

**REPORT OF THE INQUIRY COMMITTEE**

**ON**

**GRID INCIDENT**

**IN**

**NORTHERN REGION**

**ON**

**12<sup>th</sup> Oct 2007**

**New Delhi  
July 2008**

# Draft Report of the Inquiry Committee on Grid incident in Northern Region on 12<sup>th</sup> Oct 2007

## 1.0 INTRODUCTION

- 1.1 Northern Region experienced a disturbance at 1251 hours of 12th October 2007 leading to power failure in Punjab, major parts of Haryana, Himachal Pradesh, Jammu & Kashmir, UT Chandigarh and some parts of Delhi. No loss of life or equipment failure has been reported. But there was a loss of about 6270 MW generation and around 9220 MW consumer load was interrupted during this event. The power system was back to normal by 15:10 hours on the same day as far as the electrical network is concerned while the generating units which tripped in the event were synchronized by 2000 hours.

This report looks at the conditions on the bulk electric power system that existed prior to and during the disturbance, and explains how the power outage occurred. The report concludes with a series of recommendations for actions that can and should be taken by the power utilities to prevent or minimize the chance of such an outage occurring in the future.

- 1.2 Just before the incident the Northern regional grid was catering 22831 MW of load. The system frequency was 48.9 Hz. Inter-regional import by Northern Region was about 2800 MW. 400 kV Mandaula-Bawana-II was under planned shutdown since 1141 hours of the same day for maintenance. 400kV Bawana station was exporting 1170MW power towards Abdullapur, Hissar and Bahadurgarh (See Exhibit-I) and there was 394MW local load on ICTs thus catering the total load of 1564MW.
- 1.3 The incident started when 400kV Bawana- Mandaula Ckt. -I carrying a load of 1000 MW towards Bawana tripped at 12:51 Hrs, at Mandaula end, on receipt of direct receive (DT) command from 400kV Bawana Station. According to DTL at 400kV Bawana S/S no relay operated, nor any carrier signal was generated/transmitted. However no SOE record was available at Bawana end. The SOE record of Mandaula S/S of POWERGRID confirms receive of Direct Trip signal from Bawana.
- 1.4 After loss of support from 400kV Mandola, the power flow was diverted on 400 kV Ballabgarh- Bamnauli Circuit I and II to Bawana for onward transmission to Abdullapur, Hissar and further. 400kV Ballabgarh - Bamnauli line I and II which were already carrying 508MW on each ckt, crossed 1000 MW on each circuit and the overload protection set at 1500 Amps operated, tripping both lines.
- 1.5 Other parallel 400 kV lines like Dadri Panipat D/C, Dadri Malerkotla, Bassi -Hissar also tripped on protection separating Punjab, Haryana (except 220 kV Ballabgarh), HP, J&K, BBMB, UT Chandigarh and parts

of Delhi fed from Bawana and Bamnauli 400 kV substation, from rest of the Northern Grid. The deficit in this sub-system was of the order of 3700 MW. The frequency dropped sharply in this subsystem and this subsystem collapsed due to inadequate generation. The rest of the Northern Grid however survived along with the "NEW" grid.

- 1.6 Central Electricity Authority vide its order no. 5-41(13)/ Secy. / 2007/ 171 dated 18.10.07 (**Annexure-I**) constituted a Committee comprising the following members to inquire into the incident and ascertain the cause of grid disturbance and suggest remedial measures to avoid recurrence of such incident:

1. Shri S.P.S. Gaharwar, Member Secretary, NRPC- Chairman.
2. Sh. S.K. Soonee, ED, NRLDC - Member
3. Sh. Ramesh Bahri, GM (OS), PGCIL- NR-I - Member
4. Sh. R.S. Lamba, Director (PR), BBMB - Member
5. Sh. Neeraj Gulati, Chief Engineer (SO), HVPN - Member
6. Sh. A.K. Kaul, GM (SO), DTL - Member
7. Sh. J.P. Kalta, Director (PR), HPSEB - Member
8. Sh. A.R. Tak, Chief Engineer (SO), PDD, J &K - Member
9. Sh. K.S. Jolly, Chief Engineer (SO&C), PSEB - Member

- 1.7 The terms of reference of the Committee are as under:

- i) To analyse the cause leading to grid disturbance on 12.10.2007.
- ii) To review the restoration of system.
- iii) To review performance of the associated protection system  
To suggest remedial measures to avoid recurrence of such disturbance in future.
- iv) Any other relevant issues connected with the safe and secure operation of the grid.

- 1.8 The committee held its First meeting at NRPC New Delhi on 31.10.07. Representatives from BBMB, NTPC, DTL, NRLDC, NRPC, RRVPN, HPSEB, HPVN, PSEB and POWERGRID participated in the meeting.

- 1.9 The committee co-opted Shri PP Francis, DGM (OS/SIIS) , NTPC as member and Sh. R P Aggarwal SE(O), NRPC as member Convenor.

- 1.10 The Committee held its 2nd meeting on 15.11.07 to analyze the information supplied by, NTPC, BBMB, DTL, POWERGRID, HP, PSEB, HVPNL, and NRLDC in detail.

- 1.11 Chairman, Inquiry committee also visited 400 kV Sub Station of Mandaula of POWERGRID and 400 kV Bawana Sub station of DTL on 13.12.07 along with officials of POWERGRID and DTL.

## 2..0 Overview Of Northern Regional Grid

- 2.1 Northern Region is the largest in geographical area amongst the five regions in the country covering approximately 30.7% of the area and having largest number of constituents (9 states/UT's, 4 Central Generating Companies, one Central Transmission Utility and Bhakra Beas Management Board). It has largest sized hydro unit (250 MW at Tehri/ Nathpa Jhakri) in the country. Northern Grid has an effective capacity of **36,547 MW** as on 31.07.07. The Thermal-Hydro mix is of the order of 67:33.
- 2.2 Northern Region has country's first High Voltage Direct Current (HVDC) long distance transmission system in the country (2x750 MW,  $\pm$  500 kV Rihand-Dadri HVDC bipole) and first HVDC back-to-back interconnection with Western Region (2x250 MW back-to-back HVDC station at Vindhyachal). It has 1 x 500 MW HVDC back- to -back interconnection with Eastern Region at Pusauli. NR has country's first and only 400 kV Static VAR Compensators (SVC's) (2x  $\pm$  140 MVAR SVC at Kanpur).
- 2.3 The large Coal pithead thermal power stations are located in the extreme Southeastern part of the Regional Grid constituting generation capacity of around 7000 MW against which normal generation level is 5500-6000 MW.
- 2.4 Major generating stations including Super Thermal Power Stations of NTPC at Rihand and Singrauli are located in the eastern part of the grid. Due to such concentration of generation in the eastern part of the grid and major load centers in the central and western part of the grid there is bulk active power transmission from eastern to western part over long distances.
- 2.5 To handle this bulk transmission of power, a point to point high voltage DC line viz. HVDC Rihand-Dadri bipole with capacity of 1500 MW exists and operates in parallel with thirteen 400 kV AC transmission lines connecting Eastern part (Eastern UP subsystem) with Rest of Grid besides under lying 220 kV network.
- 2.6 With the commissioning of 400 kV Muzaffarpur (ER) -Gorakhpur (NR) D/C line in August, 2006, Northern grid got synchronized with the Western Region (WR), Eastern Region (ER) & North Eastern Region (NER). Since then NR, WR, ER and NER grids (i.e. Central Grid) are operating in synchronous mode. 765 kV Bina-Gwalior-Agra line (charged at 400 kV) was commissioned on 31<sup>st</sup> March 2007 and provides direct AC interconnection of Northern Region with Western region.
- 2.7 The operation of the entire Northern Regional grid is co-coordinated in real time by the Northern Regional Load Despatch Centre (NRLDC) and eight State Load Despatch Centres (SLDCs).The Map indicating 400 kV and above lines in NR is enclosed at **Exhib- II**.

