MARWA		232	G
RAITA	421	231	50.01

400/220 KV ICT'S	MW	TAP
RAIPUR I	113	
RAIPUR II	119	
RAIPUR II	121	
BHILAI I	167	
BHILAI II	167	
BHILAI III	0	
KORBA WEST	80	
RAITA I	160	
RAITA II	164	
MARWA	101	

TOTAL SCHEDULE	557
ACTUAL DRAWAL	651
STATE GENERATION	2710
DEVIATION	70

10.10hrs_Gujarat

GUJRAT SYSYTEM OVERVIEW

12-Oct-2020 10:10:00

FREQUENCY G 47.97 | GENERATION 12823 | DEMAND CATERED 15667

THERMAL / GAS GENERATION

S/S	EFF CAPACITY	MW	MVAR
ALTPS (AKRIMOTA)			
UNIT 1	125	30	-2
UNIT 2	125	28	-5
TOTAL :	250	58	
DGBP (DHUVRAN)			
GT 1	68	5	P 13
ST	39	16	S 0
GT 2	72	17	12
ST	40	17	6
GT 3	246	- 0	17
ST	130		
TOTAL :	219	418	
UTPS			
UNIT 3	200	126	19
UNIT 4	200	181	0
UNIT 5	210	143	23
UNIT 6	500	368	43
TOTAL :	1110	807	
WTPS			
UNIT 1	210	3	0
UNIT 2	210	0	0
UNIT 3	210	163	30
UNIT 4	210	0	0
UNIT 5	210	0	0
UNIT 6	210	0	0
UNIT 7	210	0	0
UNIT 8	800	653	147
TOTAL :	1470	816	
GTPS (GANDHINAGAR)			0
UNIT 3	210	0	0
UNIT 4	210	0	18
UNIT 5	210	168	
TOTAL :	630	167	
BECL (BHAVNAGAR)			1
UNIT 1	250	0	7
UNIT 2 (F)	250	90	
TOTAL :	500	90	

S/S	CAP	MW	MVAR
STPS (SIKKA)			
UNIT 3	250	181	-25
UNIT 4	250	178	-16
TOTAL :	500	360	
KLTPS (PANANDRO)			
UNIT 1	70	0	0
UNIT 2	70	0	0
UNIT 3	75	71	2
UNIT 4	75	0	S 0
TOTAL :	290	71	
SLPP (SURAT LIGNITE)			
UNIT 1	125	105	-150
UNIT 2	125	109	12
UNIT 3	125	0	-1
UNIT 4	125	118	26
TOTAL :	500	335	
GSEC			
UNIT 1	52	29	9
UNIT 2	52	29	13
UNIT 3	52	41	24
GSEC STG II			
UNIT 1	222	147	17
STG	129	107	10
TOTAL :	507	351	
UGPP STG I			
UNIT 1	30	0	S 0
UNIT 2	30	0	S 0
UNIT 3	30	0	0
UNIT 4	45	0	S 0
TOTAL :	135	0	0
UTRAN STG-II			
GT	228	221	S 14
ST	147	136	S 5
TOTAL :	375	-333	
OPGS			
UNIT 1	150	110	-16
UNIT 2	150	78	-16
TOTAL :	300	-188	

