Agenda note for 32nd Meeting of the Standing Committee on Power System Planning in Northern Region.

1. Confirmation of the minutes of 31st Standing Committee on Power System Planning in Northern Region held on 02/01/2013

The minutes of the 31st meeting of Standing Committee on Power System Planning in Northern Region held on 02.01.2013 at Gurgaon, were circulated vide CEA letter No. 1/9/10-SP&PA/ dated 04.02.2013.

Observations received from various constituents are as given below:

UPPTCL

UPPTCL vide its letter dated 13/5/2013 (copy enclosed at **Annexure-I)** has indicated that LILO of Agra (UP)-Shamshad 220kV S/c line at Agra PG mentioned in the Minutes at page 40 needs to corrected as LILO of Shamshad -Firozabad 220kV Sc line at Agra (PG). It is agreed. Members may note the same.

HVPNL :

HVPNL vide its letter dated 28/3/20103 (copy enclosed at **Annexure-II)** has forwarded following comments on the minutes,

(i) ***(Item no 10 e):***

System strengthening to overcome constraints in Northern RegionIt has been decided in the meeting that all four 315MVA 400/220kV kV ICT at 400 kV substation Ballabgarh will be replaced with 500MVA transformer. In the meeting, Haryana stressed on requirement to provide additional 400/2200kV transformer at 400kV substation Kaithal out of one of the transformer that gets spared at 400kV Ballabgarh. The proposal given by Haryana was agreed upon in the meeting.

In this regards it is mentioned that Kaithal is a 400/220kV substation of POWERGRID with transformation capacity of 2x315MVA. Presently loading of the order of 250MVA/trf is being witnessed. Under outage of one transformer the other transformer would get critically loaded. In view of above, it is seen that the request of HVPNL is in order and may be approved. Being an augmentation work in

existing POWERGRID substation it is proposed that this work may be carried out by POWERGRID under ongoing/New regional strengthening scheme.

Members may concur.

(ii) ***Item No-29:***

After deliberations it was decided that multi circuit line from 400kV substation Ballabgarh to Greater Noida 400kV D/c (5km) will be constructed on multi circuit towers, keeping in view the Right of Way constraints. It is understood that as deliberated in the meeting, the utilization of the second line in these multi circuit towers will be as per future requirements of Haryana/CTU.

In this regard it may be mentioned that under NRSS-XXXIII following ISTS elements have been proposed:

- Ballabhgarh – Greater Noida (New) 400 kV D/c (5 km from Ballabhgarh S/s on multi-circuit towers)
- Establishment of 2x500 MVA, 400/220 kV GIS substation at Greater Noida(New) with a short circuit current rating of 50 kA.

The scheme is being taken up under tariff based competitive bidding route. It may be mentioned that the elements are ISTS. The utilization of spare circuits on the above planned multi- circuit towers would be as per the decision of standing committee.

(iii) 400MVAR SVC at Hissar:

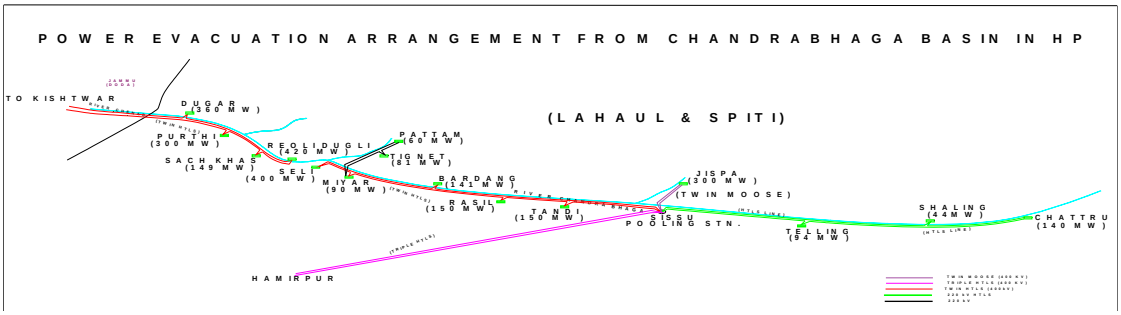
“SVC at Hissar may please be considered to be provided along with Nallagarh and Lucknow in the first instance”

In the last SCM of NR, it was discussed and agreed that during peak load conditions when agriculture demand is very high the voltage variation is very large. It was agreed that SVC at Fatehpur, & Hissar may be firmed up later and put up to Standing committee again. Studies are being carried out on all India basis to study the combined effect of all SVC being proposed till date. The requirement of SVC at Hissar would also be studied under the same and will be taken up in forth coming SCM meeting.

The minutes of the meeting may please be confirmed.

2. Evacuation of 4 nos. of HEP's of HP in Chandrabhaga/ Chenab basin

During the 30th & 31st Standing Committee Meeting of NR Tr. System for evacuation of power from Chandrabhaga Basin was discussed. As agreed during the meeting Power from generation projects in the downstream of Seli HEP i.e. Reoli Dugli (420 MW), Sach Khas (267 MW), Purthi (300 MW), Duggar (236 MW) and Kirathai-I (400MW in J&K) are to be evacuated upto Kirthai-II, beyond which Quad HTLS has been proposed.



HPPTCL vide its letter dated 02/04/2103,copy enclosed at **Annexure-III,** has now indicated that 4 nos of HEP's with cumulative capacity of 218MW (Saichu Sachkhas-104 MW,Saichu-43 MW,Chiroti Saichu-26 MW & Lujai-45 MW) would also be evacuated through this corridor by LILO of one circuit of 400kV Reoli-Kirthai-II D/c (twin HTLS) at Saichu Sachkahs where power from the HEPS shall pooled at 132kV and further inject the pooled power at 400kV level by construction of 132/400kV substation by HPPTCL.

In this regard to may be mentioned that total power to be evacuated over this corridor is about 2000MW (considering 10% overload). Considering the revised quantum of power to be evacuated over this corridor it is proposed that the corridor may be built with triple HTLS conductor as against twin HTLS conductor proposed earlier.

Further it may be mentioned that connectivity to Sach Khas was approved in last connectivity/LTA meeting held along with 31 SCM. As requested by the applicant

the connectivity of the project was granted from June, 2021 through following system

- Portion of Reoli Dugli– Kishtwar 400 kV D/c- from Sach Khas to Kishtwar - **Proposed Implementation as ISTS**
- Establishment of 400 kV switching station at Kishtwar–**Proposed implementation as ISTS**
- LILO of Dulhasti / Ratle – Kishenpur 400 D/c (Quad) line at Kishtwar

HPPTCL may indicate the time frame by which the above proposed generations of 218 MW are expected. Further connectivity/LTA as per CERC regulations has to be applied by HPPTCL in this regards.

Members may discuss and concur.

3. 400kV intra-state transmission system of Punjab

PSTCL vide its letter dated 29/5/2013 (copy enclosed at **Annexure-IV)** has indicated that a new Thermal Power station of 1320MW near Mukerian has been sanctioned under state sector. Accordingly PSTCL has proposed following composite 400kV power evacuation system for Mukerian(1320MW), Gidderbaha (2640MW) and Mansa(1320MW):

- Gidderbaha-Muktsar 400 kV D/c
- LILO of both circuits of Talwandi Sabo-Muktsar 400 kV D/c at Gidderbaha
- LILO of one circuit of Rajpura TPS-Nakodar 400 kV D/c at Dohra
- Dhuri-Amloh 400kV D/c
- Rajpura TPS -Rajpura 400kV D/c (additional link)
- Makhu-Dasuya 400 kV D/c
- Mansa-Barnala 400kV D/c
- Talwandi-Mansa TPS 400kV D/c
- Barnala-Amloh 400kV D/c
- Mukerian-Wadala Granthian(Near Batala) 400kV D/c

- Mukerian-Doraha (near Machiwara) 400kV D/c
- Wadala Granthian-Nakodar 400kV D/c
- Establishment of 2x500 MVA, 400/220 kV new substation at Wadala Granthian, Doraha, Amloh, Barnala,Mansa and Dasuya
- Augmentation of 400/220 kV transformer each at Rajpura, Dhuri, Muktsar with 1x500MVA.

However it may be mentioned that as per NTPC's connectivity & LTA application for Gidderbaha about 50% of the project is to be allotted to regional beneficiaries. Further from Mansa TPS also about 396 MW is to be evacuated outside the state. During the studies Gidderbaha-Fatehbad 400kV D/c was tentatively proposed for transfer of power outside the Punjab state. However the above system is to be firmed up after the commissioning schedule is finalised. It is mentioned that the connectivity and LTA application for Gidderbaha project was put on hold on the request of NTPC in the 31st SCM.

Study has been carried out for end of XII plan considering 12700 MW load for Punjab. Studies indicate that under normal condition loadings are within limit.

Here it may be mentioned that Punjab has present installed capacity of about 3768 MW. Further generation addition of 3920 MW (Talwandi (1980 MW), Rajpura (1400 MW) and Goindwal (540 MW)) is already in the pipe line. With the present proposal, additional generation of 3630 MW (Mukerian-1320 MW, Gidderbaha (50%)-1320 MW, Mansa TPS – 996 MW) would be available for Punjab. Hence power availability from intra-state network would be about 10200 MW. During winter the load of Punjab is minimal. In December'2012 the peak demand of Punjab was about 5300 MW. The results of the off-Peak studies (with 50% Peak load) is enclosed at **Exhibit–I.** It may be seen from the study results that planned ISTS interconnection points like Moga, Fatehabad are being heavily overloaded even under base case. As such there is requirement of additional ISTS links to be planned from intra- state system of Punjab.

PSTCL is advised to review their above proposal of composite power evacuation system in line with the observations mentioned above.

Members may discuss and concur.

4. Inter-connection of 2 nos. of 400kV Lines at Allahabad(PG) 400 kV Substation from Bara generation project

Bara STPS (3x660 MW) is a State IPP generation project, under construction in Uttar Pradesh. First unit of this generation project is expected by May, 2014 (UPPTCL may confirm). UPPTCL vide teir letter dated 15.5.2013 (copy enclosed at Annexure-V(a)) has desired to interconnect the Bara Generation project with 400/220 kV Allahabad (PG) substation for providing start-up power and evacuation of gene ration from one unit as the planned evacuation system of the above generation project being developed under PPP mode by UPPTCL.is delayed.

CEA vide letter dated 17/5/2013 (copy enclosed at Annexure-V(b))had indicated that permission is granted for connecting UPPTCL 400kV line from Bara generation project at 400/220 kV Allahabad (PG) substation as an interim measure and stated that the matter would be placed before the SCM of NR for concurrence.

In this regard CTU has submitted that Allahabad 400/220kV Substation is receiving power from Singrauli/ Rihand generation complex and Eastern region power from Sasaram. Further, Long Term Access has been granted for transfer of about 400 MW power from Meja generation project of NTPC from Allahabad 400/220 kV substation, Studies indicated that there are transmission constraints for evacuation of additional power with existing lines in Allahabad-Fathepur-Kanpur corridor. Studies are enclosed at **Exhibit–II (a) & (b).** From the studies it seen that even under (n-1) contingency the line loadings are of the order of 800-850MW/ckt on 400kV lines. As an alternate, studies were also carried out with inter connection of Bara generation with Fatehpur 765/400/220kV substation of POWERGRID. Studies are enclosed at **Exhibit–III (a) & (b).** It has been observed that 400kV lines in Fathepur-Kanpur corridor remain critically loaded. In view of this, proposed connectivity of Bara generation project with Allahabad (PG) does not appear to be feasible.

Members may deliberate and decide.

5. Studies for High Voltage for identification of Reactors

During the 24th TCC and 27th NRPC Meeting held on 29th and 30th November, 2012, the issue of reactive power management and high voltage control was

discussed. In the meeting it was desired that CTU would carry out studies for identifying reactive compensation required in intra-state network at 220 kV level. Accordingly the studies have been carried out by CTU and its findings are given below:

Approach to study:

- Present Light load condition was simulated in the studies. In winter the minimum demand of Northern region had touched about 18550 MW. Accordingly in the studies, the same load was simulated.
- All existing / planned 400 kV and 765 kV reactors have been considered.
- As the study is for identifying the reactive compensation requirement for meeting the MVAr generation by 220kV & 132kV lines under light load condition therefore, in the studies 400 kV network has been isolated from 220kV and import from 400kV network has been simulated through equivalent fictitious generation. To determine the reactive compensation requirement, MVAr absorption by the fictitious generations has been noted.

Result of studies:

- High Voltages were noted at the following 400kV buses:

BUS#	X-- NAME-- X	BASK V	V(PU)	BUS#	X-- NAME-- X	BASK V	V(PU)
17426	RISHIKE4	400	1.09	18475	BAL74-PG	400	1.037
17467	KASHIPU4	400	1.0747	18452	KOTESHWA	400	1.0367
16409	HINDAU-4	400	1.0711	18405	MEERUT	400	1.0366
16410	BHILWA-4	400	1.0699	12419	DEHAR	400	1.0361
19402	BASPA4	400	1.0604	17480	SARNATH4	400	1.0361
18460	PANCH-PG	400	1.0604	18437	LUCK4-PG	400	1.0359
18456	KARCHAMW	400	1.0602	14406	DEEPALPUR	400	1.0353
18403	NATHPA4	400	1.0595	18451	LUCK74-P	400	1.0353
18401	ABDULLAP	400	1.0588	17401	UNNAO4	400	1.0346

18421	BHIWADI	400	1.0551	17446	MURADNG4	400	1.0343
16411	CHABRA-4	400	1.0524	18473	JAIPU_PG	400	1.0343
18445	NEEMR-PG	400	1.0497	14409	PANIPAT	400	1.034
17440	MURADAB4	400	1.0486	18419	BALLABHG	400	1.034
17485	SULTANP4	400	1.0469	18406	BAREL-PG	400	1.0338
17427	GORAK_UP	400	1.0465	18438	LUCK_FC1	400	1.0334
16406	HERAPU-4	400	1.0452	18468	MEERTFS2	400	1.0333
18427	GORAKHPU	400	1.0451	18467	MEERTFS1	400	1.0333
18443	SONEP-PG	400	1.0447	18442	PATIALA	400	1.0331
18450	MANESAR	400	1.0442	18435	MANDOLA	400	1.0329
18441	GURGAON	400	1.044	15427	BAWANA4	400	1.0324
18430	BASSI	400	1.043	17402	BARELI4	400	1.0324
17482	AZAMGAR4	400	1.0426	15426	BAWANA-G	400	1.0324
18402	NALLAGAR	400	1.0389	18428	MAHARANI	400	1.0322
18434	BAHADURG	400	1.0383	14405	NAWADA	400	1.0317
17486	MAU4	400	1.0377	18404	KAITHAL	400	1.0309
18446	SIKAR	400	1.0375	18464	SOHAW-PG	400	1.0309
18499	TEHRI4	400	1.0374	18425	MALERKOT	400	1.0306
17437	LUCKN_UP	400	1.0373	14407	KABULPUR	400	1.0301
18449	TEHR-POL	400	1.037				

- As per Transmission elements outage report (available at NRLDC website) for 23-26 Dec.'12, many 400 kV transmission lines (e.g. Agra-Jaipur(S):7 times; Bassi-Bhiwadi: 4 times; Jodhpur-Merta: 4 times etc.) had to be manually opened under light load conditions. To avoid such manual line opening in future, following bus reactors have been considered in the study under high voltage conditions:

- JAIPUR(S)-125MVAr
- BASSI-125MVAr
- MERTA-125MVAr

➢ Additionally, 125 MVAr bus reactors at following substations were considered in studies to reduce the high voltages to within permissible limits throughout Northern region:

BUS#	X-- NAME --X	BASKV	MVAr
17426	RISHIKESH	400	125
16409	HINDAUN	400	125
18460	PANCHKULA-PG	400	125
17485	SULTANPUR	400	125
17427	GORAKHPUR(UP)	400	2x125
18443	SONEPAT(PG)	400	125
18450	MANESAR	400	125
18404	KAITHAL	400	125
17401	PANKI	400	125

➢ After considering 125 MVAr reactors at above mentioned substations, reactive compensation at 220kV level was studied. To determine the reactive compensation requirement, MVAr absorption by the fictitious generations has been noted and is listed below.

BUS#	X-- NAME --X	BASKV	MVAr REQUIRED	MVAr PROPOSED
18216	KAITHAL	220	-5.7	25
18202	ABDULLAPUR	220	-8.7	25
16271	CHHABRA	220	-9.9	25
12229	FATEHABAD	220	-11.4	25
14242	KIRORI	220	-12.5	25

16253	BIKANER	220	-14.1	25
18239	HISAR	220	-18	25
16278	RAJWEST	220	-18.8	25
16216	BARMER	220	-25.3	25
16208	RATANGARH	220	-34.5	25
18260	PANCHKULA	220	-42.4	25
	REWALI	220		25
15234	MAHARANIBAGH	220	-50.9	25X2
18218	JALLANDHAR	220	-85	25
	JALLANDHAR-BBMB	220		25
13224	AMRITSAR	220	-101	
	VERPAL	220		25
	KHASSA	220		25

Proposal:

To summarise, bus reactors at following substations are required under light load conditions:

	400kV			**220kV**	
S.No.	**SUBSTATION**	**MVAr**	**S.No.**	**SUBSTATION**	**MVAr**
1	RISHIKESH	125	1	KAITHAL	25
2	HINDAUN	125	2	ABDULLAPUR	25
3	PANCHKULA-PG	125	3	CHHABRA	25
4	SULTANPUR	125	4	FATEHABAD	25
5	GORAKHPUR(UP)	2x125	5	KIRORI	25
6	SONEPAT-PG	125	6	BIKANER	25

7	MANESAR	125	7	HISAR-PG	25
8	KAITHAL	125	8	RAJWEST	25
9	PANKI	125	9	BARMER	25
10	JAIPUR(S)	125	10	RATANGARH	25
11	BASSI	125	11	PANCHKULA	25
12	MERTA	125	12	REWALI	25
			13	MAHARANIBAGH	2X25
			14	JALLANDHAR-PG	25
			15	JALLANDHAR-BBMB	25
			16	VERPAL	25
			17	KHASSA	25

Members may discuss and concur.

6. Evacuation System for Lalitpur (3x660 MW) STPS -Agenda item of UPPTCL:

Lalitpur STPS (3x660 MW) is state sector generation project in Bundelkhand area of Uttar Pradesh which is awarded to M/s. Lalitpur Power Generation Co Ltd. Generation is proposed to be stepped up at 765kV for evacuation. The project is under construction and 1st unit is expected by December, 2014. The project was discussed during the last standing committee meeting and UPPTCL was advised to have another meeting with CEA and CTU after examination of the above proposal so that the evacuation system for Lalitpur could be firmed up. In this Joint meetings of CTU, CPRI, Bangalore and UPPTCL were held in CEA in March 2013 on the above proposal:

i. 765 kV Lalitpur – Agra (765/400 kV) (UP) 2xS/C lines (400 kms)

ii. Establishment of 765/400 kV, 2x1500 MVA, Agra (UP) substation

iii. Establishment of 765/220kV, 2x300 MVA substation at Lalitpur switchyard (under the scope of the generation developer)

iv. Establishment of a 220/132 kV, 2x100 MVA substation at Lalitpur

v. Establishment of 400/132 kV, 2x300 MVA Agra (South) substation

vi. 220 kV Lalitpur – Jhansi D/C line (90 km) with one circuit to be LILOed at 220/132 kV Lalitpur substation.

vii. LILO of one circuit of existing 400kV Agra (UP) – Agra (PG) 2xS/C line at 765/400 kV Agra (UP) (10 Km)

viii. LILO of existing 400 kV Agra (UP) – Muradnagar S/C line at Agra (UP) 765/400 kV substation

ix. 400 kV Agra (UP) 765/400 kV – Agra (South) S/C line.

x. 765kV Line and Bus Reactors:

- 2x330 MVAr 765kV Line reactors at Lalitpur end of 765 kV Lalitpur – Agra (765kV) UP 2xS/c lines.
- 1x330 MVAr, 765kV Bus reactor at Lalitpur generation switchyard
- 2x240 MVAr 765kV Line reactors at Agra end of 765 kV Lalitpur –Agra (765 kV) UP 2xS/c lines.
- 1x240 MVAr, 765kV Bus reactor at Agra (765 kV) UP S/s

After detailed discussion following system has been recommended for Lalitpur TPS.

i. 50% Fixed Series Compensation (FSC) in 765 kV Lalitpur-Agra (UP) 2xS/c lines along with SSR protection in Lalitpur Generating Plant.

ii. An additional requirement of 1x330 MVAr 765 kV bus reactor (2nd) at 765kV Lalitpur generation switchyard in addition to the provision of bus and line reactors as proposed by UPPTCL (Item-2x above). For charging of 765kV Lalitpur-Agra lines, it would be preferable to make it from Agra end.

iii. In place of single circuit 400 kV Agra (UP) 765/400 kV – Agra (South) line, a 400 kV D/C line should be constructed to meet contingency of a line outage.

iv. Adequate provision of space at the Lalitpur 3x660 MW Plant for 2 nos. 765kV line bay extension to enable LILO of one circuit of 765kV Jabalpur-Orai D/C line in future.

v. UPPTCL has to take appropriate measures for development of 220/132kV network in Agra and its adjoining areas to supply load of 1100 MW or more from 400kV Agra (UP) & Agra (South) sub-stations. Otherwise, generation at Lalitpur may be required to back down due to system constraint**.**

CEA letter in this regard, including details of the studies, to UPPTCL is enclosed at **Annexure-VI**.

Members may kindly note.

7. LILO of Sikar-Neemrana 400kV D/c line at Babai(RRVPNL) :

Sikar is an existing 400/220kV substation of POWERGRID. Presently it is connected to the grid through Bhiwadi-Neemrana-Sikar 400kV D/c. Further following lines have already been approved for connectivity of Sikar:

- Agra-Sikar 400kV D/c (Quad)
- Sikar-Jaipur (POWERGRID) 400kV D/c
- Sikar-Ratangarh 400kV D/c

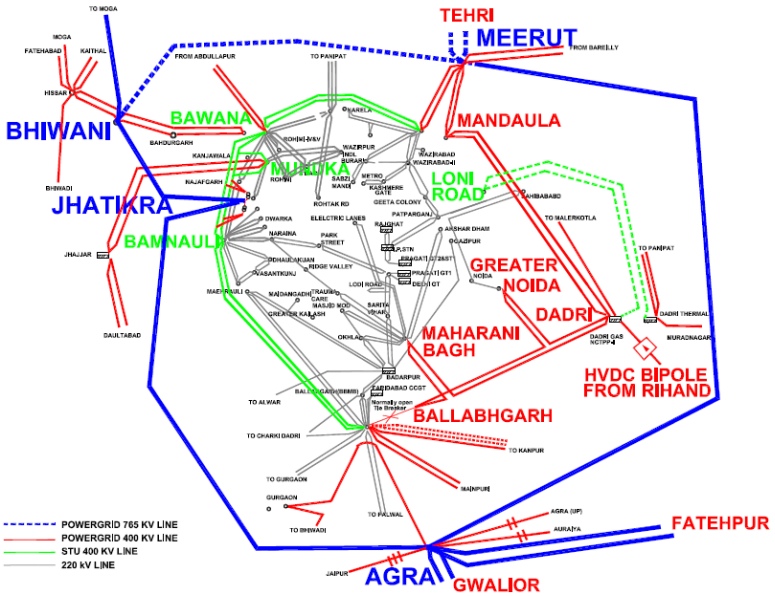
RRVPNL vide its letter dated 17/01/2013 (copy enclosed at **Annexure-VII)** has *proposed "LILO of one ckt of Sikar-Neemrana 400kV line at Babai would help in enhancing the reliability of power supply to Delhi/NCR region*" Here it may be mentioned that Babai(near Khetri) is a under construction 400/220kV substation of RRVPNL under associated transmission system for Suratgarh Super Critical TPS (2x660MW) and is to be connected to Suratgarh through 400kV D/c line. Simulation has been carried out to study the effect of proposed LILO of Sikar-Neemrana at Babai. Study results are enclosed at **Exhibit-IV(a) & (b).** Both Babai and Sikar are connected to Suratgarh TPS and Jaipur. Hence LILO SIkar-Neemrana at Babai results in off-loading of Sikar-Babai section of this line. Further it may be seen from study results that LILO of one circuit also causes unbalanced loadings on Sikar-Neemrana lines. In view of this, proposed LILO of Sikar-Neemrana line at Babai does not appear to be appropriate.