2.8 Ownership and Maintenance agency of affected lines is enclosed at Annex-II.

### 3.0 DESCRIPTION OF GRID DISTURBANCE

#### 3.1 Antecedent Condition at 1245hrs:

- a) System Frequency: 48.9Hz
- b) Northern region Load: 22831MW
- c) HVDC Rihand Dadri Flow: 1200MW
- d) Total Inter Regional Import 2802MW
- e) Total Interregional schedule 1193MW
- f) Total Interregional overdrawal 1609MW
- g) States details:

(Figures in MW)

State	Punjab	Haryana	Rajasthan	Delhi	UP	Uttarakhand	HP	JK	UT CHD
Own Generation	2265	1241	2404	1149	3105	391	263	92	0
Schedule	1870	982	1430	1288	2564	254	196	585	133
Drawl	2162	1401	1549	1346	2947	342	320	929	160
Overdrawal	292	468	119	58	383	88	124	344	27
Demand met	4428	2642	3952	2496	6052	734	584	1020	160

#### Voltage profile at important stations

Station	Voltage(kv)	Station	Voltage(kv)
Dadri(Th)	400	Bassi	404
Mandaula	398	Hissar	391
Bawana	403	Abdullapur	403
Bamnauli	405	Dehar	409
Ballabgarh	400	Patiala	397
Panipat	404	Moga	393
Malerkotla	397	Jalandhar	400

#### Generation at important Power plants

Station	Generation (MW)	Station	Generation (MW)
Bhakra	550	RAPP	240
Dadri Gas	556	Rihand	461
Dadri TPS	595	Rihand STPS-II	962
Dehar	145	Salal	202
NAPP	75	Singrauli STPS	1935
Nathpa Jhakri	454	TALA	715
Pong	323	Unchahar	980

#### 3.1.1 The incident on the 12<sup>th</sup> Oct 2007:

Tripping of lines with Flag indications are placed at Annexure -III

- ❖ The timeline of incident events given below is based on the reports received from BBMB, NTPC, POWERGRID, Sequence of Events (SoE) recorded at NRLDC, Historical Data Recording (HDR) at NRLDC. From these records, it was observed that the time synchronization of Disturbance Recorders (DRs), Event Loggers (ELs) with GPS is not in order when compared with the SoE recorded at NRLDC. Only the tripping time of 400 kV Bassi-Hissar line as per the DR and EL at Hissar matches with the SoE at NRLDC. Hence, the SoE record at NRLDC has been taken as the reference while working out the timeline of the incident on 12<sup>th</sup> October 2007.

Event start time: 12:51:24:814 Hrs taken as zero time the incident			
S. No.	Time t =	Event	Remarks
1	t= 0 (Start)	400 kV Mandaula Bawana-1 line tripped at Mandaula end at 12:51:24:814. This resulted in loss of the 400 kV D/C direct connection between Mandaula and Bawana as Ckt II was under planned shutdown since 1141 hours.	Antecedent flow on the line was 1065 MW from Mandaula to Bawana. Line tripped from Mandaula end only on Direct Trip (D/T) received. DTL reported No indication of D/T command send at Bawana end. -Event logger output from Mandaula end is <b>enclosed at Annexure-IV</b> .
2	t=20 sec 442 msec	400 kV Ballabgarh Bamnauli-II tripped at Ballabgarh end at 12:51:45:256	Main-I protection (over current element) operated at Ballabgarh. The antecedent flow on this line at 1250 hours was 497 MW which would have increased to around 1000 MW after tripping of the Mandaula-Bawana section. It was learnt that the REL 521 line protection relay at Ballabgarh end of this line has an overload element set at 1.5 (CT Ratio 1000/1) and 20 second time delay and this element might have just picked up as the loading was close to 1500 amps. The time interval of 20 second between the two trippings thus matches with the relay setting.
3	t= 40 sec 504 msec	400 kV Ballabgarh Bamnauli-I tripped at 12:52:05:318 Hrs	Tripped at Ballabgarh end on operation of Main-I line protection(over current).

			The loading on this line crossed much above the overloading set value at 1.5 (for 1000/1 CT Ratio) value after tripping of 400 kV Mandaula-Bawana-I and Ballabgarh-Bamnauli-Ckt II above and the time delay of 20 seconds matches with the relay setting.
4	<b>T=52 sec 377 msec</b>	400kv Dadri-Panipat II tripped at 12:52:17:291 hours only at Dadri NTPC end. This tripping is not appearing in NRLDC's SoE as the breaker status is not wired. The timings are as per the DR output at Dadri NTPC end from Main-I (P442 MICOM) relay.	Dadri end: Main-II operated MICOM P437 Overcurrent starting element of distance protection. Testing of this relay by NTPC revealed that the starting element picks up above 1 A (1000 A primary). A trip command is issued on the set time delay (6s) after O/C starting with appropriate direction sensing (Zone 7) and set time delay (7s) after O/C starting (zone 8). Zone 7 and zone 8 trip command have been since blocked and O/C has now been increased to 1.2 kA.
5	<b>T=57 sec 273 msec</b>	400 kV Dadri-Panipat I tripped at 12:52:22:087 Hrs at Panipat end on 67 X (O/C). Dadri end breaker tripped on direct trip received. <b>There is no indication of Panipat end breaker opening recorded at NRLDC.</b>	As per the DR from NTPC Dadri, the current flow on this circuit before tripping was 1700 amps RMS. It is reported that this line has a separate directional overcurrent and earth fault relay (CDD14) at Panipat end which is set at 1200 amps. This also tallies with 67X indication received at Panipat. <b>However it is not clear as to how a direct trip (DT) command was sent to Dadri NTPC for this overcurrent relay operation. (DT not require in this case.</b>
6	<b>T=57 sec 780 msec</b>	220 kV Ballabgarh-Ch. Dadri tripped at 12:52:22.594 Hrs at Ch. Dadri end	MICOM P442 trip phase ABC Zone-I, PSB operated fault duration 2.048 fault location 121.6 Kms from Ch Dadri end. This is a case of load encroachment following the above 400 kV line trippings.
7	<b>T=57 sec 906 msec</b>	400 kV Dadri-Malerkotla tripped at 12: 52: 22:720 hours from Malerkotla end.	Tripped on operation of Main-II protection at Malerkotla (MICOM P442). The current on this circuit has increased to 2800 amps (The <b>non directional O/C element accidentally remained enabled</b> ) The line remained charged from

			Dadri for nearly three minutes before it tripped on overvoltage at 12:54:48:60 hours at Dadri on receipt of DT from Malerkotla.
8	<b>T= 58 secs 30 msec</b>	220 kV Samaypur-Ch. Dadri tripped at Samaypur end at 12: 52: 22: 844 Hrs	Main-II protection (MM3V) operated at Samaypur end. It is a case of load encroachment considering the heavy power flows taking place across this section after tripping of the 400 kV lines above
9	<b>T=58 sec 327 msec</b>	220 kV Khetri-Charkhi Dadri-I & II tripped at 12:52:23.141 Hrs.	Ckt 1 tripped from Charkhi Dadri end only with MICOM P442 phase A, phase C, Zone-II DR:- Started phase A,B,C, trip phase A, B, C Started element Dist; Dist Trip zone-II, A/R, lockout ; fault duration 3.420msc, relay trip time 82.08 ms, fault location 139.5Kms, IA, IB, Ic, 1.768KA; 1.847KA, 1.341 KA, fault in zone-II Relay 86A, 86B, 86, 86T, A/R lockout. Ckt II tripped from Khetri end on operation of Main -I, Zone -I, and main -II, ABC phase distance protection
10	<b>t= 58 sec 413 msec</b>	220 kV Hissar-Khetri tripped at 12: 52: 23: 227 hours from Hissar end.	Distance relay operated at Hissar end (MICOM)
11	<b>t=59 sec 51 msec</b>	400kv Bassi-Hissar tripped at 12:52:23.865 Hrs	Hissar Main-I protection, RYB, Main-I Zone-I, Power swing. DR at Hissar end and EL output at Hissar enclosed at Annex.

With the above trippings, the Punjab, Haryana(major part), HP, J&K, UT Chandigarh and parts of Delhi system separated from rest of the grid.

### 3.2 Affected areas during the disturbance:

The lines tripping led to system separation & loss of load and generation in Punjab, HP, J&K and part of Delhi and Haryana. The total load of NR was about 22831 MW at the start of incident. There was a complete black out in Punjab, Himachal Pradesh, J&K and UT Chandigarh. Supply in most parts of Haryana was also lost except at Faridabad, Ballabgarh and adjoining pockets, which survived with Faridabad GPS (of NTPC) and Faridabad TPS of (Haryana), and 220 kV Ballabgarh system of BBMB. In Delhi 400kV Bawana and 400kV Bamnauli S/Stn were totally affected. Steam Turbine Generator (STG) unit of Pragati GPS also tripped.