IPP'S GENERATION

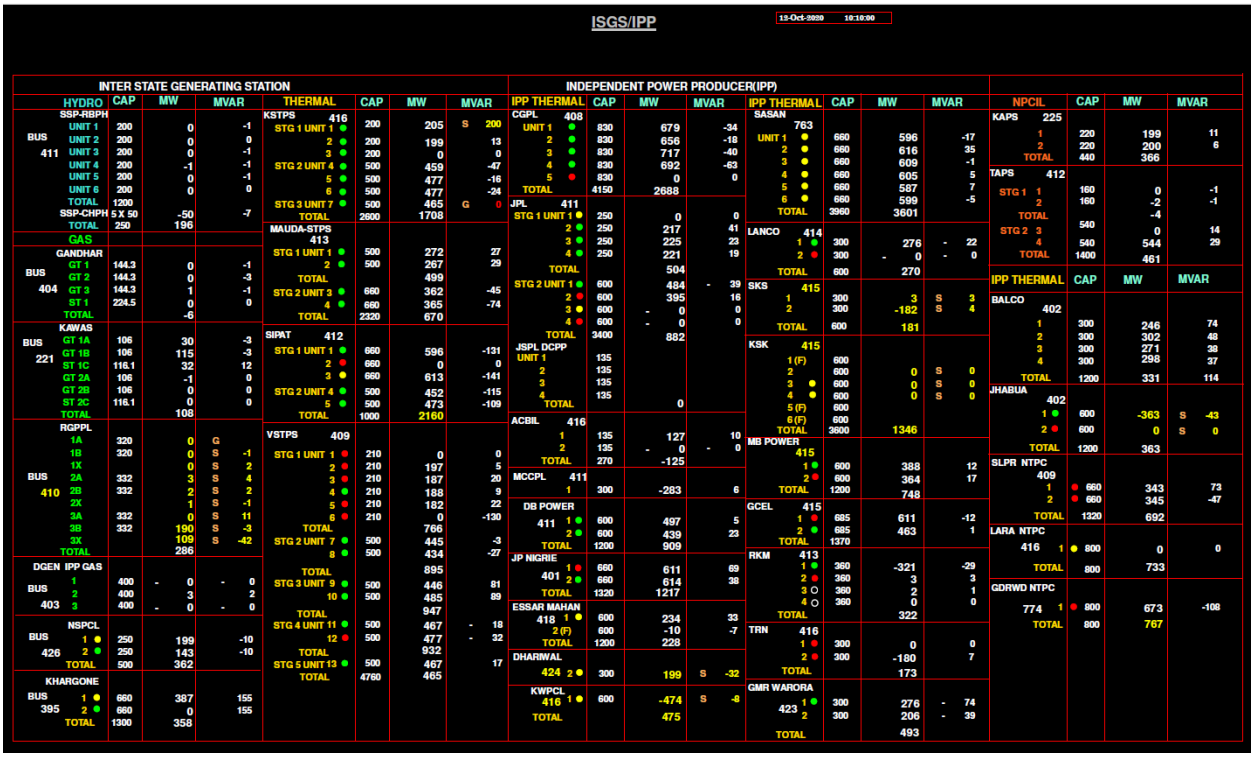
S/S	EFF CAPACITY	MW	MVAR
AECO			
UNIT C	60	0	0
UNIT D	120	111	28
UNIT E	121	0	S 0
UNIT F	121	0	S 0
GT1	32.5	0	S 0
GT2	32.5	0	S 0
STG	35	0	S 0
TOTAL :	522	340	
GIPCL			
UNIT 1	32	0	0
UNIT 2	32	22	10
UNIT 3	32	24	6
UNIT 4	49	27	9
STG 1 TOTAL :	145	73	
UNIT 5	111	0	0
UNIT 6	54	0	0
STG 2 TOTAL :	165	0	
GPEC (CLPI)			
UNIT 1	138	0	-3
UNIT 2	138	0	-3
UNIT 3	138	0	-3
ST	241	0	-1
TOTAL :	655		
GPPC (PIPAVAV)			
GT 1	351	- 215	30
ST		- 147	14
GT 2	351	- 119	3
ST		- 96	- 4
TOTAL :	702	-535	
ESSAR IPP			
GT 1	110	0	S 0
GT 2	110	0	S 0
GT 3	110	0	S 0
STG	185	0	S 0
TOTAL :	440	0	