Members may discuss.

8. Study for series reactors :

The NCR area has a 400kV high capacity D/c (Quad Moose) ring with substations like Dadri Generating station (2600MW), Mandaula, Bawana, Jhatikara 765/400kV, Bamnoli, Ballabgarh, Mundka and is connected strongly with rest of the grid through high capacity 765/400kV lines. The ring has been in operation for twenty five years. However the growth in the network and generation has resulted in increase in short circuit levels. To limit the short circuit level splitting of the 400 kV ring was proposed during 2008-09. But in light of the events in July'12 and to meet the (N-1-1) security level as per Revised Transmission Planning criteria of CEA, it has become necessary to review the earlier approved bus-splitting arrangement and possibility of alternative measures to control the short circuit level at 400 kV substations in/around Delhi .

The approved bus-splitting of Delhi ring is shown below:



The following observations are made in regards to these approved bus-splittings:

i) The Agra-Ballabgarh and Ballabgarh- Guragaon 400kV lines are on the same bay at Ballabgarh. Just by opening the main breaker and keeping the tie broker closed the required splitting can be achieved and any time we can close the main breakers. Hence the Splitting arrangement may be retained.

ii) In approved bus-splitting arrangement, Dadri-I and Dadri-II are connected at Loni road S/s of Delhi and at both 400 kV bus-sections at Dadri, adequate feeders available for evacuation of power. Hence this bus-splitting arrangement may be retained.

iii) After bus-splitting at Bawana S/s, Bawana CCGT would be connected to Delhi by 400/220kV transformers. Further it would also be connected to 400 kV Delhi ring via Abdullapur. Further with connectivity to Bhiwani 765/400kV bus, no constraint is expected in drawing power from the grid or injecting power into the grid. Hence the earlier approved bus-splitting at Bawana can be retained.

iv) With the bus-splitting at Ballabgarh S/s, 400 kV Maharani Bagh, Greater Noida and Nawada substations would be fed radially from Dadri. In case of D/c outage of this line at Dadri end, power supply to the these areas would be drastically affected. As such, this bus- splitting needs to be reviewed.

v) 765/400/220 kV Meerut is one of the major substation in Northern region. Power from Eastern and Western region are to be pooled at Meerut S/s through 765kV lines. Further generation from Tehri complex would also be pooled at Meerut. Hence strong connectivity of Delhi ring with Meerut S/s is vital. With the earlier approved bus-splitting arrangement at Mandaula S/s , under the contingency outage of Mandaula-Meerut 400kV D/c line, the power supply from Meerut to Mandaula S/s (an important load center of Delhi) would be affected. As such, this bus- splitting needs to be reviewed

The short circuit studies have been carried out without considering bus-splitting at Mandaula & Ballabgarh substations. The results indicate that fault level in Delhi ring would be as high as 60kA (RMS). The results os short circuit studies are given below:

THREE PHASE FAULT

------ AT BUS ------	/I+/	AN(I+)
18424 [DADRI4 400] AMPS	**58270.4**	**-107.93**
18419 [BLBGR4 400] AMPS	47598.3	-107.85
18425 [MLRKT4 400] AMPS	23297.7	-118.68
15427 [BAWANA 400] AMPS	**56575.3**	**-108.82**
15428 [BAMNL4 400] AMPS	39192.6	-109.99
15400 [JATBA-SP 400] AMPS	47928.9	-109.13
15401 [JATBM-SP 400] AMPS	38467.4	-110.06
15429 [MUNDKA 400] AMPS	52688.2	-108.77
18461 [MHRNIBG4 400] AMPS	29182.8	-110.95
18435 [MANDLA 400] AMPS	**60953.9**	**-108.22**

It is seen that short circuit levels at Dadri, Bawana and Mandaula S/s are very high.

In order to restrict the short circuit levels, as an alternative solution to bus-splitting, studies have also been carried out with series line reactors on 400 kV lines of Delhi ring, to limit the short circuit levels In these studies bus-splitting mentioned at (i) to (iii) have been considered. Bus-splitting and Mandaula and Ballabgarh S/s have not been considered. The detailed study report is enclosed at **Annexure-VIII**.

Based on the studies following 12 ohm series reactors are proposed:

Series Line reactors:

- Dadri-Mandaula 400kV Ckt-I & II – 2nos
- Dadri-Mahranibagh 400kV Ckt – 1nos
- Dadri-Greater Noida 400kV Ckt – 1nos
- Ballabgarh-Bamnoli 400kV Ckt-I & II – 2nos
- Ballabgarh-Nawada 400kV Ckt-I – 1nos

- Bawana-Mandaula 400kV Ckt-I & II – 2nos
- Bawana-Mundka 400kV Ckt-I & II – 2nos
- Jhattikhara-Mundka 400kV Ckt-I & II – 2nos

Series Bus reactors :

- Series bus reactors of 12 ohm at 400 kV Mandaula & Ballabgarh substations.

- It is proposed the Greater Noida substation of UPPTCL may not be connected to 765kV network of UPPTCL. If it is to be connected then proper sectionalising arrangement may be provided in such a manner that 400 kV Dadri-Greater Noida-Nawada-Ballabgarh line is kept isolated from main bus of 765/400 kV Greater Noida substation of UPPTCL under normal operation and only connected as a contingency measure when requirement arises.

Members may discuss and concur.

9. Transmission System Plan for Delhi

CEA has prepared transmission system plan for Delhi to meet is power transmission requirement in XII and XIII plan period. This transmission system plan includes establishment of following 400/220kV substations in Delhi.

- Establishment of 400/220kV 2x315MVA+2x500MVA GIS substation at Rajghat by LILO of one circuit 400kV Mandaula-BawanaD/c line
- Establishment of 400/220kV 4x500MVA GIS substation at Tuglakabad by LILO 400kV Bamnoli-Samaypur D/c line
- Establishment of 400/220kV 2x315MVA+2x500MVA GIS substation at Dwarka with 400kV D/c line from Jhatikara substation POWERGRID
- Establishment of 400/220kV 2x500MVA GIS substation at Karampura with 400kV D/c line from Jhatikara substation POWERGRID
- Establishment of 400/220kV 2x315MVA GIS substation at Rangpuri with LILO of 400kV Bamnoli-Tuglakabad D/c line
- Establishment of 400/220kV 2x500MVA GIS substation at Shalimarbagh by LILO of Bawana-Karampura 400kV D/c line

- Establishment of 400/220kV 2x315MVA+2x500MVA GIS substation at Hamidpur by LILO of one ckt of Bawana-Mandola 400kV D/c line

The load flow results are enclosed at **Exhibit-V.** It may be seen that line loadings are within limits. This is a CEA study done on the request of DERC. The proposal of DTL for implementation is yet to be submitted by DTL to the Standing Committee.

Members may Note.

10. Additional System Strengthening based on new Transmission Planning Criteria

The transmission schemes for Mundra UMPP (5x830 = 4150 MW) generation complex was planned and implemented considering Transmission Planning Criteria of 1994 which stipulated system adequacy under "n-1" contingency. The benficiaries of the project are both in WR and NR. The Transmission Planning Criteria has been revised in January, 2013 and it stipulates planning of transmission system under "n-1-1" contingency. In the revised Planning Criteria (clause 2.3), it has been indicated that the earlier systems may be reviewed and additional strengthening may be planned. Accordingly, the transmission systems for the generation complexes in Western Region was reviewed and system strengthening has been proposed as described in subsequent paras have been proposed to address the "n-1-1" contingency following additional transmission system strengthening was proposed:

- LILO of both circuits of Mundra UMPP – Limbdi 400 kV D/c (triple snowbird) at Bachau*.
- LILO of one circuit of under construction Bachau – Varsana 400 kV D/C line at Mundra UMPP (the LILO portion shall be with triple snowbird conductor)#.

* With above proposed LILO, LILO of Mundra UMPP- Limbdi at Saurashtra Pool scheme agreed in 35th Meeting of Standing Committee on Power system Planning as may be deleted.

With the implementation of Bhuj Pool the LILO of Bachau – Varsana line may be opened and the line from Mundra UMPP may be terminated at Bhuj Pool.

Load Flow studies with above schemes have been carried out and results are enclosed at **Exhibit-VI**. Further, "n-1-1" contingency have been carried and all the loadings and angles are within their limits. Presently, SPS has been planned with Mundra UMPP as backing down of generation is required with "n-1-1" contingency. To avoid backing down of available generation the scheme mentioned above needs to be implemented on urgent basis.

Members may agree with the above proposal.

11. Evacuation of Power from Adani Mundra Generation Project

M/s Adani Power Limited (APL) has established a 4620MW generation project at Mundra in Kutch dist. Gujarat. From their generation project, M/s Adani Power has tied up 3966 MW of power under long term, the details of which are as given below

- Gujarat : 2000MW
- Maharashtra : 200 MW
- Haryana : 1424 MW
- LTOA : 342 MW (With Punjab and Rajasthan (NR) as target beneficiaries without Long Term PPA)

For transfer of power to Haryana, M/s Adani Power Limited has set up Mundra – Mohindergarh ± 500kV HVDC 2500MW Bi-pole, Mohindergarh - Dhanonda 400kV (Quad) D/c and Mohindergarh – Bhiwani (PG) – 400kV D/c line as dedicated transmission system. Further M/s Adani Power Ltd applied for LTOA for 342 MW beyond Mohindergarh considering that 342 MW power is available at Mohindergarh HVDC terminal. LTOA for 342 MW was given beyond Bhiwani for which Mohindergarh – Bhiwani 400 kV D/c line was implemented by M/s Adani Power as dedicated line. Accordingly LTOA of 342 MW is still operational beyond Bhiwani.

After the commissioning of HVDC bipole, the issue of transfer of power through HVDC bipole was discussed at length among CEA, CTU and POSOCO. Keeping in view that Adani Mundra generation bus is connected to the HVDC terminal as well as to AC system and outage of a pole/bipole has impact on the power flow on AC system as well as on inter-regional system, it was decided that power flow on Adani Mundra – Mohindergarh HVDC bipole line shall be maintained at 1500 MW considering the grid security in view.

While granting the Long Term Open Access for 342 MW to M/s Adani Power Limited for Northern Region, it was indicated by M/s Adani Power that power would be available at Mohindergarh and accordingly system strengthening was finalized beyond Mohindergarh.

For transfer of power to Haryana, M/s Adani Power implemented 2500 MW HVDC bipole line as dedicated line. Since CEA's Planning Criteria envisaged N-1 criteria, the transmission scheme developed by Adani Power need to take into account one pole outage. Accordingly with this criteria only 1250 MW power can flow under N-1 condition. Keeping this aspect in view it was stated during the 10th TCC & 11th NRPC meetings held on 05/01/2009 & 06/01/2009 that in the event of outage of HVDC pole M/s Adani Power would require to have run back system from their project to maintain loading on other lines within safe limit. In addition DISCOMs of Haryana would need to plan and implement load shedding scheme in the event of outage of pole/bipole.

The 342 MW, Long Term Access is in operation beyond Bhiwani according to the LTOA intimation and application. But for bringing power to Mohindergarh, security criteria (CEA's Planning Criteria) need to be considered. This means that under one pole outage / under normal conditions for power transfer upto Mohindergarh, parallel AC system in WR, NR and inter-regional system between NR & WR shall be utilized for transfer of power.

Now, M/s Adani Power has applied for Long Term Access at their generation switchyard, so that the adequacy of parallel AC system is ascertained and suitable strengthening is planned for transferring power to NR. As per the LTA application point for LTA is Adani Generation bus. At present Adani generation bus is not an

ISTS bus, accordingly LTA is being processed usage of ISTS system beyond dedicated system of Adani / STU system and LTA is proposed to be granted for usage of ISTS system of Western Region, Northern Region and Inter-regional system. While processing the LTA application system adequacy of dedicated system as well of STU system in the vicinity has been analysed.

Keeping above in view, system studies have been carried out considering two different scenarios

- **Scenario 1** : Present Scenario
- **Scenario 2** : Scenario after commissioning of Adani Mundra – Zerda 400 kV D/c line

In all the above studies full dispatch has been considered from Adani generation including 342 MW dispatch to Northern Region. The details of the studies are discussed below:

Scenario 1

This study is for present scenario. The base case load flow study results are enclosed at **Exhibit-VII.** From the base case it may be observed that the loading on Mundra – Sami is 595 MW per ckt, Gwalior – Agra is 981 per ckt etc. In general loading is within limits in base case.

Thereafter different contingencies have been studied:

a) Contingency of outage of one ckt of Gwalior – Agra 765 kV S/c line **(Enclosed at Exhibit-VII-01)**

b) Contingency of outage of one ckt of Mundra – Sami 400 kV S/c line **(Enclosed at Exhibit-VII-02)**

From the above study results it may be seen that under the outage of one ckt of Mundra – Sami 400 kV S/c line, the remaining line gets loaded to 919 MW, which is critical.

From the above it may be seen that full power from Adani Mundra generation including 342 MW of LTA to NR cannot be evacuated.

Scenario 2:

This study has been carried out with 1500 MW power transfer through HVDC bipole and full generation. In this case additional 400 kV D/c line from Adani Mundra generation bus to Zerda has been considered. As per the preliminary information gathered from GETCO (same to be confirmed from GETCO), Adani Mundra generation bus to Zerda 400 kV D/c line would be commissioned during last qtr of 2013-14.

The base case load flow study results are enclosed at **Exhibit-VIII.** From the base case it may be observed that the loading on Mundra – Sami is 400 MW per ckt and Gwalior – Agra is 965 per ckt. In general loading is within limits in base case. Subsequently following contingencies have been studied:

a) Contingency of outage of one ckt of Gwalior – Agra 765 kV S/c line **(Enclosed at Exhibit-VIII-01)**

b) Contingency of outage of one ckt of Mundra – Sami 400 kV S/c line **(Enclosed at Exhibit-VIII-02)**

c) Contingency of outage of one pole and outage of one ckt of Mundra – Sami 400 kV S/c line **(Enclosed at Exhibit-VIII-03)**

From the above study results, no problem is envisaged in transfer of 342 MW to Northern region and the system can meet the security criteria as prescribed in Manual on Transmission Planning Criteria of January 2013. As per the studies carried out, no problem is envisaged in meeting the N-1-1 criteria as detailed in Planning Criteria.

Keeping above in view it is proposed that LTA of 342 MW to Northern region from Adani Mundra generation can become effective after the completion of Mundra – Zerda 400 kV D/c line. This LTA request may be treated as change in LTA from Bhiwani to Adani Mundra generation bus of already granted LTA of 342 MW subject to that all other terms and conditions remaining the same. Till that time the LTOA for 342 MW shall remain applicable beyond Mohindergarh / Bhiwani.

Considering a long term perspective, it is considered prudent that an additional line is planned from Adani Mundra generation bus and is integrated with the high capacity corridor being planned with RE projects. Accordingly a 400 kV D/c line

from Adani Mundra to Bhuj Pool / Banaskantha is proposed. This proposed line would integrate the Mundra generation complex with the proposed inter-regional corridor.

- Considering long term perspective , the following line is proposed:
    - 400 kV D/c line from Adani Mundra to Bhuj Pool/Banaskantha
- The system proposed along with the solar projects of Gujarat and Rajasthan is important for reliable evacuation of power from Mundra generation complex. In case of delay in implementation of ISTS system of RE corridor, the following elements are proposed to be implemented as ISTS System Strengthening scheme on priority:
    - Bhuj Pool – Banaskanta/Sankhari 765kV D/c
    - Banaskanta/Sankhari – Chittorgarh 765kV D/c
    - Chittorgarh – Ajmer(New) 765kV D/c
    - Banaskanta – Sankhari 400kV D/c
    - Ajmer (New)- Ajmer (RVPN) 400kV D/c (Quad)
    - Chittorgarh (New)- Chittorgarh (RVPN) 400kV D/c (Quad)
    - Establishment of 2x1500 MVA, 765/400kV S/s at Bhuj Pool
    - Establishment of 2x1500 MVA, 765/400kV S/s at Banaskanta/Sankhari
    - Establishment of 2x1500 MVA, 765/400kV S/s at Chittorgarh
    - Establishment of 2x1500 MVA, 765/400kV S/s at Ajmer (New)
    - Associated reactive compensation (Bus reactors & Line reactors)

(The above scheme has been mentioned under Mundra UMPP also)

Members may deliberate and give their concurrence to the above proposal.

12. Contingency arrangement for Rihand–III & Vindhyachal–IV projects of NTPC.

The following transmission system common to both WR and NR was agreed in the 29th Standing Committee Meeting of WR:

i) Vindhyachal-IV – Vindhyachal Pool 400kV D/c (Quad) line... *Commissioned*

ii) Sasan – Vindhyachal Pool 400kV D/c….. *Commissioned*

Above elements were commissioned bypassing Vindhyachal Pool

iii) Rihand-III – Vindhyachal Pool 765kV D/c (Quad) line

iv) Vindhyachal Pool – Satna 765kV 2xS/c

v) Satna – Gwalior 765kV 2xS/c line

vi) Sasan – Vindhyachal Pool 765kV S/c

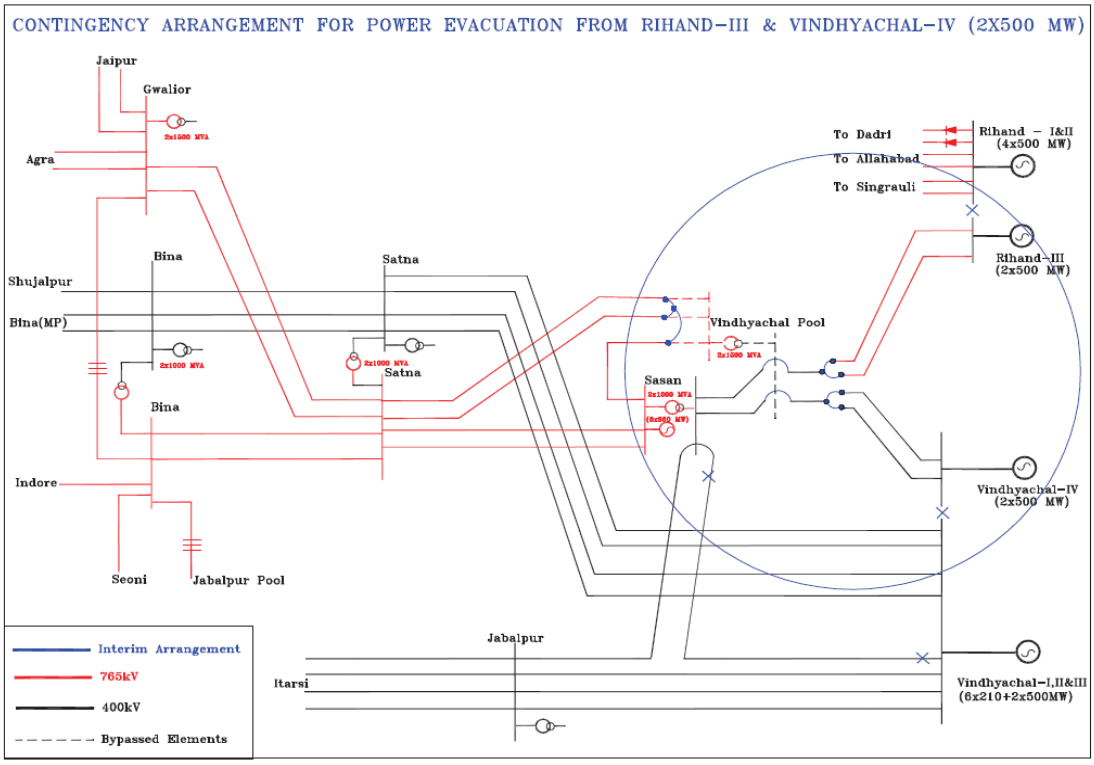
vii) Establishment of 765/400kV 2x1500MVA S/s at Vindhyachal Pool

The above system is being implemented by POWERGRID and it is expected that elements (iii) to (vii) shall be available progressively from October, 2013 to December, 2013. However, due to the likely delay in establishment of 765/400kV 2x1500MVA Vindhyachal Pool, following interim arrangement has been planned through bypassing of Vindhyachal Pool 765/400 kV substation:

- Bunching of both circuits of Rihand III–Vindhyachal Pooling station line and interconnection with one ckt of Vindhyachal Pooling Station – Sasan 400kV D/c line bypassing Vindhyachal Pool
- Bunching of both circuits of Vindhyachal -IV – Vindhyachal Pool 400kV D/c (Quad) line and interconnection with another circuit of Vindhyachal Pool – Sasan 400kV D/c line bypassing Vindhyachal Pool
- Bunching of both circuits of Vindhyachal Pool – Satna 765kV 2xS/c line and interconnection of Sasan – Vindhyachal Pool 765kV S/c line through bypassing Vindhyachal Pool.

- Both the generations i.e. Rihand-III & Vindhyachal-IV are to be kept open (bus sectionalize open) with respective generating units of earlier phase.
- With the implementation of LILO of one circuit of Vindhyachal-Jabalpur at Sasan, the section between Vindhyachal & Sasan shall be kept open. Further, the transformation capacity at Sasan switchyard shall be 2x1000 MVA, 765/400 kV for full evacuation of power from Rihand-III & Vindhayachal-IV STPP.

The interim arrangement is shown below.



Load Flow study enclosed in attached **Exhibit-IX**.. With the above arrangement, power from Rihand-III and Vindhyachal-IV can be evacuated till completion of 765/400kV, 2x1500MVA Vindhyachal Pool substation.

Members may agree to the contingency arrangement proposed as above.

13. Tehri PSP Transmission System

Following transmission scheme of Tehri PSP was discussed and agreed in the 27th Standing Committee Meeting of Northern Region transmission planning held on 30/05/2009.

- Tehri Generation – Tehri Pooling Stn. 400 kV S/c (Quad Conductor)
- Establishment of 765/400 kV, 3x1500 MVA GIS substation at Tehri Pool
- Augmentation of 765/400 transformation capacity by 1x1500 MVA at Meerut
- Charging of Tehri Pooling – Meerut line at 765 kV level
- Modification of Series Capacitors for operation at 765 kV level

POWERGRID had informed that there are severe constraints in transportation of 500 MVA, 765/400 kV ICTs (Single Phase units) to Tehri Pooling station. Considering these constraints, POWERGRID had proposed to provide 4 nos. of 800 MVA ICTs (14 Single Phase Units including 2 nos. spare units) instead of 3nos. of 1500 MVA ICTs. The four nos. of 800 MVA, 765/400 kV ICTs shall be able to evacuate from Tehri/Koteshwar HEPs with reliability. Accordingly following revised transmission system is proposed to be associated with Tehri PSP:

- *Tehri Generation – Tehri Pooling Stn. 400 kV S/c (Quad Conductor)*
- *Establishment of 765/400 kV, 4x800 MVA ICTs and GIS substation at Tehri Pooling station*
- *Augmentation of 765/400 transformation capacity by 1x1500 MVA at Meerut*
- *Charging of Tehri Pooling – Meerut line at 765 kV level*
- *Modification of Series Capacitors for operation at 765 kV level*

Members may concur to the above proposal.

14. Shifting of 50MVAR line reactor at Kankroli to Kanpur

During 31st Standing Committee Meeting for Power System Planning for Northern Region, LILO of RAPP- Kankroli D/c line at Chhitorgarh S/s was agreed. It was also agreed that the 50MVAR line reactors at Kankroli end may be converted as bus reactor at Kankroli. However, there are space constraints for bay extension at

Kankroli. Accordingly, 50MVAR line reactors at Kankroli are being diverted to Kanpur to be used as line reactors on Allahabad-Kanpur 400kV D/c line proposed under NRSS-XXX.