The details of load affected in different substations and generation lost is summarized in table below.

S. no	System	Thermal	Hydro	Load lost	
		MW	MW	MW	MWh
1	Punjab	1849	428	4430	17300
2	Haryana	982	36	2178	6800
3	Delhi	80	0	850	400
4	HP	0	263	584	1000
5	J&K	0	92	1020	2000
6	UT Chd	0	0	160	300
7	NTPC	500	0		
8	Rajasthan	190	0		
9	BBMB	0	997		
10	NHPC	0	441		
11	SJVNL	0	422		
12	<b>Total</b>	<b>3517</b>	<b>2751</b>	<b>9222</b>	<b>27800</b>

### 3.2.1 Axis of separation

The axis of separation is indicated in the sketch at **Exhibit- III**. The axis of separation is Dadri-Panipat D/C, Dadri-Malerkotla S/C, Mandaula Bawana, Ballabgarh-Bamnauli D/C, and Bassi-Hisar S/C at 400 kV level and Ballabgarh-Ch. Dadri S/C, Samaypur-Ch. Dadri S/C, Khetri-Ch.Dadri D/C and Khetri-Hisar S/C lines at 220 kV level.

### 3.2.2 Antecedent of Power Flow at 12:50 Hrs across axis of separation

Voltage level	Name of Line	Flow at 1250 hours
		MW
400 kV	Mandaula Bawana I	1065
400 kV	Mandaula Bawana II	0
400 kV	Ballabgarh Bamnauli I	497
400 kV	Ballabgarh Bamnauli II	494
400 kV	Dadri Malerkotla S/C	319
400 kV	Dadri Panipat I	361
400 kV	Dadri Panipat II	405
400 kV	Bassi Hissar S/C	220
220 kV	Khetri Hissar S/C	66
220 kV	Khetri Dadri I	53
220 kV	Khetri Dadri II	50

220 kV	Ballabgarh Dadri	I	95
220 kV	Samaypur Dadri	II	99
	<b>Net flow</b>		<b>3724</b>

#### 4.0 Restoration

The restoration sequence is as under:

S.No.	Tine (hrs)	Restoration Event
1	13:02 Hrs	BHAKRA (LEFT) # 2 black-started, Auxiliary supply restored to BHAKRA (LEFT)
2	13:06 Hrs	BHAKRA (LEFT) #1 started and Supply extended to NFL in island mode
3	13.09 Hrs	400kv Mandola-Bawana-I charged ( Mandola-Bawana-II was also charged at 1406hrs postponing shut down )
4	13.10 Hrs	Bhakra ( R ) # 6 black-started, Auxiliary Supply extended to other units of Bhakra ( R )
5	13.12 Hrs	Since Bassi Station was alive, 400kV Hisar-Bassi charged.
6	13.13 Hrs	400kV Bawana- Abdullapur -I charged (Abdullapur-Bawana-II charged at 14:30Hrs)
7	13.16- 13.19 Hrs	400kV Bamnauli-Ballabgarh-I/II charged
	13.16 Hrs	220 kV Khodri supply extended to 220 kV Kunihar (HP)
8	13:23 Hrs	400kV Dadri-Paniput-I charged
9	13:26 Hrs	400kV Bawana-Bahadurgarh line charged
10	13:27 Hrs	400kV Hisar-Moga-I line charged
11	13:28 Hrs	400kV Hisar-Bhiwani- D/C charged
12	13:29 -30 Hrs	400kV Bamnauli-Bawana D/C charged
13	13:25 HRS	220KV Nuna Majra (HVPNL) - Bahadurgarh PG D/C and Nuna Majra (HVPNL) Rohtak Charged.
14	13.31 Hrs	220KV Paniput-Dhulkote-I charged
15	13.32 Hrs	Bhakra ( R ) # 7 started
16	13:33:Hrs	220 KV Panipat - PTPS lines charged and Auxiliary supply extended to Panipat TPS
17	13:33 Hrs	400 kV Bhiwani Bahadurgarh S/C Charged
18	13:35 Hrs	220 KV Dhulkote - Ganguwal - I charged :
19	13:37 Hrs	220 KV Bhakra - Jamalpur - I Charged
20	13:38 Hrs	400 KV Bhiwani - Hisar S/C Charged
21	13:59 Hrs	220 KV Dehar - Ganguwal - I Charged. Extended auxiliary supply to Dehar Units.
22	13.42- 45 Hrs	400 kV Hisar-Bawana and Hissar Patiala Charged.
23	13:42:- 43 Hrs	220 KV Jamalpur - Sangrur - I/II Charged
24	13:48 Hrs	Bhakra island Comprising Dhulkot, Jamalpur, Ganguwal, and Sangrur synchronized with Northern grid on 220kV Bhakra-Ganguwal-IV at Bhakra
25	13.50 Hrs	400 kV Abdullapur-Jhakri-I charged (Abdullapur-Jhakri-II at 1427Hrs)
26	13:57 Hrs	220 KV Bhakra - Ganguwal - I

27	13:58: to 13:59 Hrs	220 KV Ganguwal - Interlinking - I, II charged: Auxiliary Supply now made available to Ganguwal units
28	13:58: to 14:00 Hrs	Nathpa Jhakri Units #2 and 5 synchronized
29	14:07: HRS	BHAKRA (LEFT) 5 synchronized
30	14.10 Hrs	400kV Moga-Jalandhar-I Charged
31	14:10 Hrs	Panchkula - Baddi - Kuniyar supply restored ( Existing Khodri supply was extended upto Kuniyar at 13:16 Hrs to synchronize Bhaba Power House)
32	14:10 Hrs	WYC Synchronized
33	14:12 Hrs	220 KV Bhakra - Ganguwal - II/III charged
34	14:12:- 14:18 Hrs	Baspa-II and Bhabha units got synchronized
35	14:12:- 14:16 Hrs	GANGUWAL units 2 and 3 Synchronized
36	14:18 to 14:43 Hrs	Units at Pong , Dehar & Kotla Synchronized
37	14:20 Hrs	Panchkulla-Kuniyar supply extended upto Kangoo to synchronize the Larji Power House. Shimla-I&II restored from Kuniyar. Larji-I&II feeder restored from Kangoo Sub/Station. Ghanvi M/c No.II also synchronized. Unit at Ghanvi Power House synchronized at 14:43 Hrs.
38	14.18 Hrs	400kV Moga-Kishenpur-I charged
39	14.21 Hrs	400kV Jhakri-Nalagarh-I
40	14.26 Hrs	400kV Nalagarh-Patiala
41	14:26:54:317	220 KV Pong - Bairasuil S/C Charged
42	14.43 Hrs	220 kV Jalandhar-Hamirpur-II charged
43	14.43 Hrs	220 kV Salal -Kishenpur-I charged
44	14.46 Hrs	220 kV Salal -Jammu-I charged
45	14.55 Hrs	400 kV Nalagarh-Kaithal charged
46	15:00 Hrs	220 kV Salal -Kishenpur-lines charged
47	15:01 Hrs - 15:06 Hrs	Unit # 3 and 6 at Salal HPS synchronized
48	14:09 Hrs	400kV Jalandhar-Chamera I HPS charged. But Chamera units were shut down. They were not started.
49	15.02 Hrs	220kV Kishanpur-Udhampur- line II charged
50	15.02 Hrs	220kV Kishanpur-Pampore- line II charged
51	15.06 Hrs	400kV Kishanpur-Wagoora-II
52	15.06 Hrs	220 kV Kishanpur-Dulhasti charged.
53	15.06 Hrs	Dulhasti - unit I Synchronized at Dulhasti
54	15.08 Hrs	400kV Wagoora-Uri-II line charged. (line-I under shut down)
55	15.15 Hrs	Unit # 1 and 4 at Uri HPS synchronized
56	16:18, 16:20 Hrs	GHTP L Mohabat, (#1,2) Auxiliary supply was restored at 13:55 Hrs
57	16:22 Hrs	GGSSTP Ropar #4 synchronized , Auxiliary supply was restored at 12:55 Hrs
58	16:25 Hrs	GNDTP Bathinda #2 synchronized , Auxiliary supply was restored at 14:02 Hrs
59	16:49-16:50 Hrs	Unit 5 and 6 of Panipat TPS synchronized
60	16:49-16:50 Hrs	Note : Start-up supply for unit 3 & 4 was made available at 13:33Hrs and for unit 5 & 8 at

		13:32Hrs. The lighting up of units carried out from 14.20Hrs. to 15.40Hrs.
61	16:50Hrs	GGSSSTP Ropar #2, supply restored at 12:55 Hrs
62	17.28 hrs.	Panipat TPS Unit-7 (250 MW) and Unit 4 (110 MW) synchronized
63	17:44Hrs	GNDTP Bathinda #1 synchronized, Auxiliary supply was restored at 14:02 Hrs
64	18:25 Hrs	GGSSSTP Ropar #1 synchronized , Auxiliary supply was restored at 12:55 Hrs
65	19:39 Hrs	Unit-8( 250 MW) of Panipat TPS synchronized

The Committee feels that the restoration of system was done satisfactorily.