HYDRO GENERATION

S/S	CAP	MW	MVAR
KHPS (KADANA)			
UNIT 1	60	0	0
UNIT 2	60	0	0
UNIT 3	60	0	0
UNIT 4	60	0	0
TOTAL :	240	0	
UHPS			
UNIT 1	75	0	0
UNIT 2	75	0	0
UNIT 3	75	81	0
UNIT 4	75	0	0
TOTAL :	300	81	
APL MUNDRA			
UNIT 1	330	296	36
UNIT 2	330	304	15
UNIT 3	330	300	29
UNIT 4	330	310	28
UNIT 5	660	587	79
UNIT 6	660	586	71
UNIT 7	660	548	-101
UNIT 8	660	543	-73
UNIT 9	660	603	-51
TOTAL :	4620	4315	
SUGEN			
UNIT 1	382.5	302	116
UNIT 2	382.5	221	116
UNIT 3	382.5	219	37
TOTAL :	1147.5	746	
ESSAR VADINAR (EPGL)			
UNIT 1	600	508	28
UNIT 2	600	0	3
TOTAL :	1200	506	
UNOSUGEN			
UNIT 1	382.5		-22

420023/2021/OPERATION AND MONITORING SECTION

10.10hrs_ISGS



ISGS/IPP

15-Oct-2020 10:10:00

INTER STATE GENERATING STATION

HYDRO	CAP	MW	MVAR
SSP-RBPH			
UNIT 1	200	0	-1
BUS UNIT 2	200	0	0
411 UNIT 3	200	0	-1
UNIT 4	200	-1	-1
UNIT 5	200	0	-1
UNIT 6	200	0	0
TOTAL	1200		
SSP-CHPH	5 X 50	-50	-7
TOTAL	250	196	

GAS			
GANDHAR			
GT 1	144.3	0	-1
BUS GT 2	144.3	0	-3
404 GT 3	144.3	1	-1
ST 1	224.5	0	0
TOTAL		-6	
KAWAS			
BUS GT 1A	106	30	-3
GT 1B	106	115	-3
221 ST 1C	116.1	32	12
GT 2A	106	-1	0
GT 2B	106	0	0
ST 2C	116.1	0	0
TOTAL		108	
RGPPL			
1A	320	0	G
1B	320	0	S -1
1X		0	S 2
BUS 2A	332	3	S 4
410 2B	332	2	S 2
2X		1	S -1
3A	332	0	S 11
3B	332	190	S -3
3X		109	S -42
TOTAL		286	
DGEN IPP GAS			
1	400	- 0	- 0
BUS 2	400	3	2
403 3	400	- 0	- 0
NSPCL			
BUS 1	250	199	-10
426 2	250	143	-10
TOTAL	500	362	
KHARGONE			
BUS 1	660	387	155
395 2	660	0	155
TOTAL	1300	358	

THERMAL	CAP	MW	MVAR
KSTPS 416			
STG 1 UNIT 1	200	205	S 200
2	200	199	13
3	200	0	0
STG 2 UNIT 4	500	459	-47
5	500	477	-16
6	500	477	-24
STG 3 UNIT 7	500	465	G 0
TOTAL	2600	1708	
MAUDA-STPS 413			
STG 1 UNIT 1	500	272	27
2	500	267	29
TOTAL		499	
STG 2 UNIT 3	660	362	-45
4	660	365	-74
TOTAL	2320	670	
SIPAT 412			
STG 1 UNIT 1	660	596	-131
2	660	0	0
3	660	613	-141
STG 2 UNIT 4	500	452	-115
5	500	473	-109
TOTAL	1000	2160	
VSTPS 409			
STG 1 UNIT 1	210	0	0
2	210	197	5
3	210	187	20
4	210	188	9
5	210	182	22
6	210	0	-130
TOTAL		766	
STG 2 UNIT 7	500	445	-3
8	500	434	-27
TOTAL		895	
STG 3 UNIT 9	500	446	81
10	500	485	89
TOTAL		947	
STG 4 UNIT 11	500	467	- 18
12	500	477	- 32
TOTAL		932	
STG 5 UNIT 13	500	467	17
TOTAL	4760	465	