Members may note.

15. Evacuation of Power from Sainj HEP

The issue of evacuation of power from Sainj HEP was discussed in 30th and 31st Standing Committee Meeting of NR, wherein it was proposed that injection of Sainj HEP of HPPCL could be through LILO of Parbati-II – Parbati-III 400 kV line, however in case of outage of one circuit, 10% overload generation, 0.9 pu voltage and 0.9 power factor there may be certain constraints and generation would have to be backed down. During the meeting NHPC informed that enhancement of current carrying capacity of 400 kV XLPE cable is not possible and hence evacuation of power of Sainj through XLPE cable provide at Parbati-III HEP is not feasible. It was further deliberated that cable limitation may come in case of outage of one circuit, 10% over generation, 0.9 pu voltage and 0.9 power factor and possibility of occurrence of above contingency was very remote and HPPCL had agreed to back down the generation at Sainj, if required with a view to prevent the overloading of the XLPE cable of Parbati-III switchyard. Subsequently, NHPC informed that backing down of generation at Sainj HEP does not safeguard the overheating of XLPE cable provided at Parbati-III switchyard and as such the arrangement is not acceptable to NHPC. After deliberations it was decided to form a committee consisting of representatives from CTU, CEA, HPPTCL, HPPCL & NHPC to solve the issue and if required joint site visit may be undertaken.

In line with above a joint visit was undertaken on 6th and 7th May 2013. During the visit it was observed that it would be feasible to LILO 400 kV direct circuit from Parbatri-II to Parbati Pooling station (Banala) for evacuation of power from Sainj HEP. HPPTCL has agreed to construct additional towers for LILO arrangement. The above proposal was discussed in detail during a meeting held in CEA on 14/05/2013. During the meeting NHPC raised its concern that with the implementation of the LILO arrangement, evacuation of power from Parbati-II (800 MW) would be dependent on Parbati-III & Sainj and there would not be any direct link to Parbati Pooling station. CEA & CTU stressed that keeping in view that long

term planning, the most optimum solution is through the proposed LILO of Parbati-II to Parbati Pooling station 400 kV line at Sainj.

After detailed deliberations following decisions were taken:

- For evacuation of Sainj HEP power, LILO of 2nd 400 kV direct circuit from Parbati-II HEP to Parbati Pooling station (Banala) shall be implemented by HPPTCL.
- HPPCL shall install suitable scheme at Sainj HEP generation station to ensure that current flowing through the cable at Parbati-III does not exceed 2400 Amps. This SPS scheme will back down the Sainj generation accordingly.
- In case of permanent outage of Sainj switchyard 400 kV bus, bypass of LILO arrangement will be carried out by HPPTCL for evacuation of power from Parbati-II generation.
- The above proposed arrangement should be implemented expeditiously by HPPTCL as the generation of Sainj is expected to be commissioned by December 2014.

Members may note.

16. Proposal for Static VAR Compensators (SVC) in Northern Region

In the meeting of 31st Standing Committee for Power System Planning for Northern region held on 02/01/2013 at POWERGRID Office, Gurgaon, it was decided to provide ± 400 MVAR SVC at Lucknow and Nalagarh substations of POWERGRID. Further analysis was carried out in order to finalise the technology, size etc which would be suitable to Indian Grid Conditions. POWERGRID had also appointed Dr. Narain G. Hingorani, a consultant of International repute in the field on HVDC, FACTS, Power Electronics, Power System and T&D. As per the detailed deliberations following was concluded:

For Dynamic compensation, STATCOM is preferred over SVCs in view of its faster response, requirement of less space and above all its state of art technology.

The STATCOMs may be combined with mechanically switched Reactors and Capacitors controlled by STATCOM controller. The STATCOM would be primarily

for dynamic compensation while the mechanically switched reactors / capacitors would be for reactive compensation under steady state.

Based on the discussions with consultant and CEA, it is proposed to install STATCOMs at Lucknow & Nalagarh with mechanically switched reactors/capacitors in addition to dynamic compensation as per the following details:

Substation	**Mechanically switched Compensation**		**Dynamic Compensation (STATCOM)**
	Reactor x125 MVAR	**Capacitor x125 MVAR**	**+/- MVAR**
1. Lucknow	2	1	300
2. Nalagarh	2	2	200

17. Replacement of 6 nos. of Towers of 400 kV Ballabgarh- Bamnoli D/c line with Multi-circuit towers

400 kV Ballabgarh-Bamnoli D/c is an existing line of Delhi ring and it belongs to DTL. HVPNL proposed to utilize R-o-W of part of this line (6 towers) near NH-8 to construct their approved 400 kV Daultabad-Gurgaon D/c line by employing 6 nos.multi-circuit towers due to severe R-o-W constraints near NH-8 for crossing . The proposal was agreed by DTL& HVPNL and the conversion of 6 nos. D/c towers to multi-circuit towers has been completed. Presently , both the 400 kV Ballabgarh-Bamnoli D/c line and Daultabad-Gurgaon D/c line are in operation. **Members may note.**

----------xxxxxx----------xxxxxx----------xxxxx----------

Annexure - I

U.P. Power Transmission Corporation Limited

उ0प्र0 पावर ट्रांसमिशन कारपोरेशन लिमिटेड
(उत्तर प्रदेश सरकार का उपक्रम)

Office Of The
S.E. (TP & PSS)
3rd Floor,Shakti Bhawan Extn.
14-Ashok Marg Lucknow-226001

कार्यालय
अधीक्षण अभियन्ता(टी0 पी0 एवं पी0एस0एस0)
तृतीय तल, शक्ति भवन विस्तार,
14, अशोक मार्ग, लखनऊ–226001

Speed Post

No. 200 /TP&PSS/ CEA

Date 13.05.2013

Director (SP & PA)
Central Electricity Authority
Sewa Bhawan
R.K. Puram
New Delhi - 110066

Sub :- LILO of U.P. 220 kV Line at Agra PG approved in 31st meeting of standing committee held on 3.01.2013.

Dear Sir,

Kindly refer to point '33' at page 40 of minutes of 31st standing committee meeting held at Gurgaon on 2.01.13 for Power System Planning of Northern Region. It is to point out that LILO of Agra UP-Shamsabad 220 kV SC Line at Agra PG mentioned in the minutes at page 40 needs correction which should instead be LILO of Shamsabad – Firozabad 220 kV SC Line at Agra PG as informed by UPPTCL during meeting. Kindly make a correction in the minutes accordingly quoting it as LILO of Shamsabad – Firozabad 220 kV SC Line at Agra PG and accord formal approval.

Yours Faithfully,

(Suman Guchh)
Superintending Engineer (TP&PSS)

C.C.

Member (PS) Central Electricity Authority Sewa Bhawan R.K. Puram New Delhi – 110066.

Shri BKS
Director
Ktr Agra
15/5

Annexure-II

हरियाणा विद्युत प्रसारण निगम लि०
HARYANA VIDYUT PRASARAN NIGAM Ltd.

HVPN

Office of: Director (Technical), Shakti Bhawan, Sector-6, Panchkula-134 109
FAX 0172-2585266. Phone 0172-2566330
E-mail: directortechnical@hvpn.gov.in

To

The Member (Power System),
CEA, Sewa Bhawan,
R.K. Puram, New Delhi

Memo No. Ch-24/HSS-152/Vol-XV *Dated: 28.03.2013*

Subject: Minutes of the 31st Standing Committee meeting on Power System Planning of Northern Region held on 02.01.2013.

Kindly refer your office memo no. 1/9/SP&PA-12 dated 04.02.2013 vide which the minutes of the 31st Standing Committee meeting on Power System Planning of Northern Region held on 02.01.2013 has been circulated. The minutes has been perused and observed as under:-

1. **System strengthening to overcome constraints in Northern Region (Item No. 10 e)** i.e. Augmentation of Transformation capacity at 400/220 kV Ballabhgarh substation. It has been decided in the meeting that all the four 315 MVA 400/220 kV ICT at 400 kV substation Ballabhgarh will be replaced with 500 MVA transformer. In the meeting, Haryana stressed on requirement to provide additional 400/220 kV transformer at 400 kV substation Kaithal (PGCIL) out of one of the transformer that gets spared at 400 kV substation Ballabhgarh. The proposal given by Haryana was agreed upon in the meeting. This has not been captured in the Minutes of Meeting.

2. **Proposal of providing + 400 MVAR SVC at Hissar was agreed in the first phase itself (Item No. 24)**

   It has been recorded in the minutes that after detailed deliberations, it was decided to provide SVC of + 400 MVAR at Nalagarh and Lucknow in the first phase and SVC at Fatehpur, & Hissar may be firmed up later with additional studies with All-India network and put up to Standing Committee again. However, it is pointed out that the requirement of SVC at Hisar was agreed in the meeting after deliberations. It is therefore requested that provision of SVC at Hisar may please be considered to be provided along with Nalagarh and Lucknow in the first instance.

3. **Power supply to M/s Noida Power Company Limited (NPCL) (Item no. 29):**

   After deliberations it was decided that multi circuit line from 400 kV substation Ballabhgarh to Greater Noida 400 kV D/C (5 km) will be constructed on multi circuit towers, keeping in view the Right of Way constraints.

   It is understood that as deliberated in the meeting, the utilization of the second line on these multi circuits towers will be as per future requirements of Haryana/CTU.

It is requested that the above observations may please be considered and aforesaid minutes be modified accordingly.

Director/Technical,
HVPNL, Panchkula

Copy to:

Sh. B.K. Sharma Director (SP&PA), CEA, Sewa Bhawan, R.K. Puram, New Delhi

Annexure -III

H.P. Power Transmission Corporation Limited
(A State Govt. Undertaking)
Barowalias House, Khalini, Shimla-171002
(Telefax: 0177-2626284)

NO. HPPTCL/Interconnection-Vol-IV/2013-23-25 Dated:-02-4-13

To

Dy. General Manager (ED-II),
Himachal Pradesh Power Corporation Limited,
Electrical Design Unit-II, BBMB Office Complex,
BBMB Colony, Sundernagar,
Distt. Mandi, H.P.-175019.

Subject: - Evacuation Plan for 4 Nos. HEPs in Chenab Basin.

Reference: - Your letter No. HPPCL/ED-II/MISC/2013-1899 Dated 22.3.2013.

Sir:

With reference to your letter mentioned above, it is to intimate that CEA has already finalized the evacuation arrangements for HEPs in Chenab basin and as per the Plan, power of all the HEPs on the down stream of Seli HEP shall be pooled at Reoli Dugli HEP at 400 kV level and shall be evacuated to Kishtwar through a 400 kV (Twin HTLS) D/C Line. Power of 4 Nos. HEPs under reference can be evacuated by LILO of one circuit of 400 kV Reoli-Kishtwar D/C line at Saichu Sachkhas HEP where other 3 HEPs shall pool their power at 132 kV level and further inject the pooled power at 400 kV level by construction of 132/400 kV step up sub station at Saichu Sach Khas HEP. Exhibit-I indicating the schematic evacuation plan is enclosed for information and necessary action please. It may please be noted that 400 kV Reoli-Kishtwar is proposed as ISTS and opening of ISTS line shall require approval of Northern Region Constituents.

121-SD&PA 8/4/13

Yours faithfully,

General Manager (C & D)

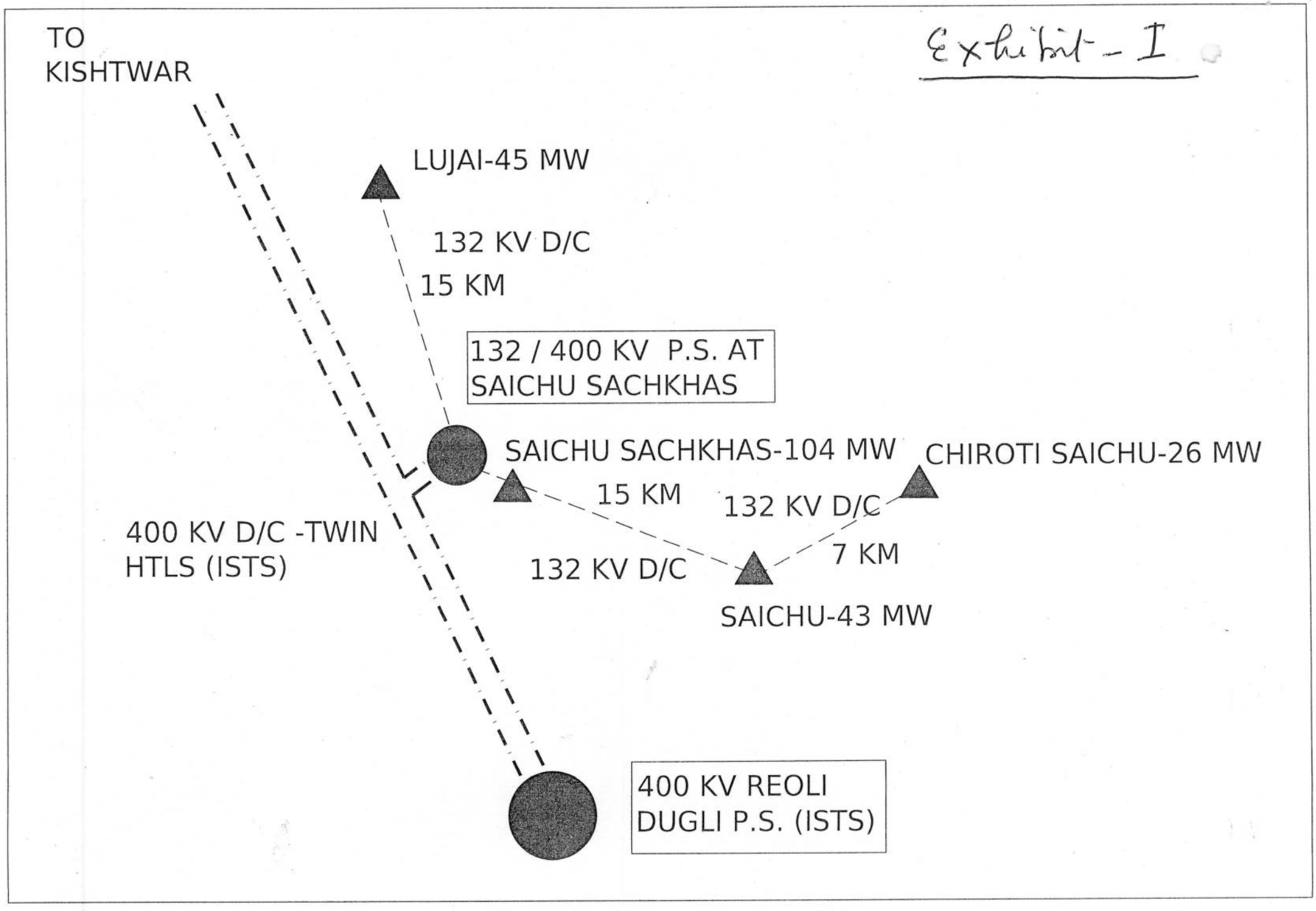
Shri BKS Director KK Ayog 9/4/13

CC: 1. Chief Engineer (SP & PA), Central Electricity Authority, Sewa Bhawan, R.K. Puram, New Delhi-110066. Schematic arrangement for 4 Nos. projects in Chenab basin which shall evacuate their power through 400 kV Reoli Dugli- Kishtwar D/C line (ISTS) is enclosed for information please.

2. Executive Director (ENGG), Power Grid Corporation of India Limited, "Saudamini" Plot No. 2, Sector-29, Gurgaon- 122001 Haryana. Schematic arrangement for 4 Nos. projects in Chenab basin which shall evacuate their power through 400 kV Reoli Dugli- Kishtwar D/C line (ISTS) is enclosed for information please.

General Manager (C & D)

Exhibit - I


TO
KISHTWAR
LUJAI-45 MW
132 KV D/C
15 KM
132 / 400 KV P.S. AT
SAICHU SACHKHAS
SAICHU SACHKHAS-104 MW
CHIROTI SAICHU-26 MW
15 KM
132 KV D/C
400 KV D/C -TWIN
HTLS (ISTS)
132 KV D/C
7 KM
SAICHU-43 MW
400 KV REOLI
DUGLI P.S. (ISTS)

Annexure - IV

PUNJAB STATE TRANSMISSION CORPORATION LIMITED

(O/o THE CHIEF ENGINEER/HR, PLANNING & IT, P.S.T.C.L., PATIALA)

(Fax Message)

To,

Chief Engineer System Planning & Project Appraisal Division,
Central Electricity Authority,
Sewa Bhawan, R K Puram,
New Delhi – 110066
(Fax 011-26103242)

Memo No 301 P-1/144
Dt. 29-5-13

Sub: **Draft Agenda for Standing Committee Meeting of Northern Region Transmission Planning- Revised 400KV Intra State Transmission System of Punjab .**

This is in continuation to our letter no. 236 dt.26.7.12 on the subject cited above. With the sanction of new Thermal Power Station of 1320 MW capacity by Pb Govt. in the State Sector near Mukerian, the evacuation system of Talwandi Sabo(TPS), Rajpura (TPS) Giderbaha (TPS) Mansa (TPS) and newly planned Mukerian (TPS) has been revised, and is attached herewith as annexure 'A ' .

It is requested to include the same as an agenda item for the next standing committee Meeting of Transmission System Planning of northern region .

DA/As above.

Chief Engineer/HR,Planning & IT,
PSTCL, Patiala.

Annexure 'A'

400KV Power Evacuation System of Mukerian TPS (1320 MW) Giderbaha TPS (2640MW) and Mansa TPS (1320MW) and System Strengthening of Punjab .

1) Giderbaha (TPS) – Mukatsar 400KV,DC line .
2) LILO of both Circuits of Talwandi Sabo (TPS) – 400KV Mukatsar DC line at Giderbaha (TPS)
3) LILO Of both circuits of 400KV Rajpura (Thermal) – 400KV Nakodar at 400KV Doraha (Near Machiwara)
4) 400KV Dhuri (Bhalwan)- 400KV Amloh (new location near Bhagwanpura) DC line – 50
5) 400KV Rajpura – Rajpura (Thermal) DC line (additional link)
6) 400KV Makhu(new location of Patti) – 400KV Dasuya DC line . — 100
7) 400KV Mukerian (TPS) – 400KV Dasuya DC line . – 20
8) 400KV Mansa- 400KV Barnala DC line
9) 400KV Talwandi Sabo (TPS) – Mansa DC line.
10) 400KV Barnala- Amloh (near Bhagwanpura)DC line
11) 400KV Mukerian (TPS)- 400KV Wadala Granthian (new location of 400K Batala) – 45 km DC line
12) 400KV Mukerian (TPS) – 400KV Doraha (near Machiwara) DC line . — 150 km
13) 400KV Wadalagranthian (new location of 400KV Batala) – 400KV Nakodar DC line
14) Establishment of new 400KV grids at Doraha (near Machiwara) Amloh (near Bhagwanpura) Wadala Granthian (new location of Batala), Barnala,Mansa and Dasuya with 2x500MVA,400/220KV I.C.Ts each .
15) Augmentation of existing 400KV grids Rajpura, Dhuri and Mukatsar with 1x500MVA,400/220KV, additional transformer at each .

Annexure -V (a)

Alok Kumar
I.A.S.
Chairman & Managing
Director

U.P. Power Transmission Corporation Ltd.
Shakti Bhawan, 14- Ashok Marg,
Lucknow-226001
E mail- c_mduppcl@sify.com
: 0522–2287827(O)
(फैक्स) : 0522–2287785

No.3836/CE (765kV&400kV Design Unit)/Dir(W&P)/2013 Date: 15.5.'2013

Member (Power System),
Central Electricity Authority,
Sewa Bhawan,
Ram Krishna Puram,
New Delhi-110066.

Subject: Proposal for next Standing Committee meeting of Transmission Planning for Northern Region: Proposal for allowing interconnection of two nos. 400kV lines at 400kV Substation Allahabad (PG) from Bara TPS (400kV).

In order to provide start-up power and ensure evacuation of power from the first generator of Bara (TPS-3x660MW) IPP , facilities of Central Transmission Utility(PGCIL) need to be utilised as an emergent alternative .

There are following points of pertinence in this context:

- That the 11th Plan of UPPTCL was approved by the CEA which comprised of lines and substations of 400KV level and above.

- That out of above transmisssion system planned and consequently approved by the CEA, construction of certain 400KV & 765kV lines & substations was awarded under PPP mode to two developers. The system for providing start-up power and evacuation of Bara was planned through these 400KV & 765kV lines only.

- That the IPP developing the Bara project : M/s Prayagraj Power has intimated that the commissioning of first unit of Bara (3x660MW) is expected to be completed by March 14, light-up of first unit boiler by November 13 thus necessitating availability of start-up power by August 13.

- That due to certain technical reasons, both the PPP projects are getting delayed and hence the contingency plan evolved as a bare minimum system for providing start-up power as well as evacuation of power from first generator of Bara requires construction of one double circuit 400kV line originating from Bara TPS to be terminated at Allahabad PG 400kV substation.

In view of the above, vide this office letter no. 1283-PS/Dir.(W&P)/UPPTCL/13 dated 08.03.2013(copy enclosed) , CEA was requested for intervention and support, to allow to utilise two (2) nos. 400kV bays at 400kV substation Allahabad (PG) so that 400kV DC line from Bara may be terminated at 400kV Allahabad and this line may act for providing start-up power as well as evacuation of first m/c (600MW). CEA was also assured that in the mean time evacuation system shall be developed and after about two years these bays shall be freed.

CEA in turn vide their letter no. 12/G/2012-SP&P dated 15.03.2013 (copy enclosed) requested Chief Operating Officer, CTU to examine the possibility for providing support to UPPTCL so that commissioning of Bara TPS is not heldup.

Chief Operating Officer CTU vide his letter no. C/CTU/N/PLG dated 30.04.2013 (Copy enclosed) have mentioned that necessary application of Connectivity/ Long Term Access may be made to the CTU as per the CERC regulations on "Grant of Connectivity, Long Term Access and Medium term Open Access in Inter-State Transmission".

In this regard, it is to confirm that open access is being requested by UPPCL separately as a medium term access as the said PPA is between the generator and various discoms.

It is also to mention that keeping in view, the urgency of work and in anticipation of standing committee approval, UPPTCL has already placed an order for constructing the above mentioned 400KV Bara TPS to Allahabad 400KV(PG) line to an existing contractor, to minimise delays.

In consideration of above facts, it is requested that :

1. UPPTCL being a STU, may be given connectivity after clearance from standing committee.

2. The work of providing 2 (two) nos. 400kV Bays at 400kV Allahabad PG substation be taken up by CTU as a deposit work of UPPTCL and may be completed at the earliest. UPPTCL agrees to get it done as a deposit work through CTU.

It is to reiterate that utilisation of two 400kV Bays at 400kV Allahabad PG substation shall be a temporary arrangement and in the mean time evacuation system shall be developed by UPPTCL and after about 2 (two) years these bays shall be freed.

It is therefore requested that above arrangement of connectivity may kindly be approved/ got approved in the next standing committee meeting. It is also requested that keeping in view the emergent position, in anticipation of this approval, CTU may kindly be requested to start constructing two Bays on priority at 400kV Allahabad Substation.

Encl:- As above

(Alok Kumar)

Copy to:

1. Sri Y.K. Sehgal, Chief Operating Officer (CTU) PGCIL, Saudamini Plot No. 2 Sector 29 Gurgaon-122001 Haryana with a request to kindly instruct officials to construct 2 Bays at 400kV Allahabad as a deposit work of UPPTCL on priority.

ANNEXURE-V(b)

Government of India
Ministry of Power
Central Electricity Authority
Sewa Bhavan, R.K. Puram
New Delhi-110066

Dated: 17th May, 2013

No. 12/G/2013-SP&PA

To

Shri Alok Kumar, IAS
Chairman & Managing Director
UP Power Transmission Corporation Ltd.
Shakti Bhavan, 14- Ashok Marg
Lucknow-226001

Subject: Permission to connect Bara TPS with 400 kV Allahabad (PG) S/Stn.