## 5. Analysis of the various tripping

### 5.1 Tripping of 400 kV Mandola - Bawana-1 line

Since circuit -II of **400 kV Mandola Bawana D/C** was under shut down, 400kV Mandola Bawana Ckt. -I was carrying a load of 1000MW towards Bawana. At 12:49:12.625 Hrs, 400kV Mandola - Bawana Ckt. -I tripped at Mandola end on receipt of 'Direct Trip Command'. According to DTL at 400kV Bawana no relay had operated nor any carrier signal was generated/transmitted. However no SOE record was available at Bawana end. The SOE record of Mandaula S/S of POWERGRID confirms receipt of Direct Trip signal. Whether the signal was "from Bawana" is not established.

As per chronological information recorded at Bawana sub station in its log book on 12.10.07, the sequence of activities prior to incident is summarized below:

Sl. No	Time	Events at Bawana Sub station ( as per log book)	Remarks
1.	11:40 Hrs	NRLDC issued code No. 10/537 for shut down of <b>400 kV Mandola Bawana-II</b>	For testing of CVT and general maintenance
2	11:41 Hrs	Switched off 400kV Mandola Bawana ckt. -II	In coordination with Mandaula
3	12:10 Hrs	Line earth switch was closed	On Mandola Bawana ckt. -II
4	12:30 Hrs	Permit to work (PTW) was issued	For Mandola Bawana ckt. -II
5	12.52 Hrs	Load disappears at Mandola Bawana ckt. -I/II	The actual time as per NRLDC is 12.49.12 Hrs

On verifying the records of counter readings of PLCC at Bawana station, it was found that the Channel -I ( Transmitter counter ) TX 1 had counter reading 566

on Circuit -I, since 2nd April 2007. Recording at 0800 Hrs on each day thereafter is 566 being repeated till 08:00 Hrs on 11<sup>th</sup> Oct 2007. At 08:00 Hrs on 12th Oct 2007, the reading changed to 571 (increase by 5). **Annexure-V(a)**

At Mandola sub station of POWERGRID the corresponding reading of Receiver counter (Rx) on 10<sup>th</sup> Oct 2007 was 647 and at the end of C shift (10 PM of 11<sup>th</sup> Oct to 8AM of 12<sup>th</sup> Oct ) the Rx D/T were increased to 654 ( increment of 7). **Annexure-V(b)**

It was reported by DTL that this circuit -I also tripped on 26.4.07 on the similar conditions (DT received from Bawana). On verifying the record at NRLDC web site it was found that this circuit has also tripped on 01.08.07 as shown below:

s.no.	line	outage date &time	revival date &time	reason for outage
1	MANDAULA - BAWANA -I	26.04.2007 18.25	26.04.2007 19.15	Direct trip received from . Bawana
2	MANDOLA-BAWANA-I Bawana end only	01.08.2007 16.01	01.08.2007 16.19	R-phase earth fault

But there is no increment in PLCC Tx counter since 2<sup>nd</sup> April 2007 in this circuit. The committee noted that these PLCC Tx & Rx counters are of electro-mechanical type. The counters are known to advance several steps for one command transmission / receipt. One to One correlation between send/receive counter change may not be possible. It is possible that the Tx/ Rx counters were not working properly.

M/S ABB, being manufacturer of the existing PLCC system, were asked to explain the receipt of spurious direct trip command. ABB Engineers explained that probability for spurious signal under direct trip, was very low, however as per their experience under week signal with increased noise level sometime generate signal for Permissible under reach (PUR)/Blocking career scheme and not for direct trip. On checking the system on 28.11.07, ABB has stated that a very fine adjustment was carried out in AFC voltage level for transmit and carrier frequency, AGC voltage level and Transmit level. And none of the module was replaced as all the primary equipment was found in order.

The committee also discussed the statement of ABB engineers and was of the view that the contention of ABB that Direct Trip command cannot be generated spuriously relates to the fact that the most secure code is used in this channel. At the same time M/S ABB agrees that a some what less secure code used in PUR, which can be spuriously generated. This pertains to the generation of coded signal in the communication channel/protection coupler. The possibility of a command being generated at either end due to lead noise is quite real. In fact this probability is quite real and has been identified in several cases. For instance, in

a recent incident on 24.10.2007, in Southern Region, all 4, 400kV lines from NTPC Simhadri station to AP Transco 400kV S/S at Kalpakka (Vishakhapatanam) tripped on receipt of Direct Trip command, over an extremely secure OF channel, with terminal equipment of ABB make. Investigation by AP Transco revealed that the remote end had indeed generated undesired command.

POWERGRID in the second meeting informed that at 12:47 Hrs isolator no.789A of Circuit -II was opened for AMP work at Mandola end on 12.10.07. (The same also appears in SOE supplied by Mandola). Committee discussed this opening of this isolator a few minutes before the incident and whether a spark due to isolator opening could cause a spurious signal. Chairman, Inquiry committee, visited 400 kV Mandola s/s of POWERGRID and 400kV S/Stn of Bawana on 13.12.07 along with officials of POWERGRID and DTL During the visit the isolator no.789A was opened to find whether any spurious signal is being generated (by arc or by induction) by the PLCC at Mandola end. And the inter trip relays of both the circuits were taken out for a very short duration to avoid any outage at Ckt No.1. No spurious signal was generated.

## **5.2 Tripping of 400kv Ballabgarh Bamnauli-D/C line**

400kv Ballabgarh-Bamnauli D/C lines tripped at Ballabgarh end on operation of Main-I protection. The REL 521 distance relay of ABB make installed at Ballabgarh end by DTL has an over current element which was set at 1.5 (corresponding to 1500 amps at CTR 1000/1) with 20 seconds delay. The loading on this line crossed this value after tripping of 400kv Mandaula-Bawana-I carrying 1050 MW tripped leading to loading of the 400 kV Ballabgarh-Bamnauli D/C line beyond 1000 amps. Also the 400 kV Delhi ring Main system has quadruple Bersimis conductors whose thermal limit is approximately 2560 amps (at 40 degree centigrade) and 5800 amps (at 10 degree centigrade). The loading even under steady state can easily cross 1000 amps as on 12<sup>th</sup> October 2007. The committee is of the view that over current protection need not be applied to 400kV lines. Also section 2 of the CBIP Publication no. 274 '**Manual on Protection of Generators, Generator Transformers and 220 kV and 400kV network**' has not recommended any such protection for 400 kV lines. The CT ratio for the entire 400 kV Delhi Ring Main system may be reviewed and increased so that metering and protection (such as on 12th October 2007) is not adversely affected in future.

## **5.3 Tripping of 400kv Dadri-Panipat II line**

Initially NTPC had reported that 400kV Dadri-Panipat II tripped on main -II Zone - III protection, based on the recording of Main-II protection operation in the DR. However, the relay did not indicate any flag details. This was discussed in 2nd meeting of the committee and the committee did not find evidence of tripping of this line on Zone -III, or load encroachment. NTPC was requested to test the relay and find whether there was some over current element in the relay,

inadvertent enabling of which had tripped the relay, as had been reported in some of the other numerical protection relays..