INDEPENDENT POWER PRODUCER(IPP)

IPP THERMAL	CAP	MW	MVAR
CGPL 408			
UNIT 1	830	679	-34
2	830	656	-18
3	830	717	-40
4	830	692	-63
5	830	0	0
TOTAL	4150	2688	
JPL 411			
STG 1 UNIT 1	250	0	0
2	250	217	41
3	250	225	23
4	250	221	19
TOTAL		504	
STG 2 UNIT 1	600	484	- 39
2	600	395	16
3	600	- 0	0
4	600	- 0	0
TOTAL	3400	882	
JSPL DCPP			
UNIT 1	135		
2	135		
3	135		
4	135		
TOTAL		0	
ACBIL 416			
1	135	127	10
2	135	- 0	- 0
TOTAL	270	-125	
MCCPL 411			
1	300	-283	6
DB POWER			
411 1	600	497	5
2	600	439	23
TOTAL	1200	909	
JP NIGRIE			
401 1	660	611	69
2	660	614	38
TOTAL	1320	1217	
ESSAR MAHAN			
418 1	600	234	33
2 (F)	600	-10	-7
TOTAL	1200	228	
DHARIWAL			
424 2	300	199	S -32
KWPCL			
416 1	600	-474	S -8
TOTAL		475	

IPP THERMAL	CAP	MW	MVAR
SASAN 763			
UNIT 1	660	596	-17
2	660	616	35
3	660	609	-1
4	660	605	5
5	660	587	7
6	660	599	-5
TOTAL	3960	3601	
LANCO 414			
1	300	276	- 22
2	300	- 0	- 0
TOTAL	600	270	
SKS 415			
1	300	3	S 3
2	300	-182	S 4
TOTAL	600	181	
KSK 415			
1 (F)	600		
2	600	0	S 0
3	600	0	S 0
4	600	0	S 0
5 (F)	600		
6 (F)	600		
TOTAL	3600	1346	
MB POWER 415			
1	600	388	12
2	600	364	17
TOTAL	1200	748	
GCEL 415			
1	685	611	-12
2	685	463	1
TOTAL	1370		
RKM 413			
1	360	-321	-29
2	360	3	3
3	360	2	1
4	360	0	0
TOTAL		322	
TRN 416			
1	300	0	0
2	300	-180	7
TOTAL		173	
GMR WARORA			
1	300	276	- 74
423 2	300	206	- 39
TOTAL		493	

NPCIL	CAP	MW	MVAR
KAPS 225			
1	220	199	11
2	220	200	6
TOTAL	440	366	
TAPS 412			
STG 1 1	160	0	-1
2	160	-2	-1
TOTAL		-4	
STG 2 3	540	0	14
4	540	544	29
TOTAL	1400	461	

IPP THERMAL	CAP	MW	MVAR
BALCO 402			
1	300	246	74
2	300	302	48
3	300	271	38
4	300	298	37
TOTAL	1200	331	114
JHABUA 402			
1	600	-363	S -43
2	600	0	S 0
TOTAL	1200	363	
SLPR NTPC 409			
1	660	343	73
2	660	345	-47
TOTAL	1320	692	
LARA NTPC 416 1	800	0	0
TOTAL	800	733	
GDRWD NTPC 774 1	800	673	-108
TOTAL	800	767	