Ref: Your Letter No. 3836/CE(765kV & 400 kV Design Unit)/Dir (W&P)/2013 Dated 15.5.2013

In the letter under reference it has been inter alia stated that in order to provide start up power and to ensure evacuation of one unit of Bara TPS (3x660 MW):

(i) UPPTCL being STU may be allowed to connect 400 kV BARA TPS-Allahabad (PG) S/Stn D/C line at Allahabad.

(ii) The order for the above line has already been placed in view of the urgency as Bara TPS is expected to be completed by March, 2014.

(iii) UPPTCL desires that the 2no. 400 kV bays at Allahabad (PG) S/Stn may be implemented by PGCIL as deposit work

(iv) The above will be an interim arrangement and after about 2 year the above bays shall be freed.

2. In view of the urgency explained above, permission is granted for connecting UPPTCL 400 kV line from Bara TPS at Allahabad (PG) as an interim measureand the matter will be placed before the Standing Committee of Power System of NR for information/concurrence.

3 With regard to your proposal for evacuation of power of one unit of Bara TPS, it may be mentioned that corridors from Allahabad to Kanpur have to carry ISGS power of existing long term PPAs as first priority . It is understood that Rihand III of NTPC is likely to be commissioned shortly and its evacuation will also have over riding priority. The possibility of evacuating power of Bara TPS would have to be carefully assessed and you may kindly take up the matter with Powergrid for their advice.

Yours faithfully,

(Ravinder)
Member (Power System)

CC: Shri Y.K. Seghal, COO, Powergrid

ANNEXURE-VI

Government of India
विद्युत मंत्रालय
Ministry of Power
केन्द्रीय विद्युत प्राधिकरण
Central Electricity Authority
प्रणाली योजना एवं परियोजना मूल्यांकन प्रभाग
System Planning & Project Appraisal Division **[ISO: 9001:2008]**
सेवा भवन, आर. के. पुरम, नई दिल्ली–110066
Sewa Bhawan, R. K. Puram, New Delhi-110066
वेबसाइट / **Website: www.cea.nic.in**

No: 12/G/00-SP&PA/ 438 dated: 26.3.2013

Shri S K Garg,
Director (Works & Projects),
Uttar Pradesh Power Transmission Corporation Ltd.,
14, Ashok Marg, Shakti Bhawan,
Lucknow-226001 (email:skgarg52new@gmail.com)

Sub: Evacuation system for Lalitpur TPS(3x660 MW) in U.P.

Sir,

UPPTCL vide its letter No. 48/TP&PSS/Standing Committee dated 5-2-13 forwarded the 765kV transmission system proposal (as given in Annexure-I) for evacuation of power from Lalitpur TPS(3x660 MW). It is noted that generation at Lalitpur will be stepped up at 765kV and evacuated through 765kV Lalitpur-Agra(765/400kV) 2x S/C lines each of 400km length. In view of the 765kV evacuation lines being long, adequacy of the evacuation system is examined from dynamic stability consideration. As reliability of PSS functioning is a serious issue as experienced in many cases, stability assessment has been primarily focused on without considering PSS at Lalitpur STPS. Accordingly, comprehensive stability studies have been carried out by CPRI and CTU separately and the findings emerged from the studies have been discussed and finalized in co-ordination with CPRI, CTU and UPPTCL, and **a report on Lalitpur evacuation with our detailed recommendations is enclosed as Annexure-II. Also, the stability study results of CTU and their views are given at Annex-III.**

However, the following additional requirements over the UPPTCL's evacuation system proposal for stable and reliable power evacuation of Lalitpur generation are given below:

(i) 50% fixed series compensation (FSC) in 765 kV Lalitpur-Agra (765/400kV– UP) 2xS/C lines at Agra end and SSR protection at Lalitpur STPS.

(ii) An additional requirement of 1x330 MVAr 765kV bus reactor (2nd) at Lalitpur resulting in altogether 2x330 MVAr bus reactors at the power station.

(iii) 400 kV Agra (765/400kV-UP)-Agra(South) S/C line should be constructed with D/C line.

(iv) UPPTCL has to ensure development of adequate 220/132kV network in Agra and its adjoining areas to supply its load of 1100 MW or more from 400kV Agra (UP) & Agra (South) sub-stations. Otherwise, generation at Lalitpur may have to be backed down due to system constraint.

It is gathered that UPPTCL is in the process of finalization of NIT for a transmission package on the construction of the 765kV lines/sub-station and associated 765kV bus (Agra) and line reactors. As construction of the proposed 765 kV lines etc will take at least two years, a separate package for implementation of the FSC may be contemplated. The requirement of 2x330MVAr Bus Reactors at Lalitpur should be covered under the generation switchyard by the generation developer.

Encl.: as above.

Yours faithfully

26/3/13

(Dr. R. Saha)
Director(SP&PA)

Annex-I

Evacuation system proposal of UPPTCL for Lalitpur STPS (3x660MW)

(i) 765 kV Lalitpur – Agra (765/400 kV) (UP) 2xS/C lines (400 kms)

(ii) Establishment of 765/400 kV, 2x1500 MVA, Agra (UP) substation

(iii) Establishment of 765/220kV, 2x300 MVA substation at Lalitpur switchyard (under the scope of the generation developer)

(iv) Establishment of a 220/132 kV, 2x100 MVA substation at Lalitpur

(v) Establishment of 400/132 kV, 2x300 MVA Agra (South) substation

(vi) 220 kV Lalitpur – Jhansi D/C line (90 km) with one circuit to be LILOed at 220/132 kV Lalitpur substation.

(vii) LILO of one circuit of existing 400kV Agra (UP) – Agra (PG) 2xS/C line at 765/400 kV Agra (UP) (10 Km)

(viii) LILO of existing 400 kV Agra (UP) – Muradnagar S/C line at Agra (UP) 765 /400 kV substation

(ix) 400 kV Agra (UP) 765/400 kV – Agra (South) S/C line.

(x) 765kV Line and Bus Reactors:

- 2x330 MVAr 765kV Line reactors at Lalitpur end of 765 kV Lalitpur – Agra (765 kV) UP 2xS/c lines.
- 1x330 MVAr, 765kV Bus reactor at Lalitpur generation switchyard
- 2x240 MVAr 765kV Line reactors at Agra end of 765 kV Lalitpur – Agra (765 kV) UP 2xS/c lines.
- 1x240 MVAr, 765kV Bus reactor at Agra (765 kV) UP S/s

Annexure-II

CEA Report on Power Evacuation system for Lalitpur STPS (3x660 MW)

1. Lalitpur STPS (3x660 MW) is state sector generation project in Bundelkhand area of Uttar Pradesh which is awarded to M/s. Lalitpur Power Generation Co. Ltd. Generation is proposed to be stepped up at 765kV for evacuation. The project is under construction and 1st unit is expected by December, 2014.

2. UPPTCL has proposed following transmission scheme for evacuation of power from Lalitpur STPS :

   (i) 765 kV Lalitpur – Agra (765/400 kV) (UP) 2xS/C lines (400 kms)
   (ii) Establishment of 765/400 kV, 2x1500 MVA, Agra (UP) substation
   (iii) Establishment of 765/220kV, 2x300 MVA substation at Lalitpur switchyard (under the scope of the generation developer)
   (iv) Establishment of a 220/132 kV, 2x100 MVA substation at Lalitpur
   (v) Establishment of 400/132 kV, 2x300 MVA Agra (South) substation
   (vi) 220 kV Lalitpur – Jhansi D/C line (90 km) with one circuit to be LILOed at 220/132 kV Lalitpur substation.
   (vii) LILO of one circuit of existing 400kV Agra (UP) – Agra (PG) 2xS/C line at 765/400 kV Agra (UP) (10 Km)
   (viii) LILO of existing 400 kV Agra (UP) – Muradnagar S/C line at Agra (UP) 765 /400 kV substation
   (ix) 400 kV Agra (UP) 765/400 kV – Agra (South) S/C line.
   (x) 765kV Line and Bus Reactors:

   - 2x330 MVAr 765kV Line reactors at Lalitpur end of 765 kV Lalitpur – Agra (765 kV) UP 2xS/c lines.
   - 1x330 MVAr, 765kV Bus reactor at Lalitpur generation switchyard
   - 2x240 MVAr 765kV Line reactors at Agra end of 765 kV Lalitpur – Agra (765 kV) UP 2xS/c lines.
   - 1x240 MVAr, 765kV Bus reactor at Agra (765 kV) UP S/s

The above evacuation system proposal of UPPTCL is shown in **Exhibit – I.**

3. In the Joint meetings of with CTU, CPRI, Bangalore and UPPTCL held in CEA in March 2013 on the above proposal, UP informed the following additional information:

   (i) The location of proposed Agra 765 kV S/s has been relocated and length of 765 kV Lalitpur – Agra (765 kV) S/c lines will not exceed 400 kms.

   (ii) 400/220 kV, 3x240 MVA ICTs at Agra (UP) substation have been replaced with 3x315 MVA ICTs.

   (iii) Presently load demand of Agra area is about 700 MW which will grow to about 1100 MW by the time frame of Lalitpur generation commissioning (2014-15). Further, about 250 MW load will be supplied directly to 220kV Lalitpur and Jhansi substations of UPPTCL from the Lalitpur STPS.

4. UPPTCL got the system studies (stability, load flow, etc) done through CPRI, Bangalore on the proposed evacuation system for 2014-15 time frame, and the results of the studies were examined by the Joint team. For assessment of dynamic stability, CTU has shared their experience that working of Power System Stabilizers (PSSs) at Power Stations is poor in many cases and it is not meticulously tuned/maintained on regular basis. Owing to this, the system experiences unsustainable power oscillations whenever a line fault occurs, especially in radially connected generators through long transmission lines. Keeping this in view, it is felt most practical that dynamics of the system should be studied and examined primarily without PSS. Accordingly, CPRI and CTU have separately conducted the necessary dynamic stability studies with PSS and without PSS of which CPRI has studied for 2014-15 time frame and CTU has considered for 2016-17 (12^{th} Plan) scenario with the same data for AVR and PSS etc. as given by CPRI.

5. It is noted from the study results that while PSS is in service, oscillations are getting properly damped during the line fault. But, without PSS, there is undamped angular oscillations at Lalitpur generators during a fault in one circuit of 765kV 2xD/C lines, and such oscillations are observed in both CTU and CPRI studies. In order to mitigate the oscillations (without PSS), system

studies employing fixed series compensation (FSC) in 765kV lines have been carried out.

6. It is noted from study results that increasing FSC in the order of 45%, 50% & 60% (as carried out by CTU) improves the damping with increase in compensation, but small oscillations persists. In order to improve damping further and optimize the quantum of FSC, **CTU has carried out the various case studies and proposed for 50% FSC in the 765kV lines and an additional requirement of 1x330MVAr 765kV bus reactor (2nd) at Lalitpur Bus. It is noted that the damping has improved considerably and CTU proposal is found to be generally in order. The study Results of CTU and their recommendations are given at Annex-III.**

7. In view of above, there shall be altogether 2x 330 MVAr Bus Reactors at the Lalitpur 765kV bus. Thus, the provision of bus and line reactors as proposed by UPPTCL (Item-2x above) along with an additional 1x330MVAr bus reactor (2nd) at Lalitpur is found to be generally in order. However, for charging of 765kV Lalitpur-Agra line, it would be preferable to make it from Agra end.

8. It may be mentioned that 765kV Jabalpur-Orai D/C inter-state line has been planned in the 31st meeting of NR SCM with a target for implementation by 2017. It is observed from the CTU studies that LILOed of the above lines at Lalitpur would enable to improve the damping and stabilize the system very fast (within 6-7sec). It is therefore suggested that there should be adequate space for extension of the generation switchyard with a provision of 4nos. 765kV line bays.

9. The **Sub-Synchronous Resonance (SSR) phenomenon in the generator-turbine system of the Lalitpur STPS corresponding to the 50% FSC in the 765kV Lalitpur-Agra 2xS/C lines should be got examined through the suppliers of FSC equipments/Machines. Accordingly, the necessary SSR protection should be implemented to avert such phenomenon.**

10. It is observed that UPPTCL has proposed for interconnecting 765/400kV Agra and 400kV Agra (South) through a 400 kV S/c line and it should be a D/c line to meet contingency of one circuit.

11. UPPTCL should take appropriate measures and ensure development of 220/132kV network in Agra and its adjoining areas to supply 1100 MW load or more from 400kV Agra (UP) and Agra (South) sub-stations, failing of which there shall be system constraints for evacuation of power beyond Agra and Lalitpur generation may have to be backed down.

12. The schematic diagram of the revised evacuation system for Laitpur (3x660 MW) Station is given in **Exhibit-II**.

13. **In view of the above findings, the following recommendations may be adhered to:**

(i) 50% Fixed Series Compensation (FSC) in 765 kV Lalitpur-Agra (UP) 2xS/c lines along with SSR protection in Lalitpur Generating Plant.

(ii) An additional requirement of 1x330 MVAr 765 kV bus reactor (2nd) at 765 kV Lalitpur generation switchyard in addition to the provision of bus and line reactors as proposed by UPPTCL (Item-2x above). For charging of 765kV Lalitpur-Agra lines, it would be preferable to make it from Agra end.

(iii) In place of single circuit 400 kV Agra (UP) 765/400 kV – Agra (South) line, a 400 kV D/C line should be constructed to meet contingency of a line outage.

(iv) Adequate provision of space at the Lalitpur 3x660 MW Plant for 4nos. 765kV line bay extension to enable LILO of 765kV Jabalpur-Orai D/C line in future.

(v) UPPTCL has to take appropriate measures for development of 220/132kV network in Agra and its adjoining areas to supply load of 1100 MW or more from 400kV Agra (UP) & Agra (South) sub-stations. Otherwise, generation at Lalitpur may be required to back down due to system constraint.

EXHIBIT - I

Proposed UPPTCL Evacuation System for Lalitpur STPS (3x660 MW)

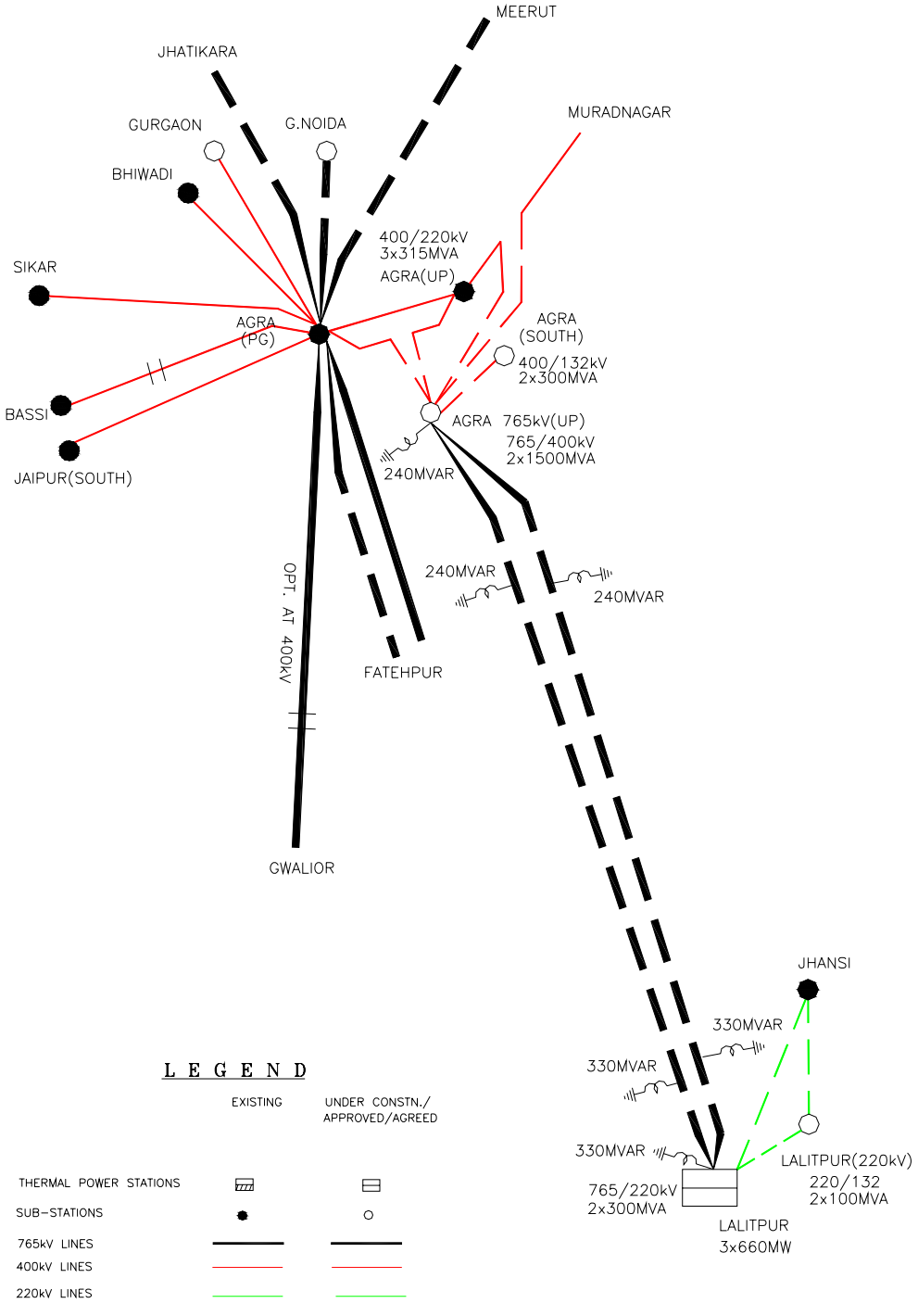
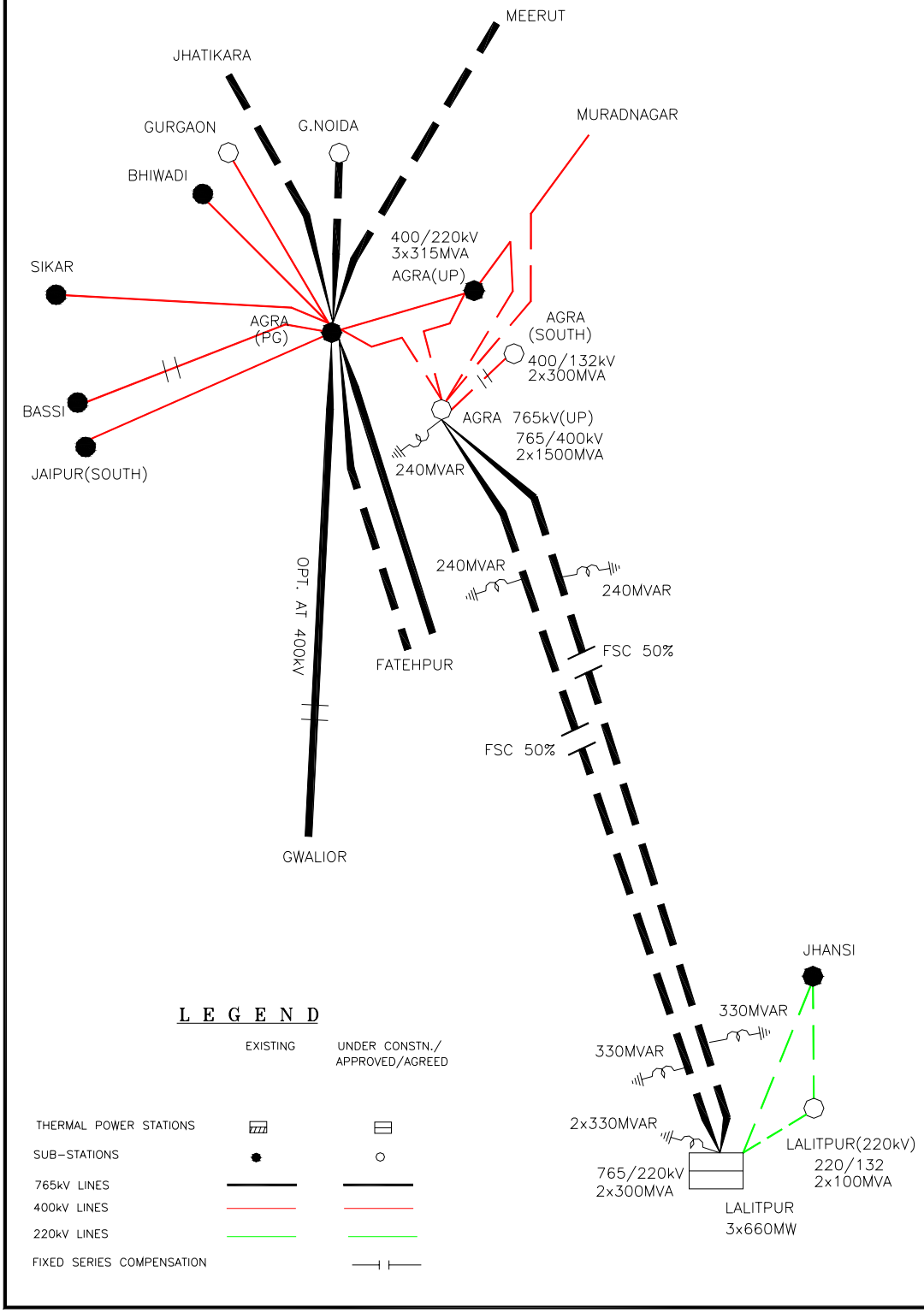


EXHIBIT - II

Modified UPPTCL Evacuation System for Lalitpur STPS (3x660 MW)

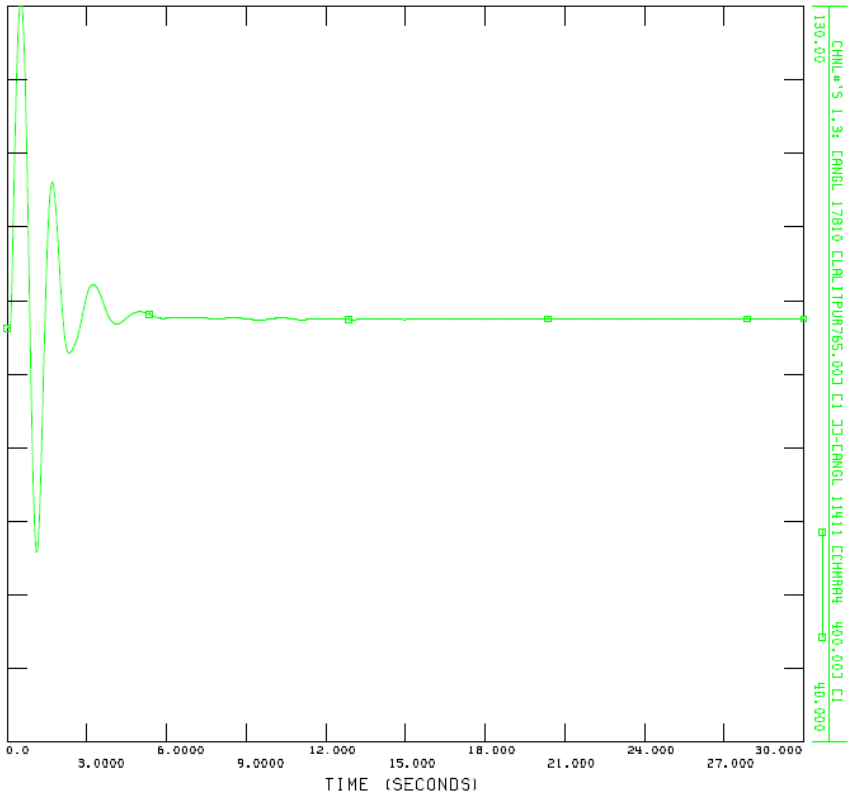


Annexure-III

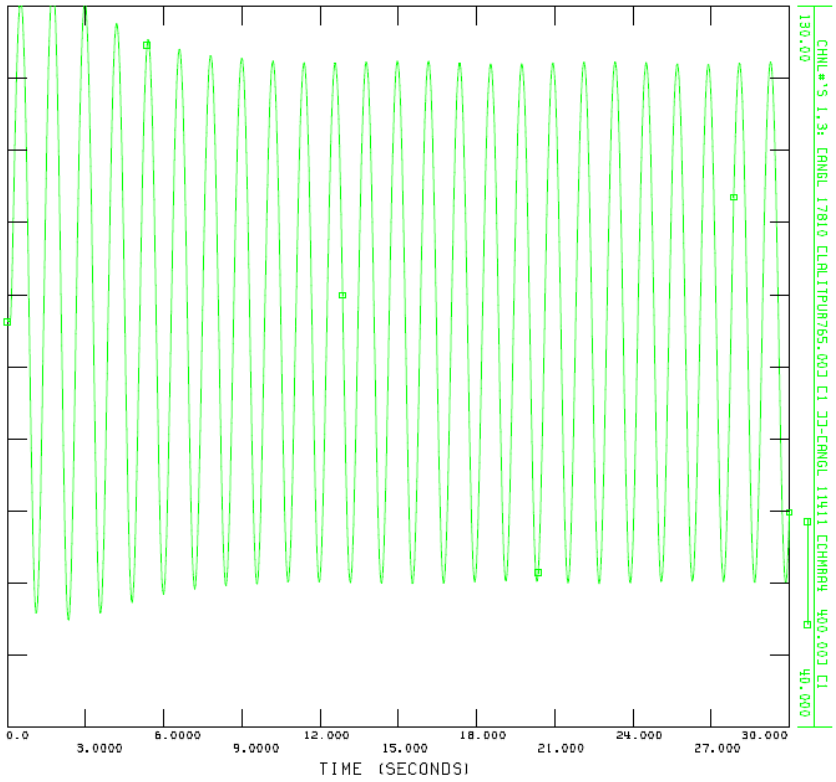
Report of CTU on the Dynamic Stability Studies on Lalitpur(3x660MW) Evacuation System & their Recommendations