During the incidental shut down of 400kV Dadri-Panipat II line on 14th Dec 2007, NTPC tested the relay ( AREVA P 437) at Dadri end. It was found that secondary current injection of just above 1 A (corresponding 1000 A in Primary) operated the relay.

NTPC has reported that the relay (AREVA P 437) has multiple protection Starting triggers, viz under impedance, Under Voltage and Over Current. There is no provision of disabling any of them. The Over Current Start setting was at the default setting of 1A, as no tripping was logically expected from this parameter. Further investigation by modifying this setting and injecting current revealed that the relay logic issues a trip command on reaching this set current threshold on elapse of a time delay. The said current setting was revised upwards.

Since there is no way the “Over current start” can be disabled, the setting has since been raised to 1.2A (12 kA, primary) so that it will not be interfering with the normal performance of the relay.

*Subsequent investigation by NTPC has identified that the Zone-7 and Zone-8 operation of the relay is independent of Impedance (distance) measurement and, after elapse of the set time, checks for starter operation along with direction for Zone-7 and just starter operation for Zone-8. Instructions for blocking Zone-7 and Zone-8 trip commands has already been issued.*

Copies of the DR of this line tripping event as recorded by the stand- alone DR (M840DR, clearly indicating Main-II tripping) and Main-I (Areva T&D, P442) are enclosed at **annexure VI**. NTPC has stated that the trip record could not be retrieved from Main-II relay.

#### **5.4 Tripping of 400kv Dadri-Panipat I**

400 kV Dadri-Panipat I line tripped at 12:52:22.740 Hrs from Panipat end on over current protection separately applied on this line at Panipat end. At the time of tripping the current was approximately 1.7 kA; the line CB at Dadri end tripped on receipt of “direct trip” command from the remote end. . It could not be ascertained from recorded data, why and how a “Direct Trip” command was sent from Panipat end. . This line tripped 653 ms after 400 kV Dadri-Panipat II (which tripped at 12:52:22.087).

#### **5.5 Tripping of 400kv Dadri Malerkotla line**

400kv Dadri-Malerkotla tripped at 12:52:34.849 Hrs with Main -II protection trip at Malerkotla end on operation of non directional O/C element . At Dadri end the line tripped on DT received. DR output at Dadri end shows that the line was idle charged from Dadri end with Malerkotla end open, for

considerable time before it finally tripped at Dadri end on Direct Trip received, following the operation of over voltage protection at Malerkotla end. At the time of tripping it can be seen from the Dadri end DR (**Annexure -VII**) that :

1. The line current was just 180A, which corresponds well with the line charging
2. On Dadri end CB opening, the voltage vanished

#### **5.6 Tripping of 400kv Bassi Hissar line**

400kv Bassi-Hissar tripped at 12:52:23.840 Hrs Hissar Main-I protection, Zone-I, on Power swing

#### **5.7 Tripping of 220kV lines**

- a) **Ballabgarh Ch Dadri:** 220kv Ballabgarh-Ch Dadri tripped at 12:52:22.594 Hrs at Ch Dadri end only. MICOM P442 trip phase ABC Zone-I PSB operated. Fault duration 2.048, fault location 121.6 Kms from Ch Dadri end. This is a case of load encroachment following the trippings 400 kV Ballabgarh -Bamnauli line D/C and 400 kV Dadri Panipat D/C.
- b) **220kv Samaypur Ch Dadri:** 220kv Ch. Dadri- Samaypur tripped at 12:52:22.844 Hrs at Samaypur end only. Main-II MM3V 30G, 30K, 85X2, 186A, 186B. It is a case of load encroachment considering the heavy power flows taking place across this section after tripping of the 400 kV lines in the vicinity.
- c) **220kV Khetri Ch Dadri-I :** 220 kV Khetri Ch Dadri -I tripped from Charkhi Dadri end only with MICOM P442 phase A, phase C, Zone-II DR:- Started phase A,B,C, trip phase A, B, C Started element Dist; Dist Trip zone-II, A/R, lockout 7; fault duration 3.420msc, relay trip time 82.08 msc, fault location 139.5Kms, IA, IB, Ic, 1.768KA; 1.847KA, 1.341 KA, fault in zone-II Relay 86A, 86B, 86, 86T, A/R lockout.
- d) **220kv Khetri Ch Dadri-II:** 220kv Khetri Ch Dadri-II tripped from Khetri end on operation of distance protection (SIGRA 4.2).
- e) **220kv Khetri - Hissar :** 220kv Khetri-Hisar tripped at 12:52:23 Hrs on Distance relay operated at Hissar end (MICOM)

From the above it was concluded that four line namely Ballabgarh- Baumnauli circuit I and II, Dadri Malerkotla and Dadri Panipat -I tripped on operation of the un- intended, surprise element of over current protection, and one line - Mandaula- Bawana- I on operation of un warranted carrier protection and one line Dadri Panipat -II on unexpected behaviour of distance protection. 400 kV Bassi-Hissar, other above mentioned 220 kV lines tripped on Power swing/ load encroachment. These trippings occurred when one element ( Bawana-Mandaula-II) was already under planned shutdown.

The tripping of these 400 kV and 220 kV circuits resulted in isolation of Punjab, major parts of Haryana, Himachal Pradesh, Jammu & Kashmir, UT Chandigarh



and some parts of Delhi, which collapsed due to mismatch of generation and load. The deficit in this sub system was of the order 3700 MW. The reported relief by UFR and df/dt was around 1679 against the designed value of 3713 MW in the affected system. The affected system had an initial deficit of 3724 MW.

The recommended relief in each stage of UFRS and df/dt and the corresponding relief submitted by states are placed below:

States	Flat Under Frequency Relays dated 12.10.08						Total UFR		df/dt	
	48.8 Hz		48.6 Hz		48.2 Hz		Desired	Reported	Desired	Reported
	Desired	Reported	Desired	Reported	Desired	Reported				
UT CHD	0	0	10	0	0	6	10	6	0	0
Delhi	27	247	35	0	88	0	150	247	193	51
Haryana i/cBBMB	83	42	105	38	262	296	450	439	600	63
HP	20	20	20	0	75	0	115	20	0	0
J&K	40		50		75	45	165	45	0	0
Punjab	180	24.39	220	86.61	400	274.23	800	808	1230	0
Punjab (BBMB)						232				
Total	350	333.39	440	124.61	900	853.23	1690	1565	2023	114
Note:										
* Assuming 1/4 <sup>th</sup> of Load relief desired from the partly affected system of Delhi.										
** Assuming 3/4 <sup>th</sup> of Load relief desired from the partly affected system of Haryana										

## 6.0 Recommendations

### 1. Blocking the over current protection on transmission lines in Northern region

The 400kv Ballabgarh-Bamnauli D/C line tripped due to an over current element in REL 521 distance relay of ABB make which was set at 1.5 (corresponding to 1500 amps at CTR 1000/1) with 20 seconds delay. This over current protection is not required **DTL has subsequently disabled this overcorrect protection and has also raised the CT Ratio to 2000/1**. All 400 kV lines in NR should be reviewed for this type of arrangement and disable the tripping under these conditions. For 220 kV systems also it may be ensured that **'the protection must not operate for highest load current during both normal and dynamic power system operation'**.

*Committee recommends that over current protection on all interconnected*

*400 and 220 kV transmission lines be disabled/removed and wherever they cannot be disabled they may be set to such a limit so that they would not operate for highest load current during both normal and dynamic power system operation.*

*Some 220kV lines have IDMT O/C protection as back up, which cannot and should not be blocked. However the setting of IDMT O/C relays must be such that the protection will not operate for over loads.*

*NTPC has reported that the numerical relay (AREVA P 437) has multiple protection Starting triggers, and identified that the Zone-7 and Zone-8 operation of this relay is independent of Impedance (distance) measurement and, after elapse of the set time, checks for starter operation along with direction for Zone-7 and just starter operation for Zone-8. Committee recommends that Zone-7 and Zone-8 trip commands may be blocked in the*

## **2. Proper maintenance of PLCC on transmission lines in Northern region**

No abnormality was observed as per testing done by ABB engineer at Bawana- Mandola line -I on 28.11.07, but this was the second incident (first on 26.4.07) of direct tripping at Mandola end when no relay operated at Bawana end. The performance of PLCC system is deteriorating in the region, hence **committee recommends for special care for maintenance of PLCC system in the Northern Region be taken.**

## **3. Performance of UFRs and df/dt relays provided for contingency Conditions**

Analysis of load relief due to operation of under frequency relays and df/dt relays indicates that the total relief observed at the time of grid disturbance was inadequate. The relief due to operation of UFR was 1565 MW against expected relief of 1690 MW whereas the relief due to operation of df/dt relays was only 114 MW against desired relief of 2023 MW. Further the relief at 48.8 Hz (Stage-I) and 48.6 Hz (Stage-II) is much below the desired level which indicates that the utilities are providing bulk of the relief at 48.2 Hz (Stage-III) which is not desirable. To remedy the situation, it is recommended that :-

- a) The constituents shall ensure that adequate relief is provided at every stage as desired by OCC.
- b) The relays should be periodically tested for their performance.
- c) 33% extra load should be connected through UFR/RLSE to account for the power cuts for load control etc.
- d) The installation of df/dt relays as per the recommendations of the OCC shall be expedited.