420023/2021/OPERATION AND MONITORING SECTION

10.10hrs_MAHARASHTRA

MSEB SYSYTEM OVERVIEW

13-Oct-2020 10:10:00

FREQUENCY G 47.97 **GENERATION** 11365 **DEMAND CATERED** 15383 **MUMBAI DEMAND** 1366

KALWA SYSTEM

HYDRO	EFF CAPACITY	MW	MVAR
KOYNA I & II POPHALE			
UNIT 1	70	5	0
UNIT 2	70	5	1
UNIT 3	70	4	4
UNIT 4	70	5	4
UNIT 5	80	5	5
UNIT 6	80	8	3
UNIT 7	80	7	R 0
UNIT 8	80	5	4
TOTAL :	600	43	
KOYNA - III PEDAMBE			
UNIT 1	80	79	-9
UNIT 2	80	0	0
UNIT 3	80	0	0
UNIT 4	80	0	0
TOTAL :	320	79	
KOYNA - IV			
UNIT 1	250	0	-1
UNIT 2	250	0	-1
UNIT 3	250	0	-1
UNIT 4	250	0	-1
TOTAL :	1000	-1	
KOYNA DPH	36	0	
VAITARNA	60	0	
TILLARY	66	0	
BHATGAR	20		
ELDARY	22.5		
SMALL HYD	350	0	
GHATGHAR	250	0	
GHATGR PSP	250		
BHIRA TR	80		
MAH IPP GEN		5043	

THERMAL /GAS	EFF CAPACITY	MW	MVAR
URAN			
UNIT 5	108	88	S -5
UNIT 6	108	62	S 13
UNIT 7	108	0	S 0
UNIT 8	108	0	S 0
WHR-I(A0)	120	90	G
WHR -II(B0)	120	0	S 0
TOTAL :	672	240	
IB AMRAWATI			
UNIT 1	270	0	0
UNIT 2	270	0	0
UNIT 3	270	0	0
UNIT 4	270	0	0
UNIT 5	270	0	0
TOTAL :	1350	0	0
DHARIWAL			
UNIT 1	300	196	-41
JAIGAD			
UNIT 1	300	277	S 19
UNIT 2	300	196	S -1
UNIT 3	300	195	S -11
UNIT 4	300	204	S 0
TOTAL :	1200	872	
WPCL (WARDHA)			
UNIT 1	135	-3	0
UNIT 2	135	86	-8
UNIT 3	135	93	-12
UNIT 4	135	85	-10
TOTAL :	540	262	-30
APML TIRORA			
UNIT 1	660	549	- 85
UNIT 2	660	360	- 45
UNIT 3	660	574	- 95
UNIT 4	660	533	-19
UNIT 5	660	556	-37
TOTAL :	3300	2585	-279
IEPL			
UNIT 1	270	0	S 0
UNIT 2	270	0	G
TOTAL :	540	0	S 0

AMBAZARI ALDC SYSTEM TATA SYSTEM

THERMAL /GAS	EFF CAPACITY	MW	MVAR
BHUSAWAL			
UNIT 3	210	0	0
UNIT 4	500	329	-57
UNIT 5	500	337	-82
TOTAL :	1210	667	
KORADI			
UNIT 6	210	0	0
UNIT 7	210	0	0
UNIT 8	660	0	S -47
UNIT 9	660	0	S -47
UNIT 10	660	340	-24
TOTAL :	2400	340	
PARLI			
UNIT 6	250	191	R 0
UNIT 7	250	172	S 0
UNIT 8	250	220	S 0
TOTAL :	750	583	
PARAS			
UNIT 3	250	215	
UNIT 4	250	240	
TOTAL :	500	456	
KHAPERKHEDA			
UNIT 1	210	146	3
UNIT 2	210	179	-1
UNIT 3	210	164	-4
UNIT 4	210	164	-21
UNIT 5	500	392	-109
TOTAL :	1340	1044	
NASIK			
UNIT 3	210	0	0
UNIT 4	210	0	0
UNIT 5	210	0	0
TOTAL :	630	0	

THERMAL /GAS	EFF CAPACITY	MW	MVAR
CHANDRAPUR			
UNIT 3	210	0	0
UNIT 4	210	133	-34
UNIT 5	500	380	-67
UNIT 6	500	0	0
UNIT 7	500	0	0
UNIT 8	500	376	- 134
UNIT 9	500	322	- 69
TOTAL :	2920	1219	