Dynamic studies:

For dynamic simulations data provided by CPRI , enclosed at Annexure-I, has been considered for studies. The system has been studied for fault close to Lalitpur followed by tripping of one circuit of Lalitpur-Agra line. Machine angle plot of Lalitpur generating units has been plotted. The system studies have been carried out with and without Power System Stabilizers. The results are plotted below:



Plot-1 : Lalitpur Machine angle- with PSS



Plot-2 : Lalitpur Machine angle- without PSS

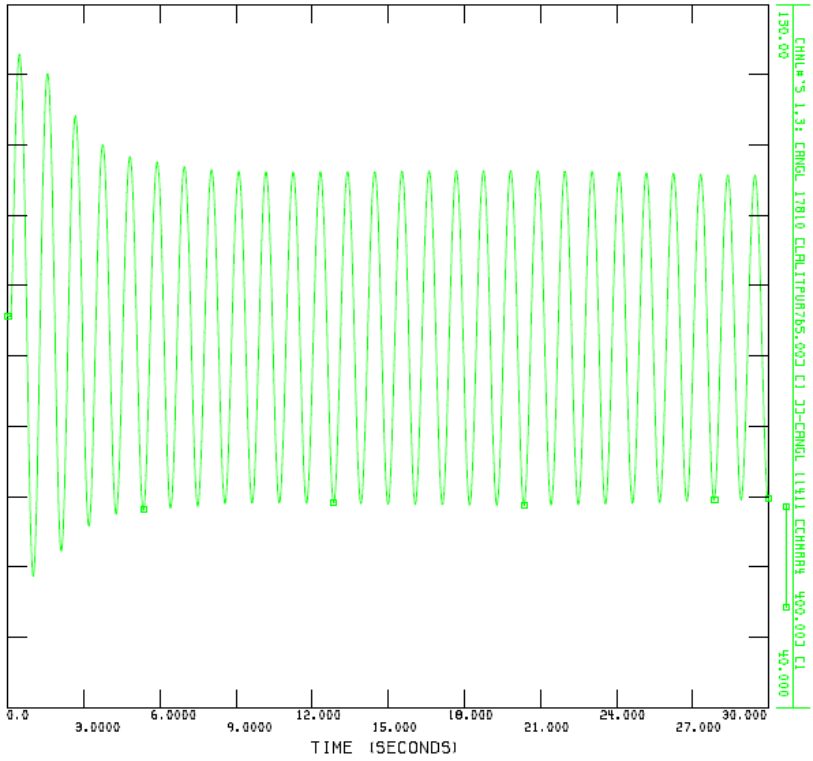
From the studies it is seen that without PSS Lalitpur generators shows undamped oscillations. The PSS model given by CPRI damps these oscillations. However experience has shown that many a times the PSS are not properly tuned. Particularly radially connected machine with long lines shows undamped oscillations. Accordingly, while planning radial generation with long lines proper anchoring is kept always. This has been followed by POWERGRID while planning systems like Sipat, Sasan and Chattisgarh. In the present case also anchoring is required. However in the lack of immediate anchoring the angular stability can be improved by one of the following methods

i. Large amount of power can be consumed locally so that quantum of power to be transferred over long distance is less.
ii. Provision of series compensation so that effective electrical distance is reduced
iii. Provision of reactive compensation at generator end. For the same MW generation, a generator absorbing MVAR would have greater angular

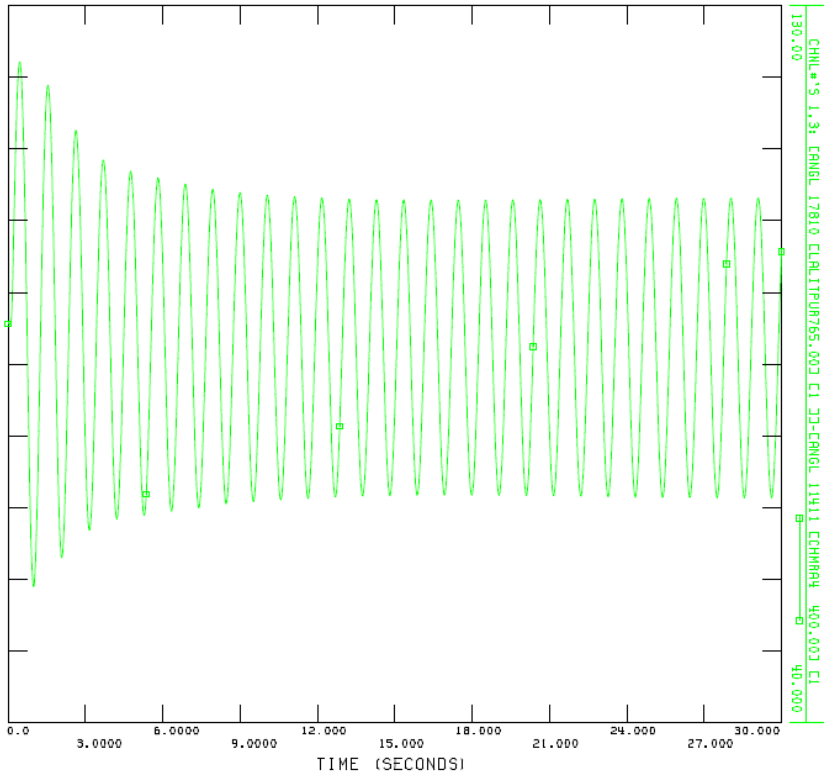
separation, then the one generating MVAR, as the magnetic coupling is poor when MVAR is being absorbed.

In case of Lalitpur generation, the amount of local load at Lalitpur and Jhansi is not very high and Parichha generation at 220kV would also be feeding partially. Further it has already been informed by UPPTCL that the local load at Agra should be about 1100MW. Hence not much further relief is expected due to local load. Accordingly simulation has been carried to study the effect of series compensation and additional bus reactor at Lalitpur

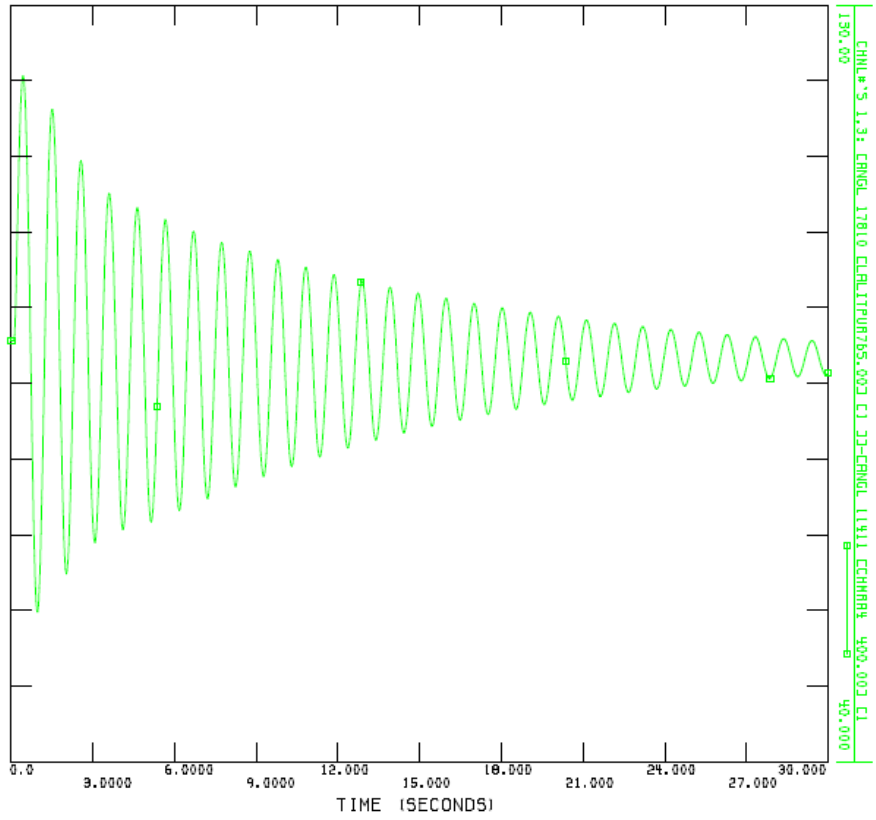
The effect of provision of series compensation on Lalitpur-Agra line has been studied. The simulation results for various level of compensation are plotted below:



Plot-3 : Lalitpur Mac. angle-without PSS- 45% series comp on Lalitpur-Agra 765kV lines



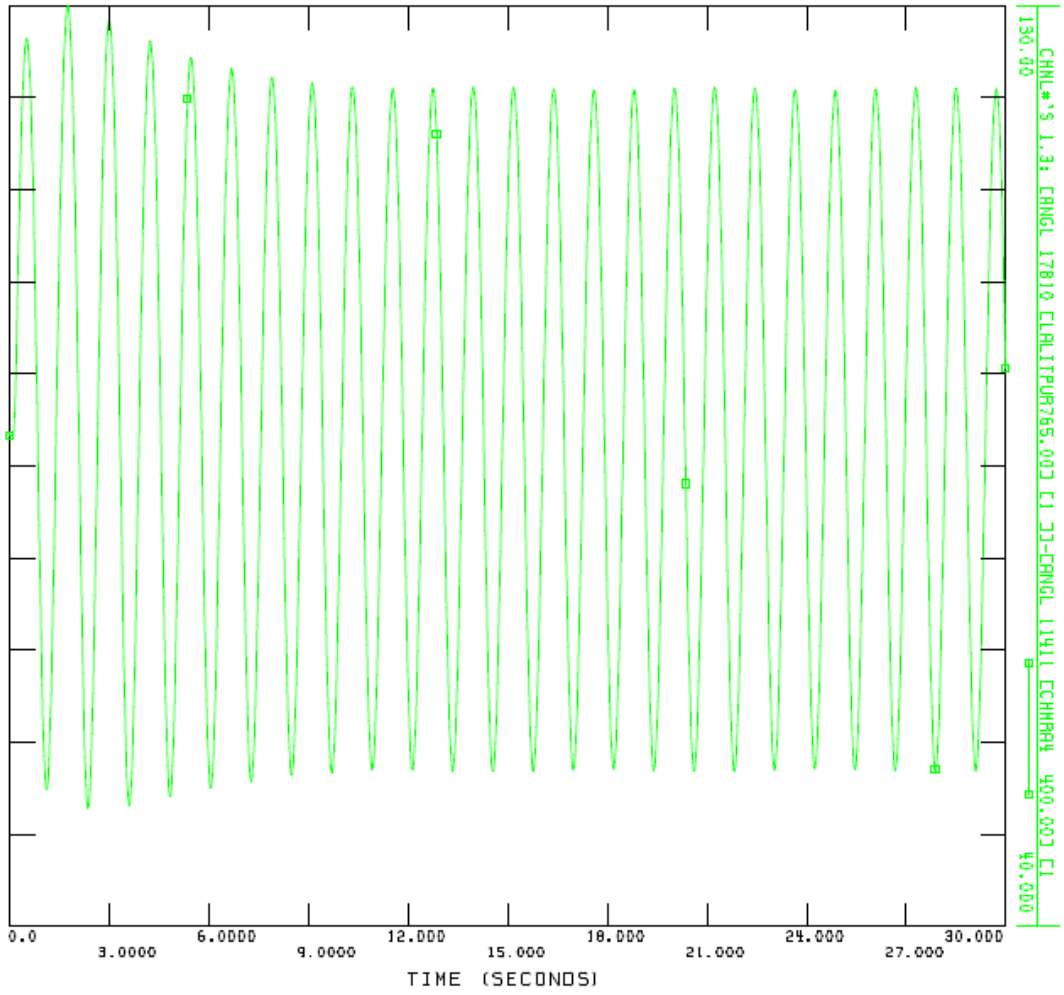
Plot-4 : Lalitpur Mac. angle-without PSS- 50% series comp on Lalitpur-Agra 765kV lines



Plot-5: Lalitpur Mac. Angle-without PSS- 60% series comp on Lalitpur-Agra 765kV lines

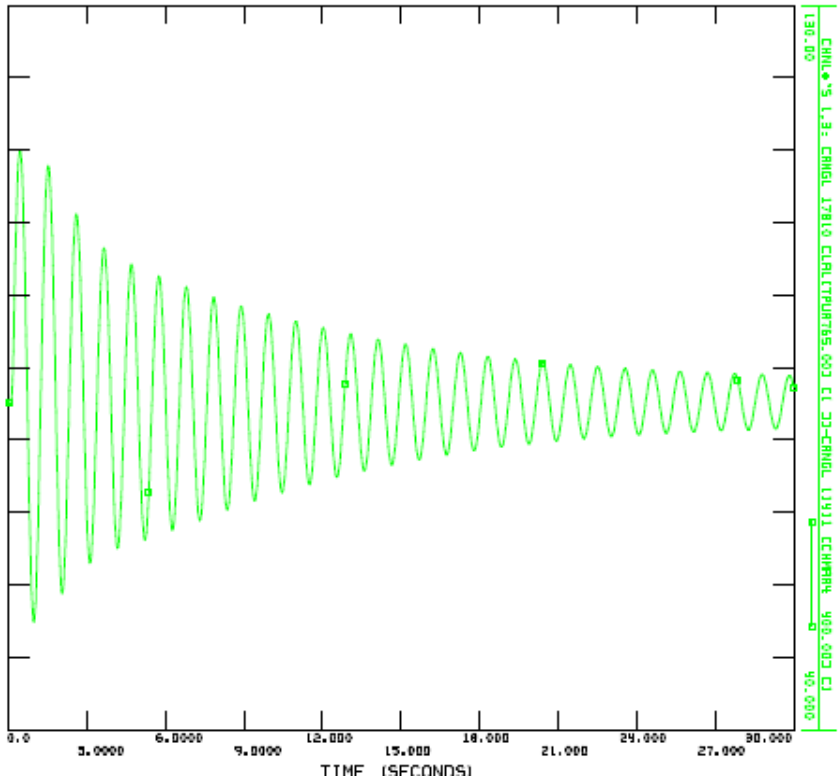
The results indicate that magnitude of oscillation decreases with level of compensation and damping also increases with compensation. However desired damping is not achieved.

The reactive MVAR compensation level of about 90% has been considerer under Lalitpur system. Studies indicate that proposed compensation is sufficient for charging from Agra end. However for stability purpose additional compensation of 330MVAR has been considered at Lalitpur generation switchyard. The results are plotted as below:

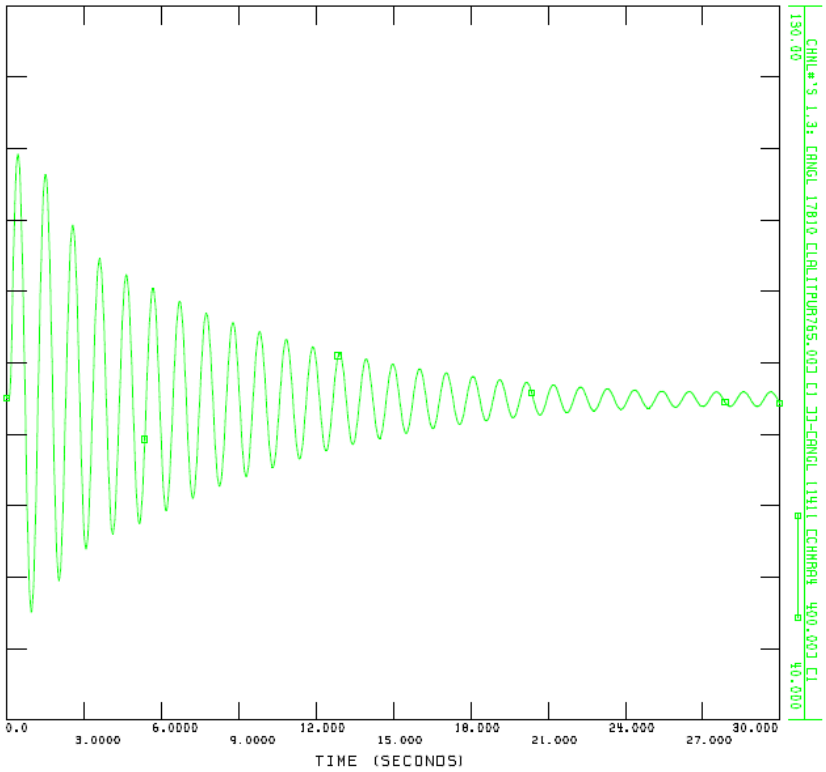


Plot-5: Lalitpur Mac. Angle-without PSS- Only Bus reactor at Lalitpur

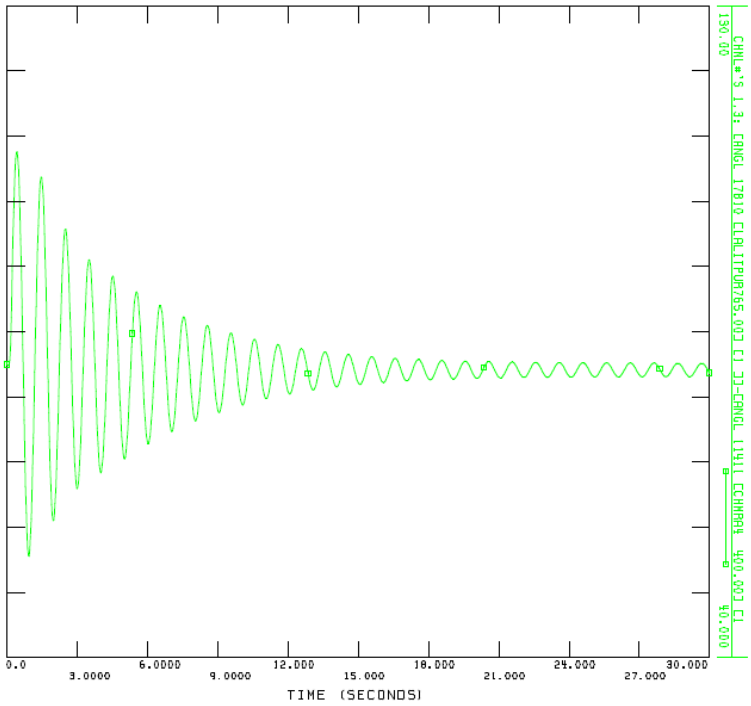
Simulation results indicate that only additional bus reactor is not able to bring desired damping. Accordingly simulation has been carried out for studying the combined effect of bus reactor and series capacitor. The results of simulations are plotted below:



Plot-6 : Lalitpur Mac. angle-without PSS- 45% series comp on Lalitpur-Agra & additional Bus reactor at Lalitpur generation



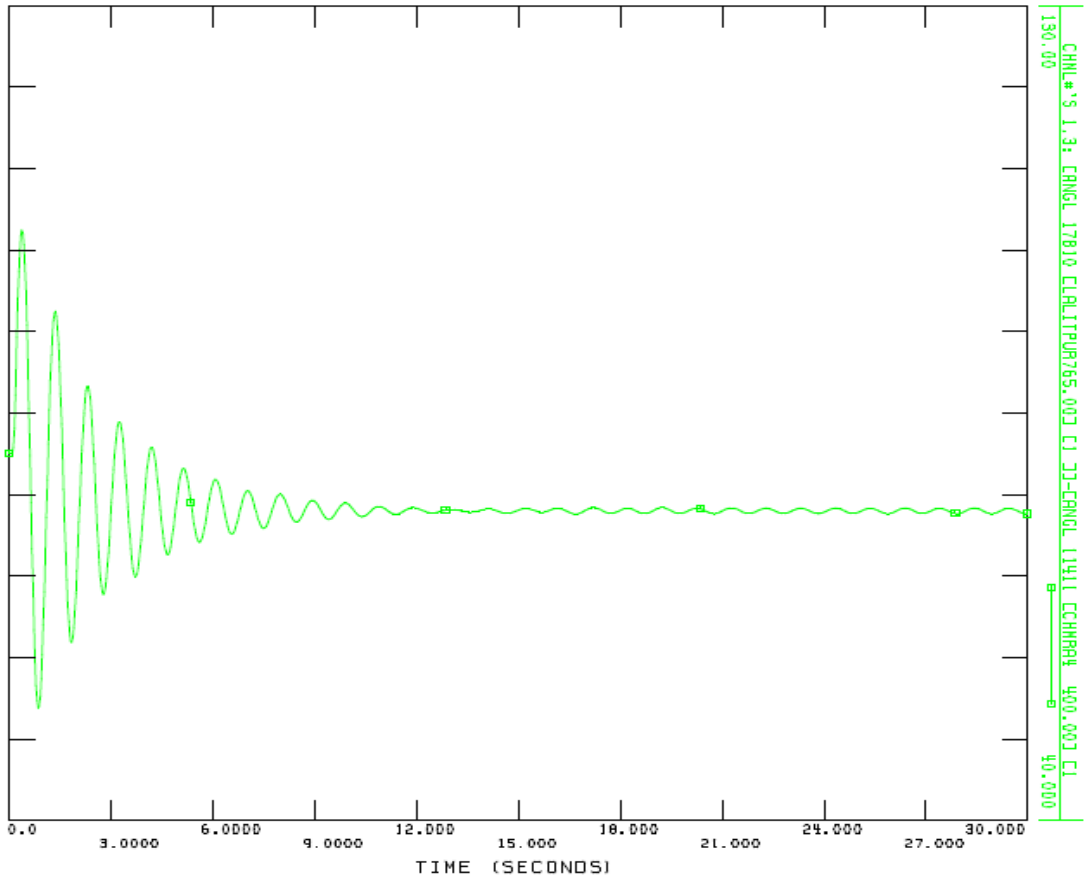
Plot-7: Lalitpur Mac. angle-without PSS- 50% series comp on Lalitpur-Agra & additional Bus reactor at Lalitpur generation



Plot-7: Lalitpur Mac. angle-without PSS- 60% series comp on Lalitpur-Agra & additional Bus reactor at Lalitpur generation

Simulations indicate that with combined effect of series compensation and bus reactor at Lalitpur is more pronounced. With 50% series compensation & above and additional 330MVAR bus reactor at Lalitpur, the desired rate of damping is achieved. Accordingly same is proposed. The supplier for series compensation shall carry out SSR studies and provide adequate protective measures.