#### 4. Event Logger (EL) at Bawana and NTPC Dadri and times synchronization of DR/ ELs

It was found that EL at 400 kV sub station Bawana of DTL has been lying faulty for a long period and is stated to be beyond economical repair. At 400kV NTPC Dadri also, old param 2000 type EL is provided, which does not store incidents (no memory). Event Logger (EL) being not available at important stations, the analysis of the sequence of events becomes very difficult. This aspect had been emphasized by various enquiry committees in the past also. This is vital not only for the event analysis and investigation but also for the operators learning. 400 kV sub station Bawana and NTPC Dadri are important sub station of NR, hence, **the committee recommends that new event logger may be provided at Bawana Sub Station. NTPC Dadri may operationalise the EL, if possible by rectifying the defects in the existing system and if not feasible replace the existing EL immediately.**

Also Time synchronisation for DRs/ELs at substation is an issue discussed time and again. Still not much headway has been made as would be clear from this event. **The committee recommends that time synchronization at 400 kV and important 220 kV be done by all utilities.**

#### 5. Training of Sub station operators

It has been observed that uniformity is not adopted in recording of reading at different substations. Also incidents of cuttings and over writing without verifying signatures indicate non serious approach adopted by the operating personnel of the sub stations. It is utmost important that the personnel stationed on all 400 kV & 220 kV substations and Switchyard should be able to have clear understanding and comprehension of various annunciations/alarms/trips appearing and their proper recording be emphasized. **So this committee also proposes that periodical refresher courses to upgrade the skill and alertness must be conducted under the aegis of NRPC and NRLDC.**

#### 6. Islanding schemes for stations

There have been frequent loss of load in the system of Punjab/HP/Haryana/J&K/BBMB. To restrict the extent of blackout as well as generation loss, the Protection Committee of NRPC might consider islanding schemes for generating stations and subsystems at an appropriate frequency. Any such scheme would however require initiative and close co-operation by state utilities in terms of load as well as availability of synchronising facilities at intermediate substations for quickly restoring systems.

#### 7. Functioning of FGMO

To control the frequency variation primary response from generating units in the form of Free Governor Mode of Operation (FGMO) is essential during integrated as well as islanded mode. In the absence of governor's response survival of islanded system is difficult. The committee recommends that FGMO may be made operational at all the generating stations.

**.8. SPS on 400 kV Mandaula-Bawana D/C and Bamnauli-Bawana D/C**

The 400 kV Mandaula-Bawana D/C and Bamnauli-Bawana D/C are vital infeeds to Bawana sub station. A System Protection Scheme (SPS.) which senses the flow on all these four lines and sheds the entire Bawana load in case of loss of all the four infeeds is necessary so that this entire west Delhi load does not act as a drag on the islanded system of Punjab/HP/Haryana/J&K/BBMB. The committee recommends implementation of above SPS in consultation with protection sub committee of NRPC.

9. In addition to SPS, Under Voltage and Under Frequency load shedding at Bawana and Bamnauli is considered necessary to avoid the load drag on the islanded system of Punjab/HP/Haryana/J&K under contingency. Therefore committee recommends that this scheme may be implemented at the earliest.

## Acknowledgement

The committee gratefully acknowledges the cooperation extended by the officials of BBMB, HVPNL, PSEB, HPSEB, DTL, NTPC, NRLDC and POWERGRID in the collection of information pertaining to Grid incident and its analysis.

The committee places on the record its appreciation of the assistance provided by, Shri R M Malhotra, Dy. General Manager DTL, Shri S R Narasimhan, Chief Manager, NRLDC, Shri Rajesh Kumar, Manager, NRLDC and Shri Vikram Singh, Executive Engineer, NRPC in helping in the analysis and preparation of the report.