TATA SYSTEM

TATA			
UNIT 4	150	0	
UNIT 5	500	456	
UNIT 7A	120	116	
UNIT 7B	60	66	
UNIT 8	250	0	
TOTAL :	1080	637	

HYDRO SYSTEM

TATA BHIRA	150	194	
+ BHIRA PSS	150	0	
TATA BHIVPURI	75	86	
TATA KHOPOLI	72	11	
TATA HYDRO TOT	447		
DAHANU			
UNIT 1	250	196	G
UNIT 2	250	183	G
TOTAL :	500	379	
VIPL			
UNIT 1	300	0	G
UNIT 2	300	0	G
TOTAL :	600	0	

10.10hrs_MPSEB

MPSEB SYSTEM OVERVIEW

13-Oct-2020 10:10:00 R

FREQUENCY G 47.97 **GENERATION** 3319 **DEMAND CATERED** 10191

THERMAL GENERATION

S/S	EFF CAPACITY	MW	MVAR
SATPURA			
UNIT 6	200	0	0
UNIT 7	210	0	0
UNIT 8	210	-3	-2
UNIT 9	210	-2	-4
UNIT 10	250	255	37
UNIT 11	250	252	21
TOTAL :	1330	492	
SGTPS			
UNIT 1	210	167	-28
UNIT 2	210	162	-26
UNIT 3	210	0	0
UNIT 4	210	188	2
UNIT 5	500	493	-67
TOTAL :	1340	1045	
AMARKANTAK			
UNIT 5	210	213	21
TOTAL :	210	211	
SINGHAJI			
UNIT 1	600	486	7
UNIT 2	600	0	0
UNIT 3	660	0	0
UNIT 4	660	0	0
TOTAL :	2520	482	7
JP BINA			
UNIT 1	250	147	3
UNIT 2	250	146	13
TOTAL :	500	145	
BLA THERMAL			
UNIT 1	45	20	6
UNIT 2	45	20	6
TOTAL :	90		

HYDRO GENERATION

S/S	EFF CAPACITY	MW	MVAR
I'SAGAR			
UNIT 1	125	0	0
UNIT 2	125	0	0
UNIT 3	125	0	0
UNIT 4	125	0	0
UNIT 5	125	116	13
UNIT 6	125	121	13
UNIT 7	125	120	7
UNIT 8	125	0	0
TOTAL :	1000	356	
BARGI			
UNIT 1	45	0	S -1
UNIT 2	45	45	S -6
TOTAL :	90	45	S -6
PENCH			
UNIT 1	80	79	-15
UNIT 2	80	79	-16
TOTAL :	160	157	
TONS			
UNIT 1	105	98	-6
UNIT 2	105	99	4
UNIT 3	105	0	0
TOTAL :	315	198	
SILPARA (BANS)			
UNIT 1	15	-9	-2
UNIT 2	15	-10	1
TOTAL :	30	-19	
DEOLONE			
UNIT 1	20	0	S 0
UNIT 2	20	0	S 0
UNIT 3	20	0	S 0
TOTAL :	60		

THERMAL /GAS	EFF CAPACITY	MW	MVAR
ZINNA (BANS 4)			
UNIT 1	10	0	S 0
UNIT 2	10	0	S 0
TOTAL :			
RAJGHAT			
UNIT 1	15	0	0
UNIT 2	15	0	0
UNIT 3	15	0	0
TOTAL :	45	0	0
G'SAGAR			
UNIT 1	23	0	S 0
UNIT 2	23	0	S 0
UNIT 3	23	0	S 0
UNIT 4	23	0	S 0
UNIT 5	23	0	S 0
TOTAL :	115	1	
OMKAR'R			
UNIT 1	65	0	0
UNIT 2	65	0	0
UNIT 3	65	0	0
UNIT 4	65	0	0
UNIT 5	65	65	-5
UNIT 6	65	65	-5
UNIT 7	65	0	0
UNIT 8	65	0	0
TOTAL :	520	130	
MADIKHEDA			
UNIT 1	20	20	-2
UNIT 2	20	20	0
UNIT 3	20	20	0