With 50% Series Compensation and 330 MVAR Bus Reactor the desired rate of damping is achieved, however there are some minor oscillations. To minimise these oscillations and to improve damping, studies were carried out by with tripping of one unit at Lalitpur through SPS as a secondary protection.



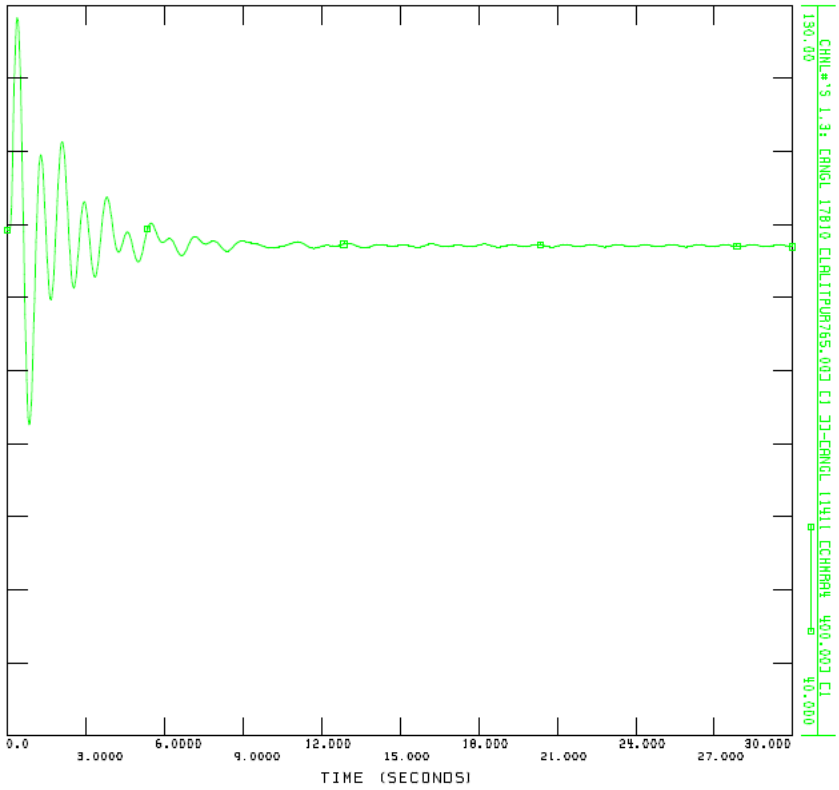
Plot-7: Lalitpur Mac. angle-without PSS- 50% series comp on Lalitpur-Agra & additional Bus reactor at Lalitpur generation. One gen unit dropped through SPS with line outage.

From the above result it may be seen that there is substantial improvement in damping of oscillations.

Further it is to mention that during the 31st standing committee meeting of NR following transmission system,

- Jabalpur Pooling station - Orai 765 KV D/c line
- Orai – Aligarh 765kV D/c line
- Orai – Orai(UPPTCL) 400kV D/c (Quad) line
- LILO of one circuit of Satna-Gwalior 765 KV line at Orai S/s
- 2x1000MVA, 765/400KV substation at Orai S/s
- LILO of Agra-Meerut 765 kV S/c line at Aligarh S/s
- 765KV Switching Station at Aligarh (GIS)
- LILO of Kanpur – Jhatikara 765 kV S/c at Aligarh S/s

The system is expected to be commissioned by 2017. To provide additional anchoring to Lalitpur generation study has been carried out with LILO of Jabalpur-Orai 765kV D/c at Lalitpur. The dynamic simulation is plotted below. From the studies it is seen that with the compensation the generator oscillations are well damped.



Plot-7: Lalitpur Mac. angle-without PSS- 50% series comp on Lalitpur-Agra & additional Bus reactor at Lalitpur generation & LILO of Jabalpur-Orai at Lalitpur

Conclusion:

- The system simulations as per data provided by CPRI/UPPTCL indicate that with PSS the system oscillation are damped. However without PSS generators exhibit undamped oscillations.

- Experience has shown that many times the PSS are not properly tuned and cannot be relied upon. Accordingly 50% series compensation on Lalitpur-Agra lines with 330MVAR (2^{nd}), additional bus reactor at Lalitpur is proposed.
- UPPTCL to ensure that at Agra the drop is about 1100MW.
- As a long term measure for anchoring Lalitpur generation, LILO of Jabalpur-Orai 765kV lines at Lalitpur is proposed.
- During interim period it is suggested that if there is any constraint, due to unforeseen conditions, then Special Protection scheme can be designed to trip the one machine at Lalitpur as a secondary protection.

ANNEXURE-VII

Rajasthan Rajya Vidyut Prasaran Nigam Ltd.
Regd.Office:Vidyut Bhawan, Jyoti Nagar, Janpath, Jaipur
Phone Number:2740373
Fax No.:0141-2740794
E-MAIL: ppmrvpn@sancharnet.in

No.RVPN/SE(P&P)/PSS/D.85

Jaipur,Dt: 17/01/2013

Shri Mukesh Khanna,
General Manager (SEF),
Power Grid Corporation Of India Ltd.,
Saudamini "Plot No. 2, Sector-29,
Gurgaon-122 001, Haryana

Fax No: 011-26171042/26102045

Sub: Regarding LILO of PGCIL's 400 kV D/C Sikar – Neemrana line at RVPN's under construction 400 kV GSS Babai

Sir,

RVPN has commenced the construction of 400 kV GSS at Babai, which has been approved under the transmission system associated with Suratgarh Super Critical TPS (2x660 MW) with interconnection through 400 kV D/C Suratgarh SCTPS-Babai line (on quad moose conductor)

PGCIL's 400 kV D/C Sikar- Neemrana line is crossing RVPN's 400 kV GSS Babai at a distance of 1 kM, therefore, it is suggested that PGCIL may consider to Loop in Loop out of one circuit of 400 kV D/C Sikar-Neemrana line at 400 kV GSS Babai which would help in enhancing the reliability of power supply to Delhi/NCR region. In case PGCIL propose to connect the said 400 kV line to 400 kV GSS Babai, which is under construction at present, requirement of 400 kV bays may be indicated at the earliest so that same could be taken up along with original work.

Your's faithfully,

17-1-2013

(S. K. JAIN)
CHIEF ENGINEER (PPM)

Copy to the Chief Engineer (SP&PA), System Planning & Projects Appraisal Division, Central Electricity Authority, Sewa Bhawan, R. K. Puram, New Delhi-110066 for information.

17-1-2013

CHIEF ENGINEER (PPM)

O/C

Studies for Series Reactors

1.0 Introduction:

Power Demand in Northern region is growing exponentially. The maximum peak demand of NR has touched 45,860 MW and by 2016-17 the demand is expected to be about 61,000MW. To meet the growing power demand generation and new lines are being added. All this has resulted in high short circuit level. One area which has been critically affected is the NCR area. The NCR area has a 400kV high capacity D/c (Quad Moose) ring with Substations like Dadri Generating station (2600MW), Mnadaula, Bawana, Jhatikhara 765/400kV, Bamnoli, Ballabgarh, Dadri and is connected stroingly with rest of the grid through high capacity 765/400kV lines. The ring has been in operation for twenty five years. However the growth in the network and generation has resulted in increase in short circuit levels. To limit the short circuit level splitting of the ring was proposed during 2008-09. But in light of the events in July'12 and need for meeting the (N-1-1) security level as per Revised Transmission Planning criteria of CEA has neccesiated a need to review the splitting arrangement and possibility of alternative measures to control the short circuit level. This report summarises the studies carried out and analysis of the results.

2.0 Present proposal of splitting Delhi Ring

The approved splitting of Delhi ring is shown in Figure-I. There are five splitting. The effective of splitting and arrangement

i) The Agra-Ballabgarh and Ballabgarh- Guragaon 400kV lines are on the same bay at Ballabgarh. Just by opening the main breaker and keeping the tie broker closed the required splitting can be achieved and any time we can close the main breakers. Hence the Splitting arrangement may be retained.

ii) Dadri-I and Dadri-II are connected at Loni road. And at both bus adequate feeders exists for evacuation of power. Hence the Splitting arrangement may be retained.

iii) After splitting of Bawana CCGT it is connected to Delhi by 400/220kV transformers. Further it is connected to ring via Abdullapur. Further with connectivity to Bhiwani 765/400kV bus no constraint is expected in drawing power from the grid or injecting power into the grid. Hence the original envisaged splitting can be retained.

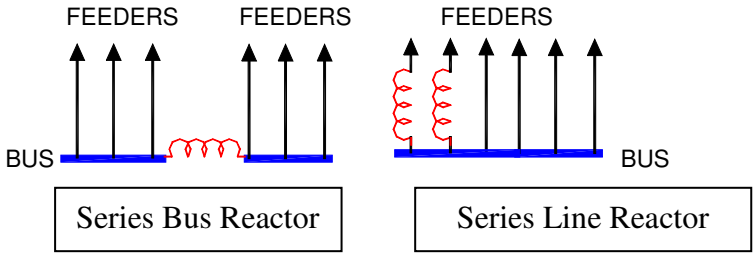
iv) With the splitting of Dadri-Ballabgarh 400kV line from Ballabgarh end, Mahranibagh, Greater Noida and Nawada would be fed radially from Dadri. In case of D/c outage power supply to the areas would be drastically affected. The splitting needs revisited

v) Meerut is one the major substation in Northern region. Power from Eastern and Western region are to be pooled at Meerut through 765kV lines. Further generation from Tehri complex would also be pooled at Meerut. Hence connectivity with Meerut is vital. With split arrangement in case of Mandaula-Meerut 400kV D/c power supply from Meerut to Mandaula an important load center would be affected. The splitting needs to be revisited.

The Studies indicate that fault level in Delhi ring would be as high as 60kA (RMS). Hence to restrict the short ciruit Study has been carried out to limit the short circuit through series reactor.

3.0 Series Reactors :

Series reactor can be provided in two methods for controlling fault current i.e (i) Series bus reactors and (ii) Series line Reactors. The characteristic of both are as follows:



Series bus reactor

- The effectiveness of the series bus reactor would varying depending upon the location where it located. When properly located, due to current infeed effect, even a small value is very effective in controlling the short circuit.
- The effect of the series bus reactor is very prominent at small values and its effect diminishes as the impedance value increases. Table-1 shows the effect of bus reactor which has equal feed on both sides.

Table-1 : Effect of series bus reactor on Short Circuit.

X(ohm)	SC Current (kA)	Change in SC (kA)
0	50.9	
2	46.35	4.55
4	43.18	3.17
6	40.86	2.32
8	39.09	1.77
10	37.7	1.39
12	36.57	1.13
14	35.64	0.93

X(ohm)	SC Current (kA)	Change in SC (kA)
16	34.86	0.78
18	34.02	0.84
20	33.63	0.39

- Effect of series bus reactor on adjacent buses is less.
- If the feed for injection and drawl are not equally distributed then high current may flow through the series bus reactor causing a voltage drop.
- Very difficult to install on existing bus where provision has not been kept.

Series line reactor

- Series line reactor is very effective when small numbers of identified feeders are contributing maximum short circuit current.
- Series line reactors would be effective in reducing the short circuit level of both From bus and To bus between the line is connected.
- High fault feed is usually combined effect of small line and connected to a strong bus. Hence Series line reactor on such lines may be even higher then the line impedance.
- Addition of series bus reactor may affect the load flow on the line under steady state condition. In such conditions compensating devices like capacitor may be required.

Study has been carried out to limit the short circuit level thru line reactors. In cases where line reactors are not very effective bus reactors have been used. Need for some of the series line reactors to be compensated sections by series capacitor would be studied after finalisation of series reactors.

4.0 Short Circuit Simulations:

Base Case

Short circuit studies has been carried out considering (i) to (iii) splitting only. Splitting and Mandaula and Dadri-Ballabgarh have not been considered. The short circuit level at various in Delhi ring is as follows:

THREE PHASE FAULT

------ AT BUS ------				/I+/	AN(I+)
18424	**[DADRI4**	**400]**	**AMPS**	**58270.4**	**-107.93**
18419	[BLBGR4	400]	AMPS	47598.3	-107.85
18425	[MLRKT4	400]	AMPS	23297.7	-118.68
15427	**[BAWANA**	**400]**	**AMPS**	**56575.3**	**-108.82**
15428	[BAMNL4	400]	AMPS	39192.6	-109.99
15400	[JATBA-SP	400]	AMPS	47928.9	-109.13
15401	[JATBM-SP	400]	AMPS	38467.4	-110.06
15429	[MUNDKA	400]	AMPS	52688.2	-108.77
18461	[MHRNIBG4	400]	AMPS	29182.8	-110.95
18435	**[MANDLA**	**400]**	**AMPS**	**60953.9**	**-108.22**

It is seen that Dadri, Bawana and Mandaula are very high. Element wise contribution is given in ***Annexure-Base***

Case-1 : Series line reactors at Dadri

At Dadri it is seen that about 45kA short circuit is mainly from Mandola, Mahranibagh and Greater Noida lines element wise contribution is given in ***Annexure-Base***. It is seen that Mandola and Ballabgarh are also getting 17 and 19 kA from Dadri. To restrict the high short circuit contribution small series reactor of about 10ohm has been considered on following lines :

- 10 ohm series line reactor on Dadri-Mandaula 400kV Ckt-I
- 10 ohm series line reactor on Dadri-Mandaula 400kV Ckt-II
- 10 ohm series line reactor on Dadri-Mahranibagh 400kV Ckt
- 10 ohm series line reactor on Dadri-Greater Noida 400kV Ckt

Even 10ohms is equivalent to about 40km long quad line. Short circuit study results with series line reactor are as follows:

THREE PHASE FAULT

------ AT BUS ------			/I+/	AN(I+)
18424	[DADRI4 400]	AMPS	44335.1	-109.23
18419	[BLBGR4 400]	AMPS	46208.6	-107.84
18425	[MLRKT4 400]	AMPS	23275.6	-118.51
15427	[BAWANA 400]	AMPS	54744.9	-108.97
15428	[BAMNL4 400]	AMPS	38909.1	-109.92
15800	[JATTI 765]	AMPS	29378.5	-107.40
15400	[JATBA-SP 400]	AMPS	47377.4	-109.14
15401	[JATBM-SP 400]	AMPS	38259.2	-110.00
15429	[MUNDKA 400]	AMPS	51817.6	-108.81
18461	[MHRNIBG4 400]	AMPS	25244.3	-111.46
18435	[MANDLA 400]	AMPS	56145.7	-108.72

The four series reactors have been effective in reducing the short circuit at Dadri by 15kA. Contribution element wise is tabulated in ***Annexure-Case1***.

Case-2 : Series line reactors at Bawana:

At Bawana it is seen that about 43kA short circuit is mainly from Mandola and Mundka. To control the short circuit at Bawana following line reactors have been considered:

- 10 ohm series line reactor on Bawana-Mandaula 400kV Ckt-I & II
- 10 ohm series line reactor on Bawana-Mundka 400kV Ckt-I & II

Short circuit study results with series line reactor are as follows:

THREE PHASE FAULT

------ AT BUS ------			/I+/	AN(I+)
18424	[DADRI4 400]	AMPS	43430.5	-110.29
18419	[BLBGR4 400]	AMPS	46108.5	-108.66
18425	[MLRKT4 400]	AMPS	23243.2	-119.70
15427	[BAWANA 400]	AMPS	41746.4	-111.94
15428	[BAMNL4 400]	AMPS	38651.1	-110.69
15800	[JATTI 765]	AMPS	28432.7	-108.13
15400	[JATBA-SP 400]	AMPS	40463.4	-110.39
15401	[JATBM-SP 400]	AMPS	37934.4	-110.74
15429	[MUNDKA 400]	AMPS	42048.0	-110.31
18461	[MHRNIBG4 400]	AMPS	25196.0	-112.38
18435	[MANDLA 400]	AMPS	48676.8	-110.61

The four series reactors have been effective in reducing the short circuit at Bawana by 13kA. Contribution element wise is tabulated in ***Annexure-Case2***.

Case-3: Series line reactors at Ballabgarh :

To control the short circuit at Ballabgarh following line reactors have been considered onn lines which have high contribution to short circuit:

- 10 ohm series line reactor on Ballabgarh-Bamnoli 400kV Ckt-I & II
- 10 ohm series line reactor on Ballabgarh-Nawada 400kV Ckt-I

THREE PHASE FAULT

------ AT BUS ------			/I+/	AN(I+)
18424	[DADRI4 400]	AMPS	43158.9	-110.31
18419	[BLBGR4 400]	AMPS	40190.2	-109.38
18425	[MLRKT4 400]	AMPS	23242.7	-119.70
15427	[BAWANA 400]	AMPS	41705.3	-111.94
15428	[BAMNL4 400]	AMPS	34326.6	-111.54
15800	[JATTI 765]	AMPS	27822.3	-108.24
15400	[JATBA-SP 400]	AMPS	40237.1	-110.40
15401	[JATBM-SP 400]	AMPS	34515.0	-111.43
15429	[MUNDKA 400]	AMPS	41865.6	-110.32
18461	[MHRNIBG4 400]	AMPS	24822.8	-112.41
18435	[MANDLA 400]	AMPS	48643.7	-110.61

The series reactors have been effective in reducing the short circuit at Ballabgarh by 6kA. Contribution element wise is tabulated in ***Annexure-Case3***.

Case-4: Series line reactors at Jhattikhara

To control the short circuit at Jhatikhara following line reactors have been considered:

- 10 ohm series line reactor on Jhattikhara-Mundka 400kV Ckt-I & II

THREE PHASE FAULT

------ AT BUS ------			/I+/	AN(I+)
18424	[DADRI4 400]	AMPS	43140.9	-110.33
18419	[BLBGR4 400]	AMPS	40150.2	-109.35
18425	[MLRKT4 400]	AMPS	23241.9	-119.70
15427	[BAWANA 400]	AMPS	40667.8	-112.11
15428	[BAMNL4 400]	AMPS	34041.0	-111.48
15800	[JATTI 765]	AMPS	26611.1	-108.30
15400	[JATBA-SP 400]	AMPS	33246.2	-111.21
15401	[JATBM-SP 400]	AMPS	34141.0	-111.35
15429	[MUNDKA 400]	AMPS	38017.7	-110.87
18461	[MHRNIBG4 400]	AMPS	24821.4	-112.41
18435	[MANDLA 400]	AMPS	48447.9	-110.66

The series reactors have been effective in reducing the short circuit at Jhatikhara by 7kA. Contribution element wise is tabulated in ***Annexure-Case4***.

Case-5: Series Bus reactor at Mandaula & Ballabgarh

It seen that with all the above line reactors some of the buses have high short circuit level. Analysis indicate that Mandaula there are about 8 feeders which feed about 5-6kA. Similarly even in Ballabgarh there is no large feed but presence of about 9 feeders which contribute to high short circuit. Hence splitting at Mandaula and Ballabgarh has been considered.

THREE PHASE FAULT

------ AT BUS ------			/I+/	AN(I+)
18424	[DADRI4 400]	AMPS	41190.6	-109.66
18419	[BLBGR4 400]	AMPS	35764.1	-108.93
18425	[MLRKT4 400]	AMPS	23271.6	-118.64
15427	[BAWANA 400]	AMPS	38082.1	-111.43

15428	[BAMNL4	400]	AMPS	33543.7	-110.66
15800	[JATTI	765]	AMPS	26556.9	-107.50
15400	[JATBA-SP	400]	AMPS	33071.6	-110.36
15401	[JATBM-SP	400]	AMPS	33751.1	-110.54
15429	[MUNDKA	400]	AMPS	37345.2	-110.01
18461	[MHRNIBG4	400]	AMPS	23179.7	-112.20
18435	[MANDLA	400]	AMPS	39207.8	-110.82
8435	[SPLMAND	400]	AMPS	36341.0	-111.54
8422	[SPLTBLG	400]	AMPS	26733.9	-111.53

To limit the short circuit level at Dadri and provide margin for future growth the study been has been repeated with 12 ohms for all proposed series reactors along with series line reactor at Mandaula-Meerut D/c line. The results is as follows:

THREE PHASE FAULT

------ AT BUS ------				/I+/	AN(I+)
18424	[DADRI4	400]	AMPS	39110.2	-109.79
18419	[BLBGR4	400]	AMPS	34698.1	-108.97
18425	[MLRKT4	400]	AMPS	23267.8	-118.63
15427	[BAWANA	400]	AMPS	36411.9	-111.66
15428	[BAMNL4	400]	AMPS	32950.3	-110.71
15800	[JATTI	765]	AMPS	26239.3	-107.49
15400	[JATBA-SP	400]	AMPS	31936.7	-110.40
15401	[JATBM-SP	400]	AMPS	33237.6	-110.58
15429	[MUNDKA	400]	AMPS	35879.1	-110.09
18461	[MHRNIBG4	400]	AMPS	22425.3	-112.35
18435	[MANDLA	400]	AMPS	34966.6	-111.61
8435	[SPLMAND	400]	AMPS	34339.6	-111.74

One of the major contributors to Dadri short circuit is Greater Noida. The Great Noida when connected to Greater Noida 765/400kV substation of UPPTCL there will be high contribution. It is proposed that a splitting arrangement may be provided so that under normal condition Dadri-Ballabagrh would be connected directly and as and when required it would be connected to Greater Noida. Result of studies are as below:

THREE PHASE FAULT

------ AT BUS ------				/I+/	AN(I+)
18424	[DADRI4	400]	AMPS	35358.4	-109.95
18419	[BLBGR4	400]	AMPS	33961.6	-108.90
18425	[MLRKT4	400]	AMPS	23258.2	-118.54
15427	[BAWANA	400]	AMPS	36418.8	-111.59
15428	[BAMNL4	400]	AMPS	32833.7	-110.64
15800	[JATTI	765]	AMPS	26240.8	-107.43
15400	[JATBA-SP	400]	AMPS	31937.3	-110.33
15401	[JATBM-SP	400]	AMPS	33150.1	-110.51
15429	[MUNDKA	400]	AMPS	35873.7	-110.02
18461	[MHRNIBG4	400]	AMPS	21397.4	-112.35
18435	[MANDLA	400]	AMPS	37178.6	-110.93
8435	[SPLMAND	400]	AMPS	34410.3	-111.68
8422	[SPLTBLG	400]	AMPS	22526.0	-112.13

5.0 Conclusion :

- To control the short circuit level of Delhi Ring following 12 ohm series reactors are proposed:

Series Line reactors:

- Dadri-Mandaula 400kV Ckt-I & II – 2nos
- Dadri-Mahranibagh 400kV Ckt – 1nos
- Dadri-Greater Noida 400kV Ckt – 1nos
- Ballabgarh-Bamnoli 400kV Ckt-I & II – 2nos
- Ballabgarh-Nawada 400kV Ckt-I – 1nos
- Bawana-Mandaula 400kV Ckt-I & II – 2nos
- Bawana-Mundka 400kV Ckt-I & II – 2nos
- Jhattikhara-Mundka 400kV Ckt-I & II – 2nos

Series Bus reactors :

- Series bus reactors on Mandaula & Ballabgarh

- It is proposed the Greater Noida substation of UPPTCL may not be connected to 765kV network of UPPTCL. If it is to be connected then proper sectionalising arrangement may be provided that Dadri-Greater-Noida-Nawada-Ballabgarh line may be sectionalised from main bus and connected as and when requirement arises.