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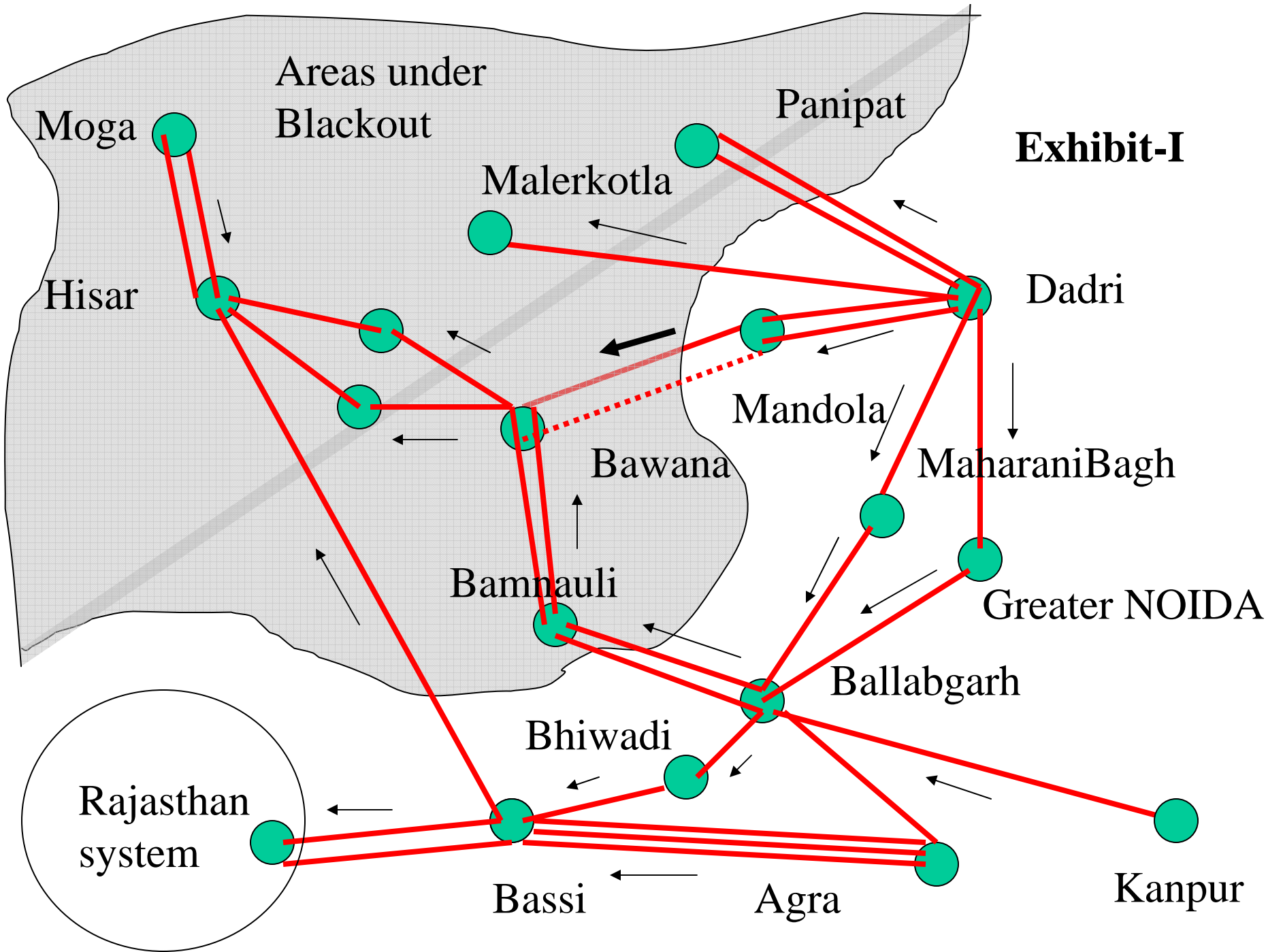
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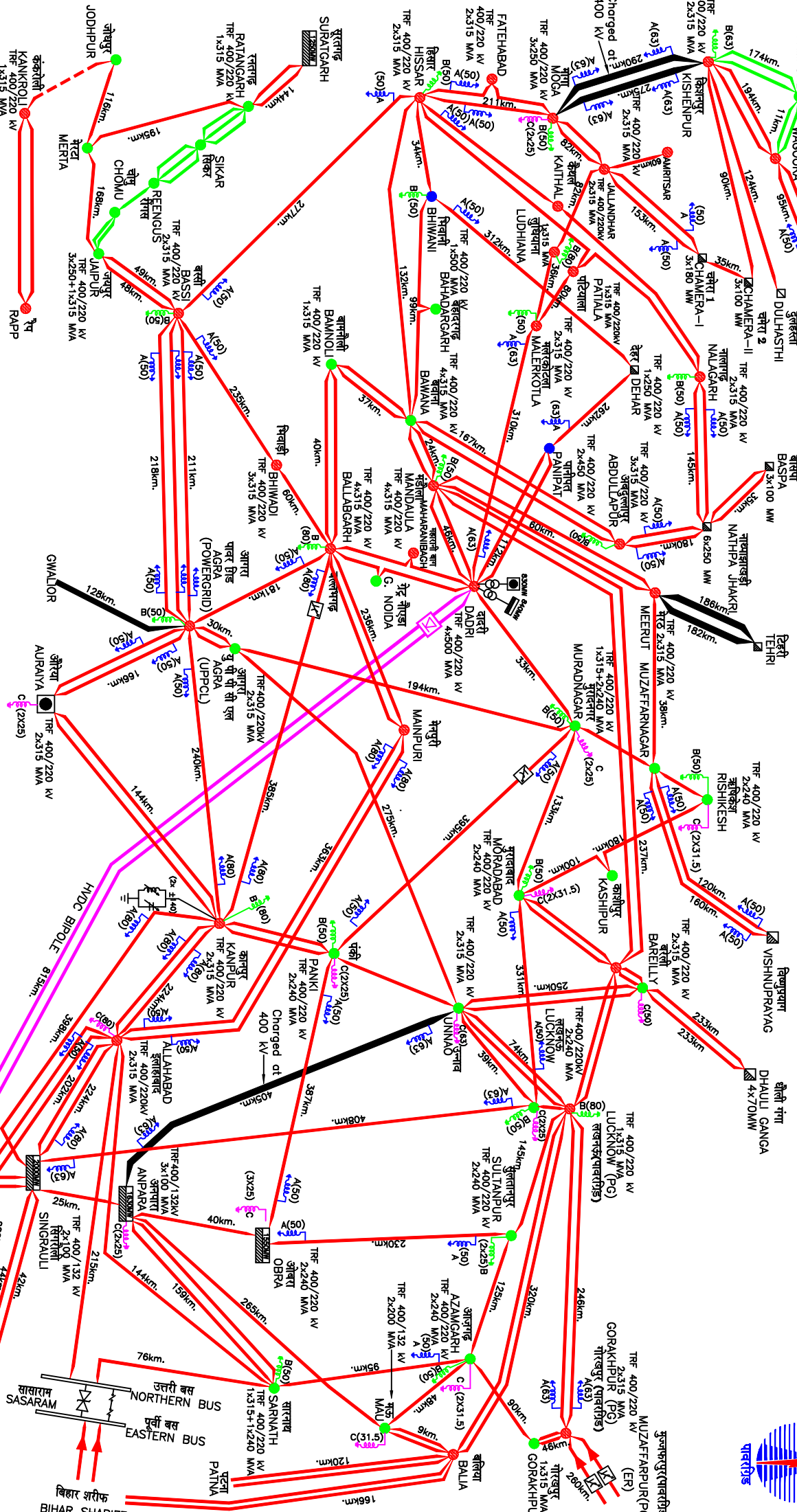
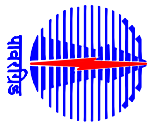
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# 400 केवी उत्तर क्षेत्रीय गिड डायग्राम OF NORTHERN REGION



## LEGEND:-

- 400 kV UNSWITCHED LINE REACTOR
- 400 kV SWITCHED BUS/LINE REACTOR
- 33 kV SWITCHED BUS REACTOR
- HDCC BACK TO BACK
- 220 kV TRANSMISSION LINES
- SVC & BUS/LINE REACTOR RATING IN MVAR
- 765 kV TRANSMISSION LINES
- HDCC - 500 kV LINE
- FACT
- 400 kV TRANSMISSION LINES
- 220 kV TRANSMISSION LINES
- STATIC VAR COMPENSATOR
- 400 kV UNSWITCHED LINE REACTOR
- 400 kV SWITCHED BUS/LINE REACTOR
- 33 kV SWITCHED BUS REACTOR
- HDCC BACK TO BACK
- 220 kV TRANSMISSION LINES
- SVC & BUS/LINE REACTOR RATING IN MVAR

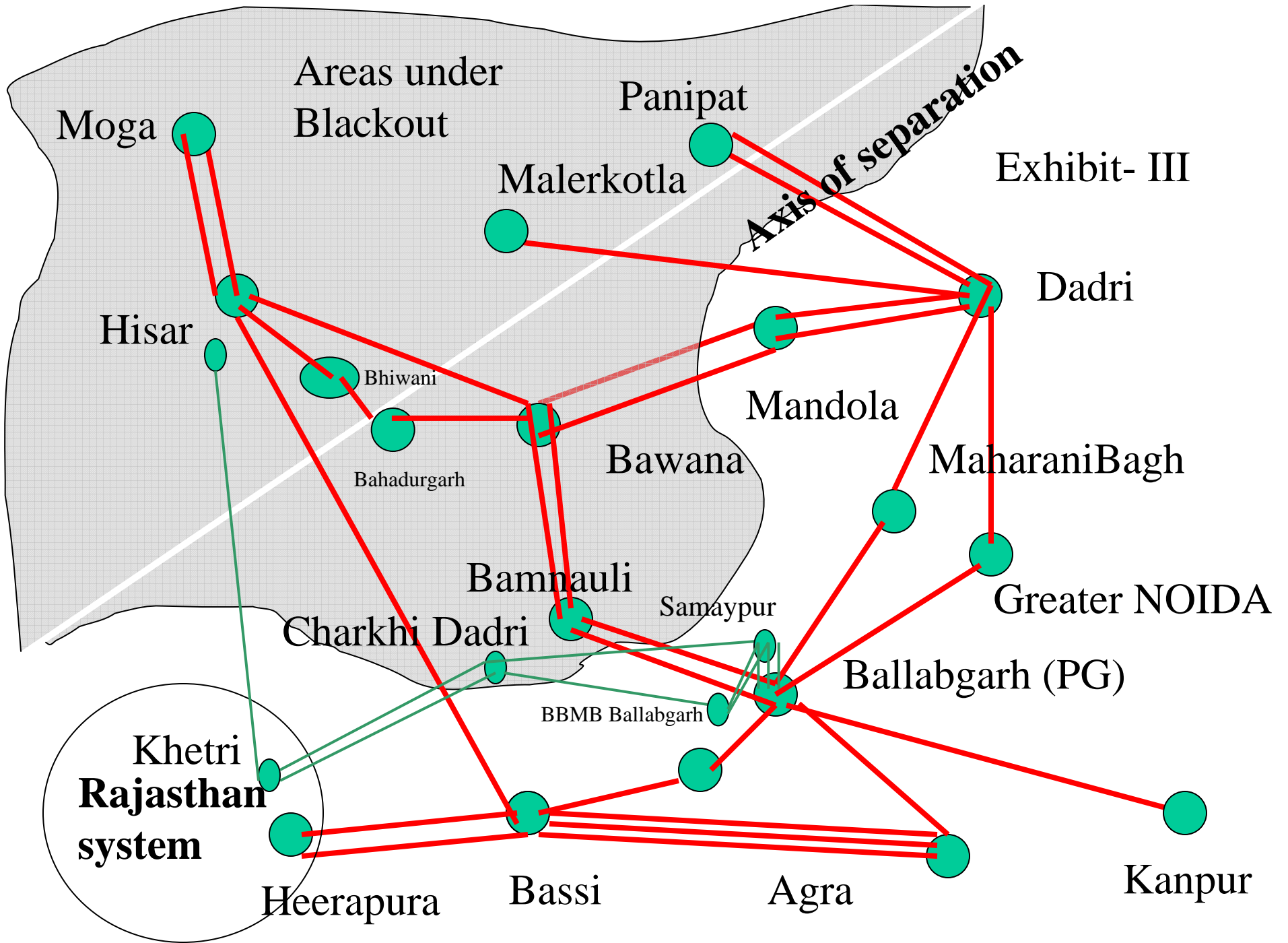
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30 केवी ११० केवी/१३२ केवी  
NRLDC/POWERGRID