420023/2021/OPERATION AND MONITORING SECTION OVERVIEW OF ALL FLOWS FROM SCADA DATA OF AEML

Time	Dhn_Mvira j	Ghd_MBo isar	Ghd_MB orivali	Vsv_MB oisar	Ary_TBvl	Ary_Mbv l1	Ary_Mbv l2	Vsv_TV sv1	Vsv_T Vsv2	Sk_TSk 1	Sk_TSk2	RBvl_TB vl	RBvl_M Bvl1	RBvl_M Bvl2	Gri_MB vl1	Gri_MB vl2	Time	MBOl	MBVL	Total MSETCL	Total TPC	Total Exchange
9:45:00	108.66	-121.34	89.44	-128.35	-44.48	-113.35	-112.48	24.69	24.69	-27.06	-27.78	34.39	-63.84	-64.30	-20.94	-23.90	9:45:00	-141.03	-309.38	-450.41	-15.56	-465.96
9:46:00	110.40	-121.34	89.44	-126.24	-43.83	-113.35	-112.48	24.69	24.69	-27.06	-27.78	34.39	-63.84	-64.30	-20.94	-23.90	9:46:00	-137.18	-309.38	-446.56	-14.91	-461.47
9:47:00	112.38	-121.34	89.44	-129.56	-44.48	-113.35	-112.48	24.69	24.69	-27.06	-27.78	34.39	-63.84	-64.30	-20.94	-23.90	9:47:00	-138.52	-309.38	-447.90	-15.56	-463.45
9:48:00	103.00	-121.34	89.44	-128.04	-44.76	-113.35	-112.48	24.69	24.69	-27.06	-27.78	34.39	-63.84	-64.30	-20.94	-23.90	9:48:00	-146.38	-309.38	-455.75	-15.84	-471.59
9:49:00	105.09	-121.34	89.44	-122.96	-45.06	-113.35	-112.48	24.69	24.69	-27.06	-27.78	34.39	-63.84	-64.30	-22.69	-23.90	9:49:00	-139.21	-311.12	-450.34	-16.14	-466.48
9:50:00	103.97	-121.34	89.44	-130.15	-45.06	-113.35	-112.48	24.69	24.69	-27.06	-27.78	34.39	-63.84	-64.30	-22.69	-23.90	9:50:00	-147.52	-311.12	-458.64	-16.14	-474.78
9:51:00	101.97	-121.34	89.44	-119.92	-45.34	-113.35	-112.48	24.69	24.69	-27.06	-27.78	34.39	-63.84	-64.30	-22.69	-23.90	9:51:00	-139.29	-311.12	-450.41	-16.42	-466.83
9:52:00	101.73	-121.34	89.44	-126.24	-45.06	-113.35	-112.48	24.69	24.69	-27.06	-27.78	34.39	-63.84	-69.34	-22.69	-23.90	9:52:00	-145.86	-316.16	-462.02	-16.14	-478.16
9:53:00	99.59	-121.34	89.44	-127.45	-45.93	-113.35	-118.21	24.69	24.69	-27.06	-27.78	34.39	-70.18	-69.34	-22.69	-23.90	9:53:00	-149.21	-328.23	-477.43	-17.01	-494.44
9:54:00	103.69	-121.34	89.44	-125.34	-45.65	-119.08	-118.21	24.69	24.69	-27.06	-27.78	34.39	-70.18	-69.34	-22.69	-23.90	9:54:00	-142.99	-333.95	-476.94	-16.73	-493.67
9:55:00	100.53	-121.34	89.44	-126.83	-45.65	-119.08	-118.21	24.69	24.69	-27.06	-27.78	34.39	-70.18	-69.34	-22.69	-23.90	9:55:00	-147.64	-333.95	-481.59	-16.73	-498.32
9:56:00	100.98	-121.34	89.44	-127.17	-45.93	-119.08	-118.21	24.69	24.69	-27.06	-27.78	39.71	-70.18	-69.34	-22.69	-23.90	9:56:00	-147.53	-333.95	-481.48	-11.69	-493.17