Annexure-Base

Basecase

Dadri Fault level	
Transmission Element	**Fault current contribution (kA)**
Machines -4 Nos	4
Loni Road	5
G. Noida	18.8
Dadri ICT	5
MLRKT	1.8
Mandola -I	9
Mandola -II	9
Maharanibagh	6
	58.27

Bawana Fault level	
Transmission Element	**Fault current contribution (kA)**
Abdullapur	3.5
Sonepath	5
Bawana ICT	3.4
Mundka-I	10
Mundka-II	10
Mandola-I	12.5
Mandola-II	12.5
	56.57

Mandola Fault level	
Transmission Element	**Fault current contribution (kA)**
Meerut-I	4.6
Meerut-II	4.6
Meerut-III	4.6
Meerut-IV	4.6
Mandola ICT	4.9
Bawana-I	10.3
Bawana-II	10.3
Dadri-I	8.6
Dadri-II	8.6
	60.95

Mundka Fault level	
Transmission Element	**Fault current contribution (kA)**
Jhajjar-I	4.8
Jhajjar-II	4.8
Jattikala-I	7.6
Jattikala-II	7.6
Mundka ICT	2
Bawana -I	12.8
Bawana -II	12.8
	52.68

Bamnoli Fault level	
Transmission Element	**Fault current contribution (kA)**
Bamnoli ICT	6.2
Jattikalan-I	8.4
Jattikalan-II	8.4
Ballabgarh-I	8
Ballabgarh-II	8
	39.19

Ballabgarh Fault level	
Transmission Element	**Fault current contribution (kA)**
Bamnoli-I	5.9
Bamnoli-II	5.9
Nawada	12.8
Mainpuri-I	2
Mainpuri-II	2
Ballabgarh ICT	7
Kanpur-I	2
Kanpur-II	2
Kanpur-III	2
Maharanibagh	6
	47.59

Annexure-Case-I

10 ohm line reactor on Dadri-Mandaula & Dadri-Mahrani bagh/Greater Noida lines.

Dadri Fault level

Transmission Element	Fault current contribution (kA)
Machines -4 Nos	3.948
Loni Road	5.8
G. Noida	9.85
Dadri ICT	5
MLRKT	1.9
Mandola -I	6.5
Mandola -II	6.5
Maharanibagh	5
	44.33

Bawana Fault level

Transmission Element	Fault current contribution (kA)
Abdullapur	3.5
Sonepath	5
Bawana ICT	3.5
Mundka-I	10
Mundka-II	10
Mandola-I	11.4
Mandola-II	11.4
	54.74

Mandola Fault level

Transmission Element	Fault current contribution (kA)
Meerut-I	4.7
Meerut-II	4.7
Meerut-III	4.7
Meerut-IV	4.7
Mandola ICT	5.3
Bawana-I	10.6
Bawana-II	10.6
Dadri-I	5.4
Dadri-II	5.4
	56.14

Mundka Fault level

Transmission Element	Fault current contribution (kA)
Jhajjar-I	4.8
Jhajjar-II	4.8
Jattikala-I	7.7
Jattikala-II	7.7
Mundka ICT	2.2
Bawana -I	12.3
Bawana -II	12.3
	51.81

Bamnoli Fault level

Transmission Element	Fault current contribution (kA)
Bamnoli ICT	6.23
Jattikalan-I	8.4
Jattikalan-II	8.4
Ballabgarh-I	8
Ballabgarh-II	8
	38.9

Ballabgarh Fault level

Transmission Element	Fault current contribution (kA)
Bamnoli-I	6
Bamnoli-II	6
Nawada	11.7
Mainpuri-I	1.9
Mainpuri-II	1.9
Ballabgarh ICT	7
Kanpur-I	2
Kanpur-II	2
Kanpur-III	2
Maharanibagh	5.6
	46.2

Annexure-case-2

10 ohm line reactor on Bawana-Mandaula & Bawana-Mundka lines.

Dadri Fault level

Transmission Element	Fault current contribution (kA)
Machines -4 Nos	4
Loni Road	5.8
G. Noida	9.9
Dadri ICT	5
MLRKT	1.9
Mandola -I	6
Mandola -II	6
Maharanibagh	5
	43.43

Bawana Fault level

Transmission Element	Fault current contribution (kA)
Abdullapur	3.6
Sonepath	5.3
Bawana ICT	4
Mundka-I	7
Mundka-II	7
Mandola-I	7.5
Mandola-II	7.5
	41.75

Mandola Fault level

Transmission Element	Fault current contribution (kA)
Meerut-I	4.9
Meerut-II	4.9
Meerut-III	4.9
Meerut-IV	4.9
Mandola ICT	5.5
Bawana-I	6.3
Bawana-II	6.3
Dadri-I	5.6
Dadri-II	5.6
	48.9

Mundka Fault level

Transmission Element	Fault current contribution (kA)
Jhajjar-I	5
Jhajjar-II	5
Jattikala-I	8
Jattikala-II	8
Mundka ICT	2.5
Bawana -I	6.8
Bawana -II	6.8
	42.04

Bamnoli Fault level

Transmission Element	Fault current contribution (kA)
Bamnoli ICT	6.2
Jattikalan-I	8.25
Jattikalan-II	8.25
Ballabgarh-I	8
Ballabgarh-II	8
	38.65

Ballabgarh Fault level

Transmission Element	Fault current contribution (kA)
Bamnoli-I	6
Bamnoli-II	6
Nawada	11.7
Mainpuri-I	2
Mainpuri-II	2
Ballabgarh ICT	7
Kanpur-I	2
Kanpur-II	2
Kanpur-III	2
Maharanibagh	5.6
	46.1

Annexure-case-3

10 ohm line reactor on Ballabgrah-Bamnoli and Ballabgarh-Nawada lines.

Dadri Fault level

Transmission Element	Fault current contribution (kA)
Machines -4 Nos	3.904
Loni Road	5.8
G. Noida	9.5
Dadri ICT	5
MLRKT	1.9
Mandola -I	6
Mandola -II	6
Maharanibagh	5.2
	43.15

Bawana Fault level

Transmission Element	Fault current contribution (kA)
Abdullapur	3.6
Sonepath	5.3
Bawana ICT	4
Mundka-I	7
Mundka-II	7
Mandola-I	7.6
Mandola-II	7.6
	41.7

Mandola Fault level

Transmission Element	Fault current contribution (kA)
Meerut-I	4.9
Meerut-II	4.9
Meerut-III	4.9
Meerut-IV	4.9
Mandola ICT	5.5
Bawana-I	6.3
Bawana-II	6.3
Dadri-I	5.5
Dadri-II	5.5
	48.64

Mundka Fault level

Transmission Element	Fault current contribution (kA)
Jhajjar-I	5
Jhajjar-II	5
Jattikala-I	8
Jattikala-II	8
Mundka ICT	2.5
Bawana -I	6.8
Bawana -II	6.8
	41.86

Bamnoli Fault level

Transmission Element	Fault current contribution (kA)
Bamnoli ICT	6.5
Jattikalan-I	8.4
Jattikalan-II	8.4
Ballabgarh-I	5.5
Ballabgarh-II	5.5
	34.32

Ballabgarh Fault level

Transmission Element	Fault current contribution (kA)
Bamnoli-I	4.7
Bamnoli-II	4.7
Nawada	7.3
Mainpuri-I	2.1
Mainpuri-II	2.1
Ballabgarh ICT	7.4
Kanpur-I	2.1
Kanpur-II	2.1
Kanpur-III	2.1
Maharanibagh	6
	40.19

Annexure-Case-4

10 ohm line reactor on Jhatikhara-Mundka lines.

Dadri Fault level

Transmission Element	Fault current contribution (kA)
Machines -4 Nos	3.9
Loni Road	5.8
G. Noida	9.5
Dadri ICT	5
MLRKT	1.9
Mandola -I	6
Mandola -II	6
Maharanibagh	5.2
	43.14

Bawana Fault level

Transmission Element	Fault current contribution (kA)
Abdullapur	3.6
Sonepath	5.3
Bawana ICT	4
Mundka-I	6.3
Mundka-II	6.3
Mandola-I	7.6
Mandola-II	7.6
	40.66

Mandola Fault level

Transmission Element	Fault current contribution (kA)
Meerut-I	4.9
Meerut-II	4.9
Meerut-III	4.9
Meerut-IV	4.9
Mandola ICT	5.5
Bawana-I	6.2
Bawana-II	6.2
Dadri-I	5.6
Dadri-II	5.6
	48.44

Mundka Fault level

Transmission Element	Fault current contribution (kA)
Jhajjar-I	5
Jhajjar-II	5
Jattikala-I	5.8
Jattikala-II	5.8
Mundka ICT	2.6
Bawana -I	6.9
Bawana -II	6.9
	38.01

Bamnoli Fault level

Transmission Element	Fault current contribution (kA)
Bamnoli ICT	6.5
Jattikalan-I	8.3
Jattikalan-II	8.3
Ballabgarh-I	5.5
Ballabgarh-II	5.5
	34.01

Ballabgarh Fault level

Transmission Element	Fault current contribution (kA)
Bamnoli-I	4.7
Bamnoli-II	4.7
Nawada	7.3
Mainpuri-I	2
Mainpuri-II	2
Ballabgarh ICT	7.4
Kanpur-I	2
Kanpur-II	2
Kanpur-III	2
Maharanibagh	6
	40.15

Annexure-Case-5

10 ohm series bus reactor at Mandaula & Ballabgarh

Dadri Fault level

Transmission Element	Fault current contribution (kA)
Machines -4 Nos	4
Loni Road	5.7
G. Noida	9.3
Dadri ICT	5
MLRKT	1.9
Mandola -I	5.3
Mandola -II	5.3
Maharanibagh	4.9
	41.11

Bawana Fault level

Transmission Element	Fault current contribution (kA)
Abdullapur	3.6
Sonepath	5.4
Bawana ICT	4.1
Bawana-Spt	12.2
Mundka-I	6.3
Mundka-II	6.3
	38.08

Mandola Fault level

Transmission Element	Fault current contribution (kA)
Meerut-I	5.9
Meerut-II	5.9
Mandola-Splt	10
Mandola ICT	5.8
Dadri-I	5.7
Dadri-II	5.7
Split bus-1	**39.2**
Meerut-III	6.1
Meerut-IV	6.1
Mandola-Splt	11
Bawna-1	6.5
Bawana-II	6.5
Split bus-2	**36.34**

Mundka Fault level

Transmission Element	Fault current contribution (kA)
Jhajjar-I	5
Jhajjar-II	5
Jattikala-I	5.8
Jattikala-I	5.8
Mundka ICT	2.6
Bawana -I	6.5
Bawana -II	6.5
	37.34

Bamnoli Fault level

Transmission Element	Fault current contribution (kA)
Bamnoli ICT	6.6
Jattikalan-I	8.3
Jattikalan-II	8.3
Ballabgarh-I	5.2
Ballabgarh-II	5.2
	33.54

Ballabgarh Fault level

Transmission Element	Fault current contribution (kA)
Bamnoli-I	4.8
Bamnoli-II	4.8
Ballabhgarh-Splt	7.9
Mainpuri-I	2
Mainpuri-II	2
Ballabgarh ICT	7.8
Kanpur-I	2
Kanpur-II	2
Kanpur-III	2
Split-bus-I	**35.76**
Nawada	7.9
Maharani-Bagh	6.7
Ballabhgarh-Split	12
Split-bus-II	**26.73**

Annexure-case6

10 ohm series bus reactor at Mandaula & Ballabgarh

Dadri Fault level

Transmission Element	Fault current contribution (kA)
Machines -4 Nos	3.944
Loni Road	5.8
G. Noida	8.55
Dadri ICT	5
MLRKT	1.9
Mandola -I	4.7
Mandola -II	4.7
Maharanibagh	4.7
	39.11

Bawana Fault level

Transmission Element	Fault current contribution (kA)
Abdullapur	3.68
Sonepath	5.4
Bawana ICT	4.2
Bawana-Spt	11.2
Mudka-I	5.92
Mundka-II	5.92
	36.41

Mandola Fault level

Transmission Element	Fault current contribution (kA)
Meerut-I	4.4
Meerut-II	4.4
Meerut-Splt	9.3
Mandola ICT	6
Dadri-I	5.4
Dadri-II	5.4
Split bus-1	**34.96**
Meerut-III	6.34
Meerut-IV	6.34
Mandola-Splt	9.51
Bawna-1	6
Bawana-II	6
Split bus-2	**34.33**

Mundka Fault level

Transmission Element	Fault current contribution (kA)
Jhajjar-I	5
Jhajjar-II	5
Jattikala-I	5.56
Jattikala-II	5.56
Mundka ICT	2.6
Bawana -I	6
Bawana -II	6
	35.87

Bamnoli Fault level

Transmission Element	Fault current contribution (kA)
Bamnoli ICT	6.67
Jattikalan-I	8.3
Jattikalan-II	8.28
Ballabgarh-I	8.28
Ballabgarh-II	4.9
	32.95

Ballabgarh Fault level

Transmission Element	Fault current contribution (kA)
Bamnoli-I	4.63
Bamnoli-II	4.63
Ballabggarh-Spt	7.1
Mainpuri-I	2.1
Mainpuri-II	2.1
Ballabgarh ICT	7.9
Kanpur-I	2.1
Kanpur-II	2.1
Kanpur-III	2.1
Split-bus-I	**34.69**
Nawada	7.42
Maharani-Bagh	6.76
Ballabhgarh-Split	10.8
Split-bus-II	**24.95**

Annexure-case-7

Dadri Fault level

Transmission Element	Fault current contribution (kA)
Machines -4 Nos	4
Loni Road	6
G. Noida	4
Dadri ICT	5
MLRKT	1.9
Mandola -I	5.2
Mandola -II	5.2
Maharanibagh	4.4
	35.35

Bawana Fault level

Transmission Element	Fault current contribution (kA)
Abdullapur	3.7
Sonepath	5.4
Bawana ICT	4.17
Bawana-Spt	11.4
Mudka-I	5.92
Mundka-II	5.92
	36.41

Mandola Fault level

Transmission Element	Fault current contribution (kA)
Meerut-I	6.1
Meerut-II	6.1
Meerut-Splt	8.9
Mandola ICT	5.9
Dadri-I	5
Dadri-II	5
Split bus-1	**37.17**
Meerut-III	6.3
Meerut-IV	6.3
Mandola-Splt	9.7
Bawna-1	6
Bawana-II	6
Split bus-2	**34.41**

Mundka Fault level

Transmission Element	Fault current contribution (kA)
Jhajjar-I	5.1
Jhajjar-II	5.1
Jattikala-I	5.6
Jattikala-II	5.6
Mundka ICT	2.6
Bawana -I	6
Bawana -II	6
	35.87

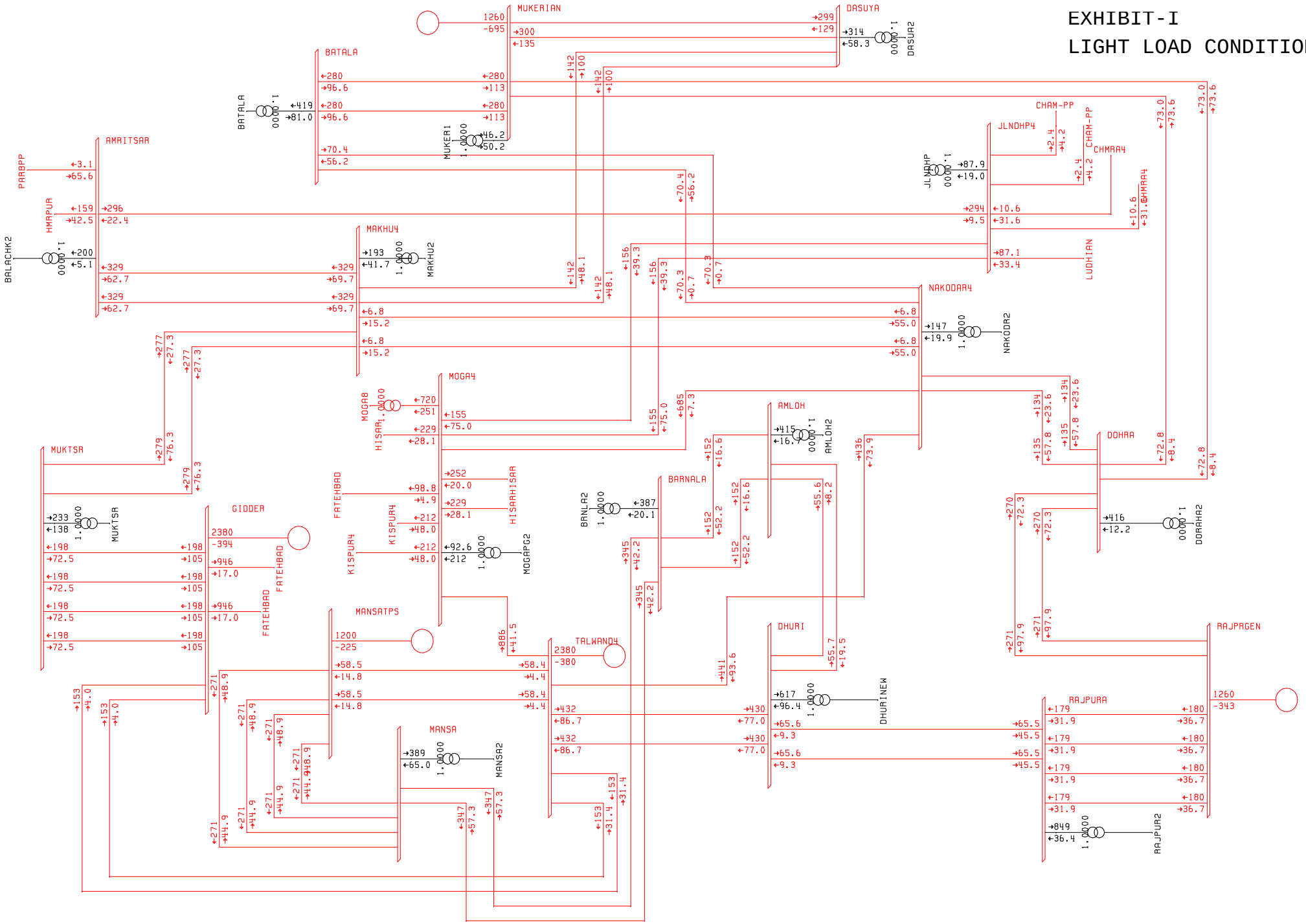
Bamnoli Fault level

Transmission Element	Fault current contribution (kA)
Bamnoli ICT	6.65
Jattikalan-I	8.3
Jattikalan-II	8.3
Ballabgarh-I	4.8
Ballabgarh-II	4.8
	32.83

Ballabgarh Fault level

Transmission Element	Fault current contribution (kA)
Bamnoli-I	4.65
Bamnoli-II	4.65
Ballabggarh-Spt	6.3
Mainpuri-I	2.2
Mainpuri-II	2.2
Ballabgarh ICT	7.8
Kanpur-I	2.1
Kanpur-II	2.1
Kanpur-III	2.1
Split-bus-I	**33.96**
Nawada	5
Maharani-Bagh	6.5
Ballabhgarh-Split	11
Split-bus-II	**22.53**

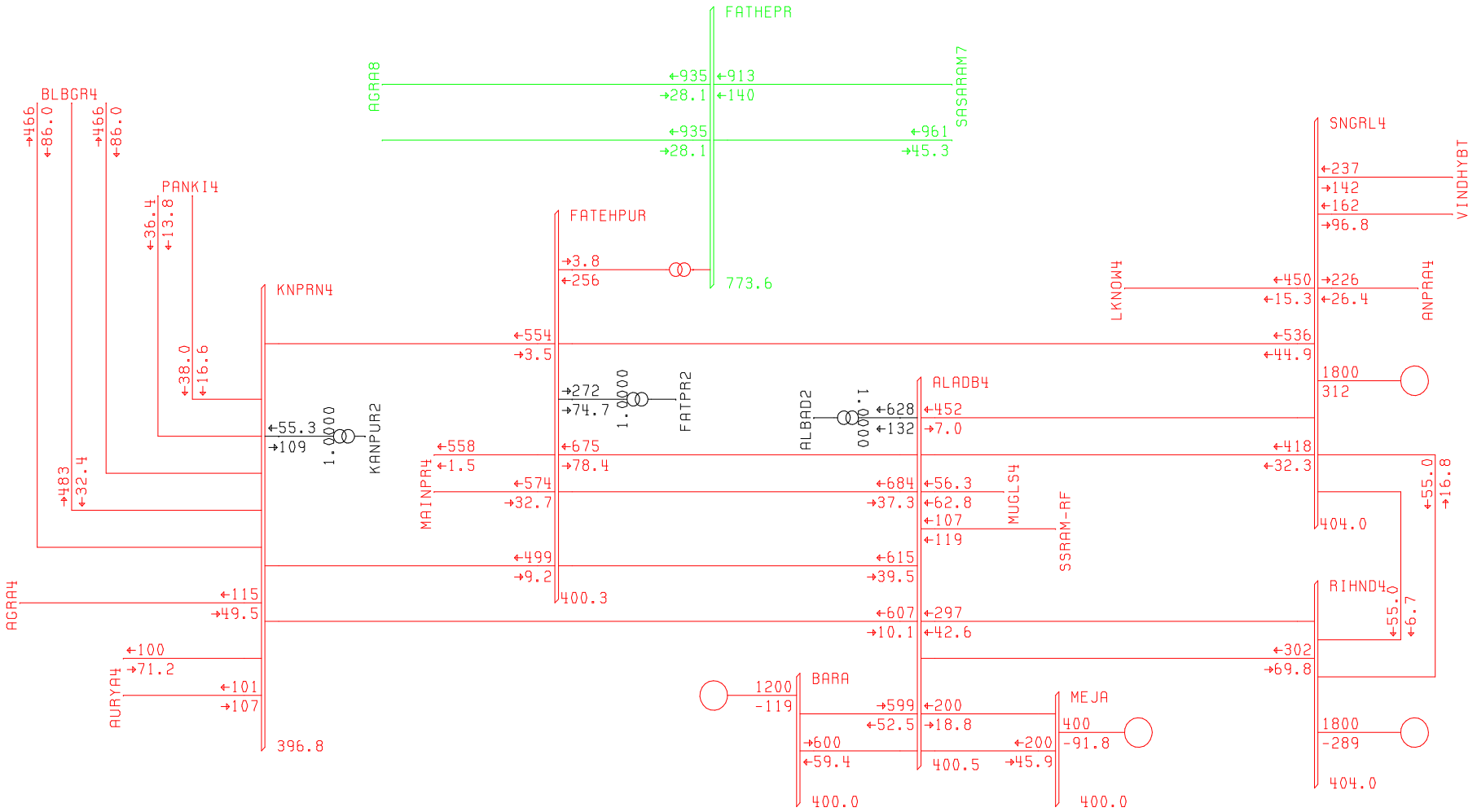
EXHIBIT-I
LIGHT LOAD CONDITION



POWER TECHNOLOGIES, INC.	MON, JUL 08 2013 12:02	KV: ≤220 , ≤400 , ≤765	BUS - NONE BRANCH - MW/MVAR EQUIPMENT - MW/MVAR

EXHIBIT-II(a)

sTUDY FOR BARA TPS
iNJECTION AT ALLAHABD-BASE CASE



STUDY FOR BARA TPS-BASE CASE
INJECTION AT ALLAHABAD

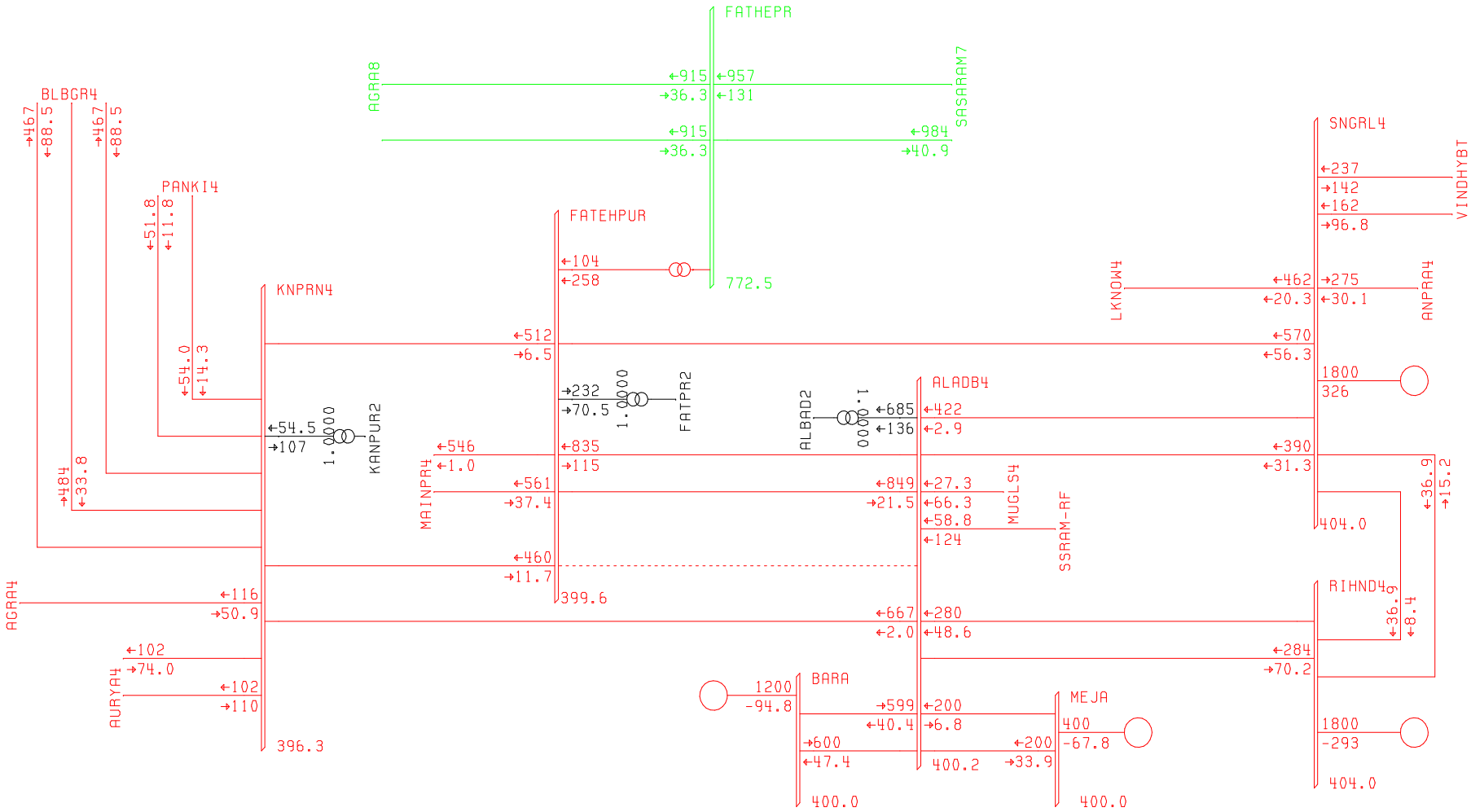
POWER TECHNOLOGIES, INC.