400 केवी उत्तर क्षेत्रीय गिड डायग्राम  
400 KV GRID DIAGRAM OF NORTHERN REGION

प्रारंभकर्ता  
DRN. Ramjit

जून, २००८  
JUNE, 2008





<b>Annexure -II</b>				
<b>Transmission line ownership</b>				

S.No.	Line	Bay equipment mtced by		Line ownership and Maintained
		End 1	End 2	
1	400 kV Mandaula Bawana-D/C	Owned by DTL , mtd by POWERGRID	DTL	DTL
2	400 kV Ballabgarh Bamnauli- ID/C	Owned by DTL , mtd by POWERGRID	DTL	DTL
3	400kv Dadri- Panipat D/C	NTPC	owned PG and Mtd by BBMB	POWERGRID
4	400 kV Dadri- Malerkotla	NTPC	POWERGRID	POWERGRID
5	220 kV Samaypur- Ch. Dadri	BBMB	BBMB	BBMB
6	220 kV Samaypur- Ch. Dadri	BBMB	BBMB	BBMB
7	220 kV Khetri- Charkhi Dadri-I & II	RVPN	BBMB	BBMB
8	220 kV Hissar-Khetri	BBMB	RVPN	RVPN

**ANNEXURE:III Relay Flag indication**

S. No.	line	Time of trip	Time of restoration	Relay Flag indication	
				End A	Other end
1	400kV Mandaula Bawana-1	12:51:24:814	13.09	Direct trip signal from bhavana CB II auto trip 85 LO , main & tie CB 186A, 186B.	N/A
2	400kv Ballabgarh Bamnauli-II	12:51:45:256	13.19	ABB make REL 521 distance relay over current element. Main-I protection operated at Ballabgarh.	Direct trip channel/2 recieved
3	400kv Ballabgarh Bamnauli-I	12:52:05:318	13:16	Main-I line protection	Main -1 protection tripped
4					
5	400kv Dadri- Panipat II	12:52:17:291	14:29	Main-I (P442 MICOM) relay. Main -II zone- 7 ( areva p 437)	
6	400 kV Dadri- Panipat I	12:52:22:087	13:23	Channel ½ Direct trip command received CB auto trip, group A & B three phase trip	Over current 86,67X,A/R relay 186A, 186B OF X-3, A/R relay 186A, 186B OF X-4
7	220 kV Ballabgarh- Ch. Dadri	12:52:22.594	14:19	Did not trip	MICOM P442 trip phase ABC Zone-I PSB operated
8	400 kV Dadri- Malerkotla	12:52:22:720	21:10	Direct trip from the other end due to high voltage, group A & B three phase trip, no indication in D.R.	Main -II protection trip
9	220 kV Samaypur- Ch. Dadri	12:52:22:844	14:26	Main-II MM3V 30G, 30K, 85X2, 186A, 186B	Did not trip

10	220 kV Khetri- Charkhi Dadri-I & II	12:52:23.141	15:39	MAIN-I distance prot. Zone -1 MAIN-II- phase ABC carrier received 7sent .PSB operated.	MICOM P442 phase A, phase C zone-II Relay 86A, 86B, 86, 86T, A/R lockout
11	220 kV Hissar- Khetri	12:52:23:227	16:02	UFR operated, Micom facia A-phase , c-phase,trip phase ABC ,distance trip ZONE-1	MAIN-I phase ABC zone -1 , dist- 74.29km,PSB . MAIN-II-, 186 ,186dist 66.6km ,carrier fail
12	400kv Bassi- Hissar	12:52:23.865	13.12		Main-I protection, Zone-I, Power swing
13	220 KV Ch. Dadri - Rewari S/C	12:52:23:151	13:54	Tripped on operation of under frequency relay.	Did not trip
14	220 KV Ch. Dadri - Mohinderga rh	12:52:23:159.	13:56	Tripped on operation of under frequency relay	Did not trip
15	220 KV Bhakra - Ganguwal - IV	12:52:31:393	13:48	Alarm Annunciation Indications:- Auto reclose lockout trip, Main-I trip A, Main- I trip B, Main-I trip C, MICOM relay, Trip / Alarm, TC-I & TC-II, MICOM Indications: Trip, healthy, zone-I, Carrier send, PSB operated, MICOM Relay Active Group-I, started phase ABC, tripped phase ABC,	

				start element distance, distance trip z-l, 12/10/07-12:52:30.468, AR lockout start > system frequency 50.00 HZ, fault duration 1.007s, relay trip, time 80.00ms, fault location 140.4Km, IA-461.5A, IB-441.5, IC-540.8A, VBN-37.64KV, VBN-46.97KV, VCN-41.88KV, Fault resisenace 426.8ohm, fault in zone-l.	
16	220 KV Bhakra - Ganguwal - V	12:52:31:574	14:49	MICOM relay: Active group -I, started phase ABC, tripped phase ABC, started elements distance, Distance trip z-l, 12/10/07, 12:52 30.466, AR lockout, ssystem frequency 50.00 HZ, Fault duration 3.1135, Relay trip time 80.00ms, Fault location 0.000m, 1A-5067	
17	220 KV Bhakra - Jamalpur - I	12:52:32:393	13:37	Alarm Annunciation Indications:- Auto reclose lockout trip, Main-I, Trip-A, Main-I, Trip B, Main-I, Trip C, Main relay Trip/Alarm, TC-I & TC-II and auto reclose operated alarm. MICOM Indications:- Trip, healthy, zone-I, SOTF, Carrier send, MICOM Relay Active group-I, started phase A, Tripped	Opened manually.

				phase ABC, start elements distance over current start element distance, overcurrent start I>I, Earth fault start IN, SOTF TOR tripp, 12/10/07 13:43, 15.447, AR lockout system frequency 49.32 HZ, Fault duration 57.45 ms, relay trip time 79.4ms, Fault location 3.957 Km, IA-1.680A, IB-30.00A, IC-29.41A, VAN-1355KV, VBN-120.7 KV, VCN-127.6KV, Fault resistance 8.775ohm fault in zone - zone-1	
18	220 KV Bhakra - Jamalpur - II	12:52:32:568	14:46	Opened manually.	MICOM trip zone-I out trip, Main-I Trip A, Main-I Trip B, Main Trip C
19	220 KV Jalandhar - Pong - II	12:52:33:497	14:46	Opened manually.	Main-I P-10 A-N, C-N, Z3, C-A, A-B, B-C, Z3F, 86C,86T. Main-II MM3V 186A, 186B
20	220 KV Jalandhar - Pong - I	12:52:33:523	14:15	Opened manually.	Main-I P-10 A-N, B-N, C-N, Z3, C-A, A-B, B-C, Z3F. 86A, 86B, 86C, 86T.
21	220 KV Bhakra - Jamalpur - I	13:43:14:547	20:19	Auto reclose lockout trip, Main-I, Trip-A, Main-I, Trip B, Main-I, Trip C, Active group-I, start elements distance over current Earth fault start IN.	Main-I MICOM P442 Statring phaseA, trip A,B,C. Tripped Zone-II Carrier received. Fault distance

					78.63 Kms Fault duration 435.9 ms Main-II MM3V 30G,30H,30D. Aux relay VAA O/C,& DP,Trip ckt faulty. Facia a/r lockout Main-I trip a,b,c micom relay trip/ALARM