9:57:00	103.12	-121.34	89.44	-125.94	-45.65	-119.08	-118.21	24.69	24.69	-27.06	-27.78	39.71	-70.18	-69.34	-22.69	-23.90	9:57:00	-144.16	-333.95	-478.11	-11.41	-489.52
9:58:00	101.67	-121.34	89.44	-122.62	-45.93	-119.08	-118.21	24.69	24.69	-27.06	-27.78	39.71	-70.18	-69.34	-22.69	-23.90	9:58:00	-142.29	-333.95	-476.24	-11.69	-487.93
9:59:00	65.27	-158.93	128.28	-139.47	-47.46	-119.08	-118.21	24.69	24.69	1.41	1.14	39.71	-70.18	-69.34	-22.69	-23.90	9:59:00	-233.14	-295.12	-528.26	44.17	-484.09
10:00:00	65.93	-161.39	129.13	-139.82	-47.46	-127.19	-126.33	25.82	25.82	1.16	1.49	66.59	-82.68	-83.66	-10.95	-11.30	10:00:00	-235.27	-312.99	-548.26	73.44	-474.83
10:01:00	63.65	-161.39	237.89	-220.09	-46.58	-127.19	-126.33	25.82	25.82	1.16	1.49	67.30	-82.68	-83.66	-10.95	-11.65	10:01:00	-317.82	-204.59	-522.41	75.02	-447.39
10:02:00	-35.82	-267.58	237.89	-272.14	-46.58	-127.19	-126.33	25.82	25.82	41.06	43.21	103.29	-82.68	-83.66	26.49	26.36	10:02:00	-575.54	-129.13	-704.66	192.62	-512.04
10:03:00	-161.01	0.52	141.55	-364.81	-36.32	-127.19	-126.33	25.82	25.82	41.06	43.21	103.29	-107.74	-109.95	26.49	26.36	10:03:00	-525.30	-276.80	-802.10	202.88	-599.23
10:04:00	-237.39	0.52	183.44	-367.20	-36.64	-127.19	-126.33	25.82	25.82	41.06	43.21	103.29	-107.74	-109.95	26.49	26.36	10:04:00	-604.07	-234.91	-838.98	202.56	-636.42
10:05:00	-240.81	0.52	183.44	-368.09	-37.23	-106.14	-105.85	25.82	25.82	41.06	43.21	103.29	-90.79	-93.63	26.49	26.36	10:05:00	-608.38	-160.11	-768.49	201.97	-566.52
10:06:00	0.00	0.52	0.01	-2.03	-0.82	-2.59	-4.36	25.82	25.82	0.00	0.00	0.00	0.00	0.00	26.49	26.36	10:06:00	-1.51	45.90	44.39	50.82	95.21
10:07:00	0.00	0.52	0.01	-2.90	-0.82	-2.59	-4.36	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10:07:00	-2.38	-6.95	-9.33	-0.80	-10.13
10:08:00	0.00	0.52	0.01	-2.90	-0.54	-2.59	-4.36	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10:08:00	-2.38	-6.95	-9.33	-0.52	-9.85
10:09:00	0.00	0.52	0.01	-2.90	-0.54	-2.59	-4.36	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10:09:00	-2.38	-6.95	-9.33	-0.52	-9.85
10:10:00	0.00	0.52	0.01	-2.62	-0.54	-2.59	-4.36	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10:10:00	-2.10	-6.95	-9.05	-0.52	-9.57

420023/2021/OPERATION AND MONITORING SECTION