MON, JUL 08 2013 9:05

KV: ≤220 , ≤400 , ≤765

BUS - VOLTAGE (KV)
BRANCH - MW/MVAR
EQUIPMENT - MW/MVAR

EXHIBIT-II(b)



INJECTION AT ALLAHABAD
OUTAGE OF ONE CKT OF ALLAHABD-
FATEHPUR 400Kv LINE

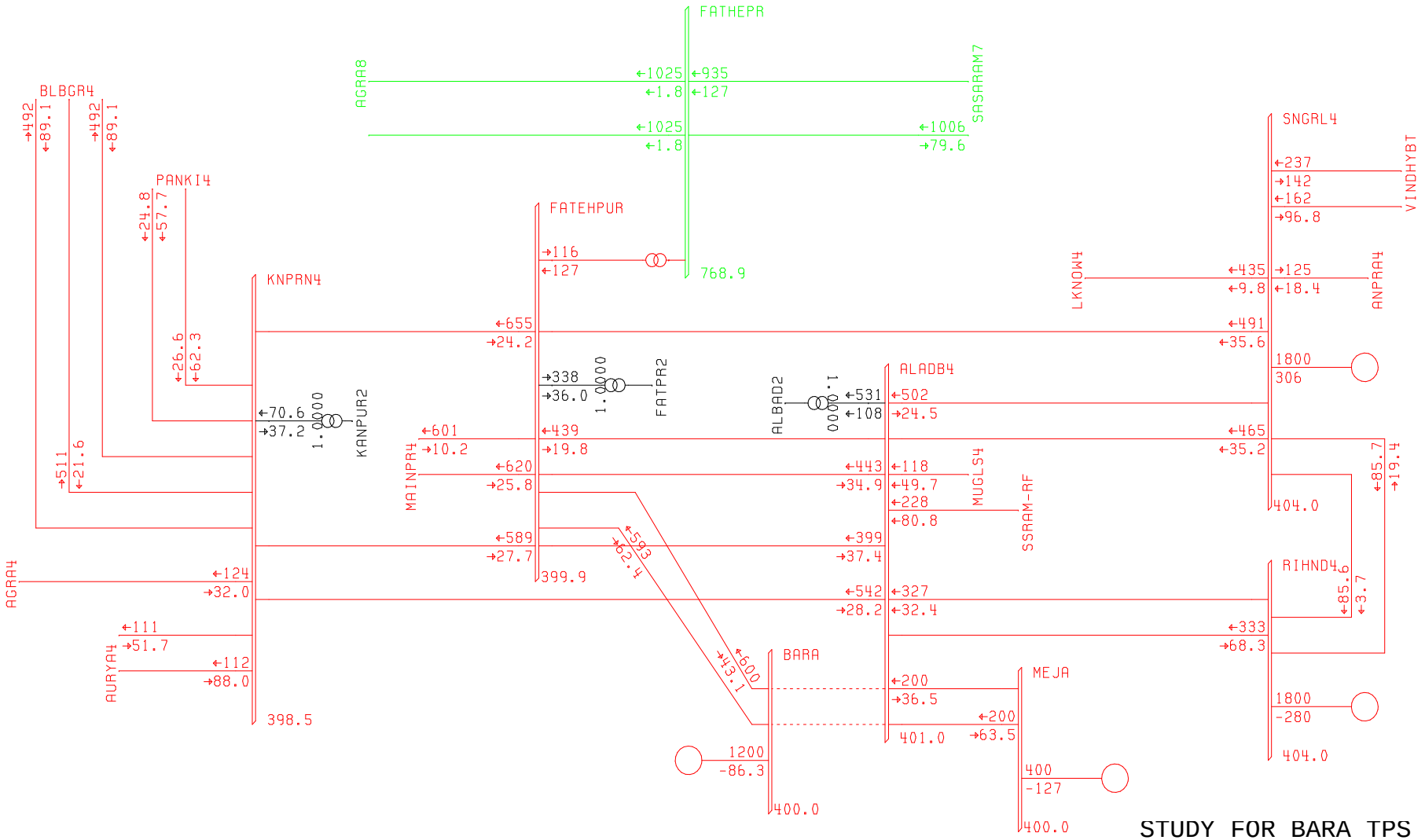
POWER TECHNOLOGIES, INC.

MON, JUL 08 2013 9:05

KV: ≤220 , ≤400 , ≤765

BUS - VOLTAGE(KV)
BRANCH - MW/MVAR
EQUIPMENT - MW/MVAR

EXHIBIT-III(a)



STUDY FOR BARA TPS
INJECTION AT FATEHPUR
BASE CASE

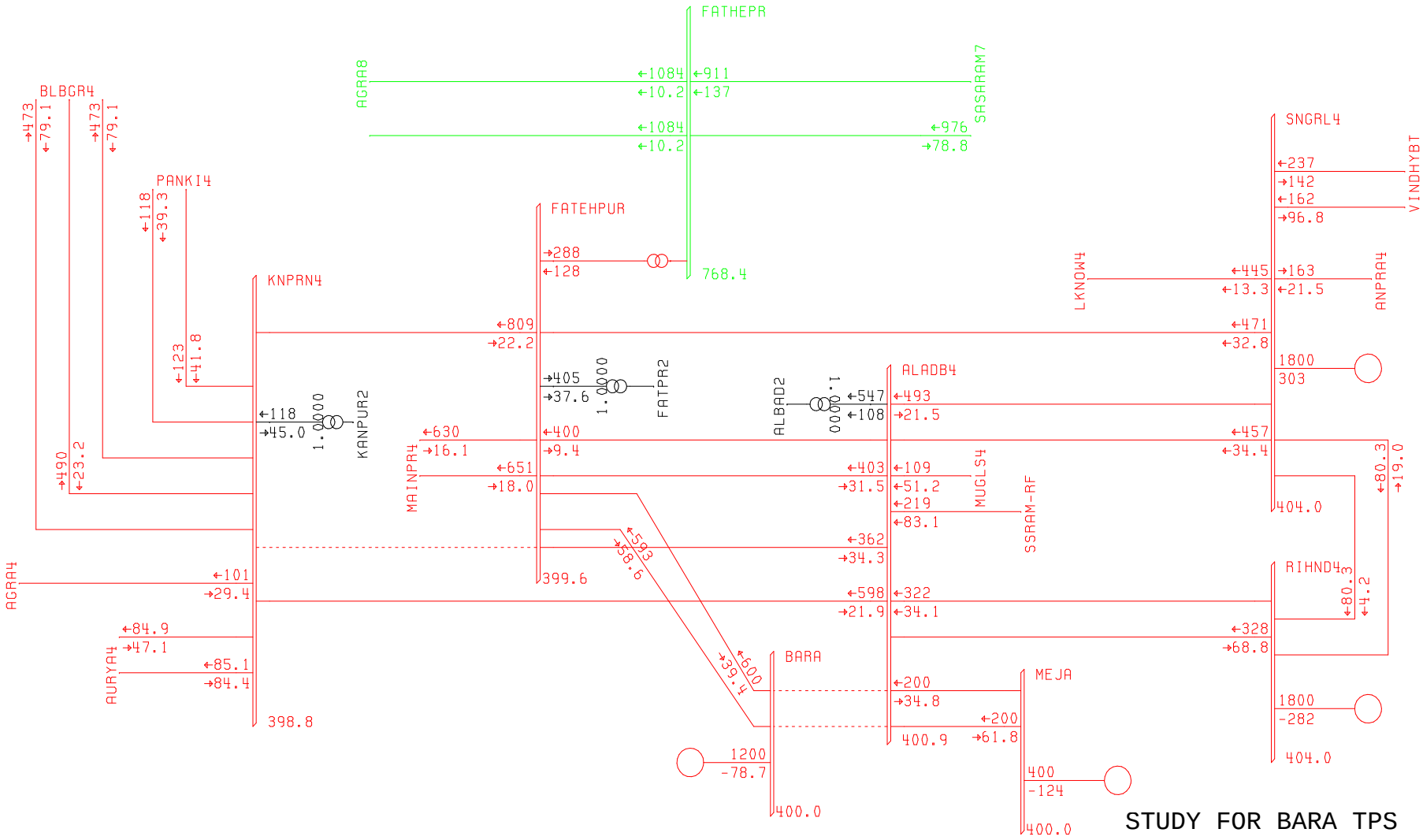
POWER TECHNOLOGIES, INC.

SAT, JUL 06 2013 15:51

KV: ≤220 , ≤400 , ≤765

BUS - VOLTAGE (KV)
BRANCH - MW/MVAR
EQUIPMENT - MW/MVAR

EXHIBIT-III(b)



STUDY FOR BARA TPS
INJECTION AT FATEHPUR
OUTAGE OF ONE CKT OF FATEHPR-KANPUR LIN

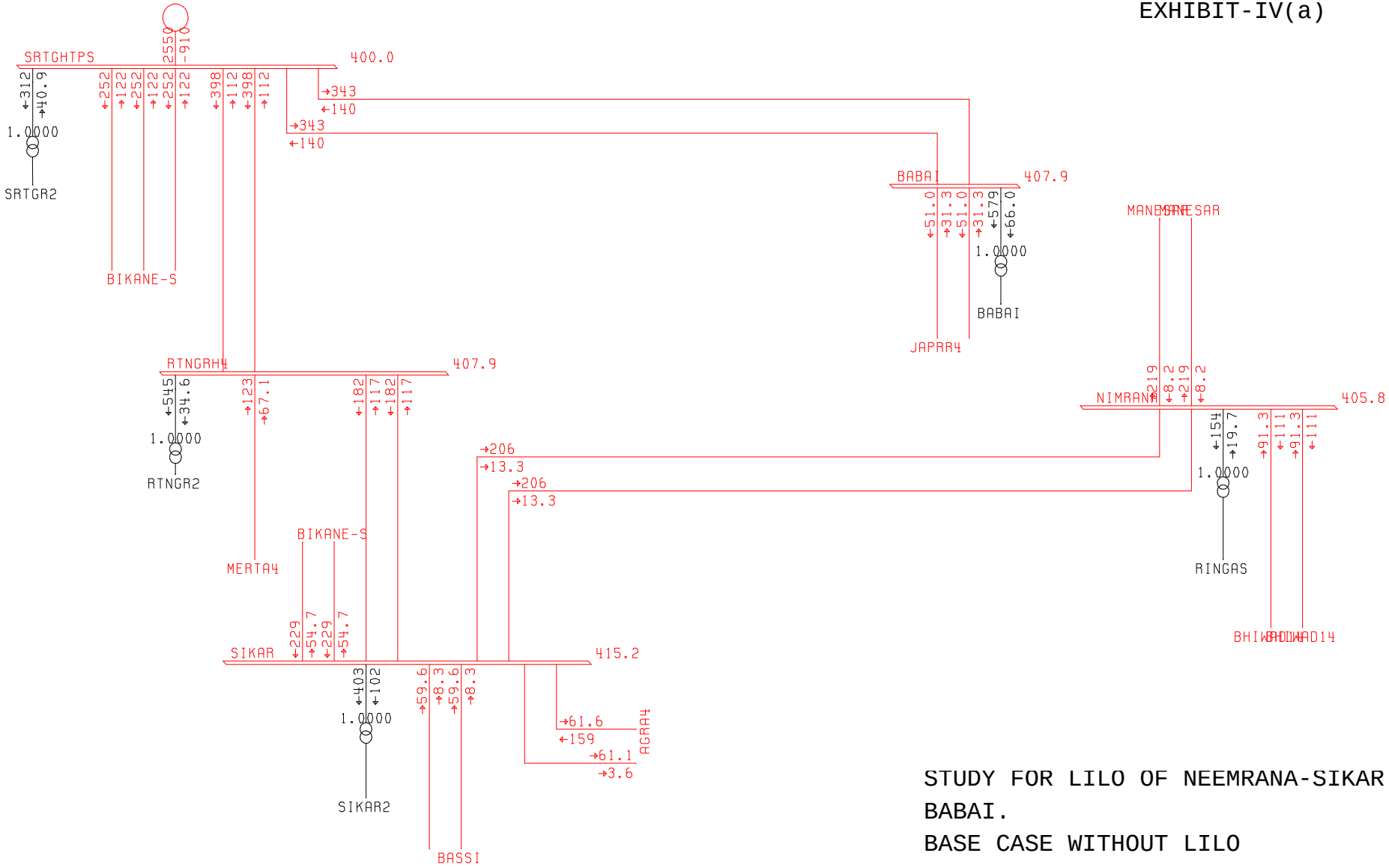
POWER TECHNOLOGIES, INC.

SAT, JUL 06 2013 15:51

KV: ≤220 , ≤400 , ≤765

BUS - VOLTAGE (KV)
BRANCH - MW/MVAR
EQUIPMENT - MW/MVAR

EXHIBIT-IV(a)



STUDY FOR LILO OF NEEMRANA-SIKAR AT BABAI.
BASE CASE WITHOUT LILO

POWER TECHNOLOGIES, INC.

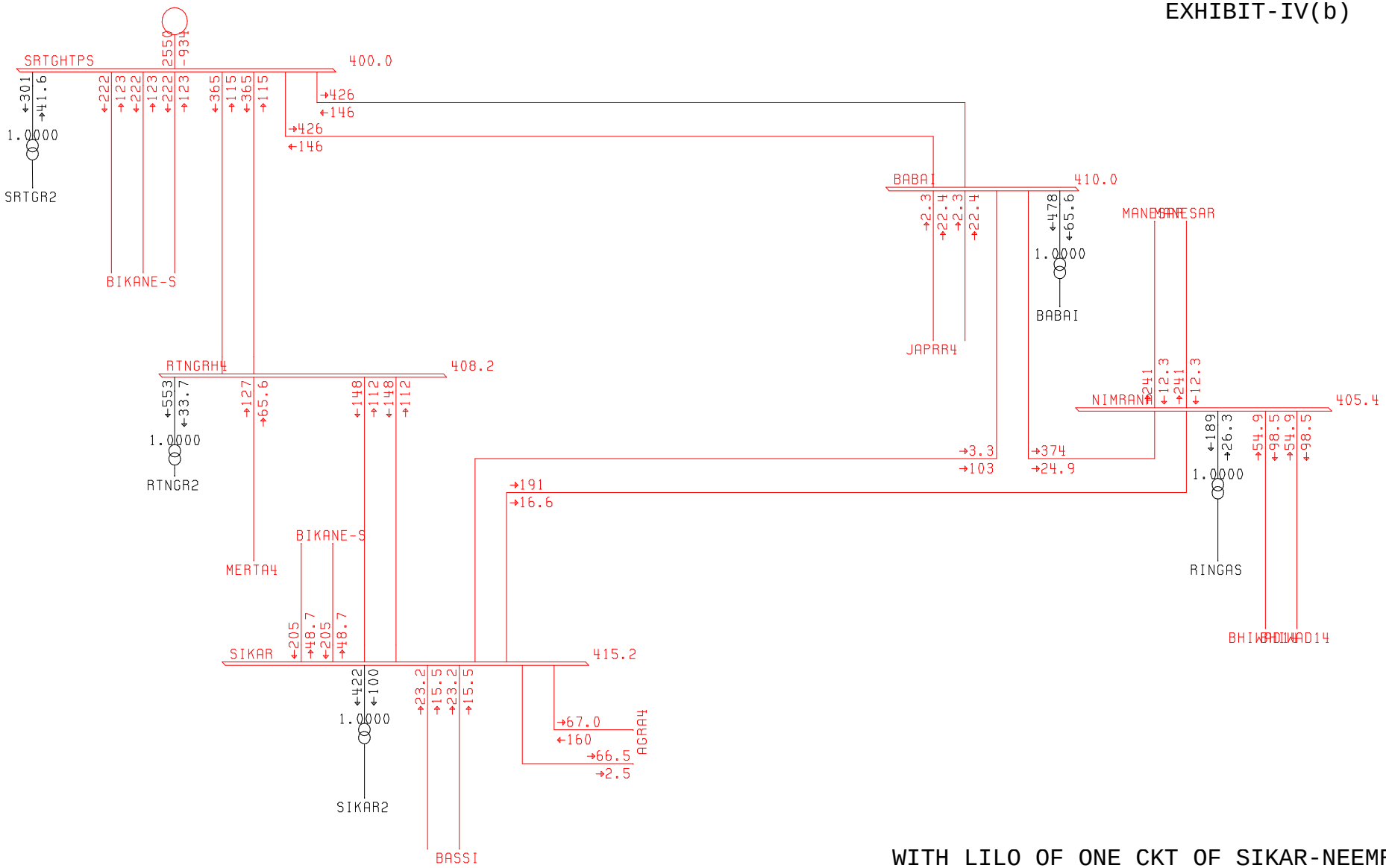
OFF PEAK-WITH STRENGTHENING

SAT, JUL 06 2013 13:15

KV: ≤220 , ≤400 , ≤765

BUS - VOLTAGE(KV)
BRANCH - MW/MVAR
EQUIPMENT - MW/MVAR

EXHIBIT-IV(b)



WITH LILO OF ONE CKT OF SIKAR-NEEMRANA AT BABAI

POWER TECHNOLOGIES, INC.

OFF PEAK-WITH STRENGTHENING

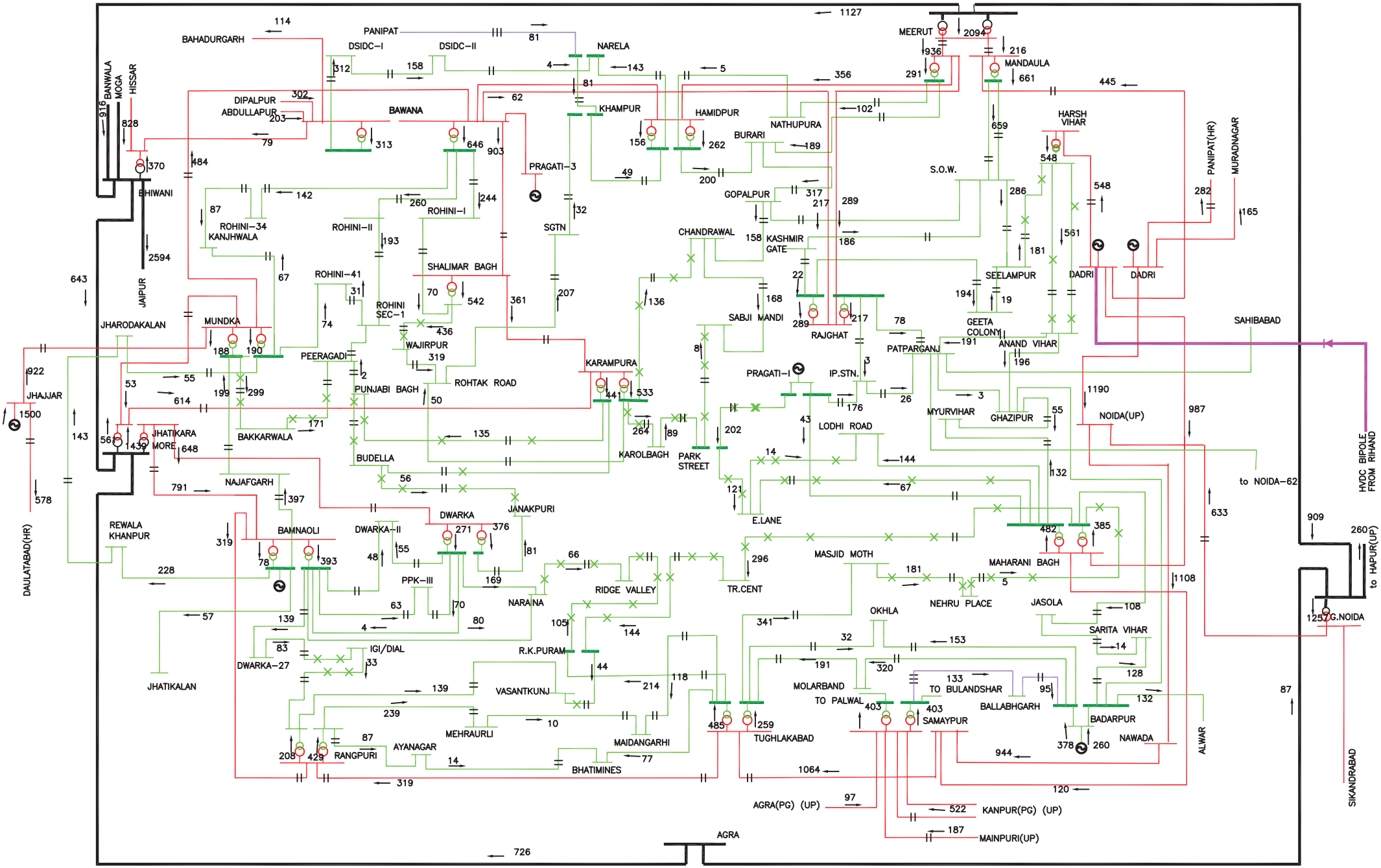
SAT, JUL 06 2013 13:16

KV: ≤220 , ≤400 , ≤765

BUS - VOLTAGE(KV)
BRANCH - MW/MVAR
EQUIPMENT - MW/MVAR

EXHIBIT-V

SINGLE LINE DIAGRAM OF DELHI–2021–22 BASE CASE WITH PROPOSED MODIFICATIONS



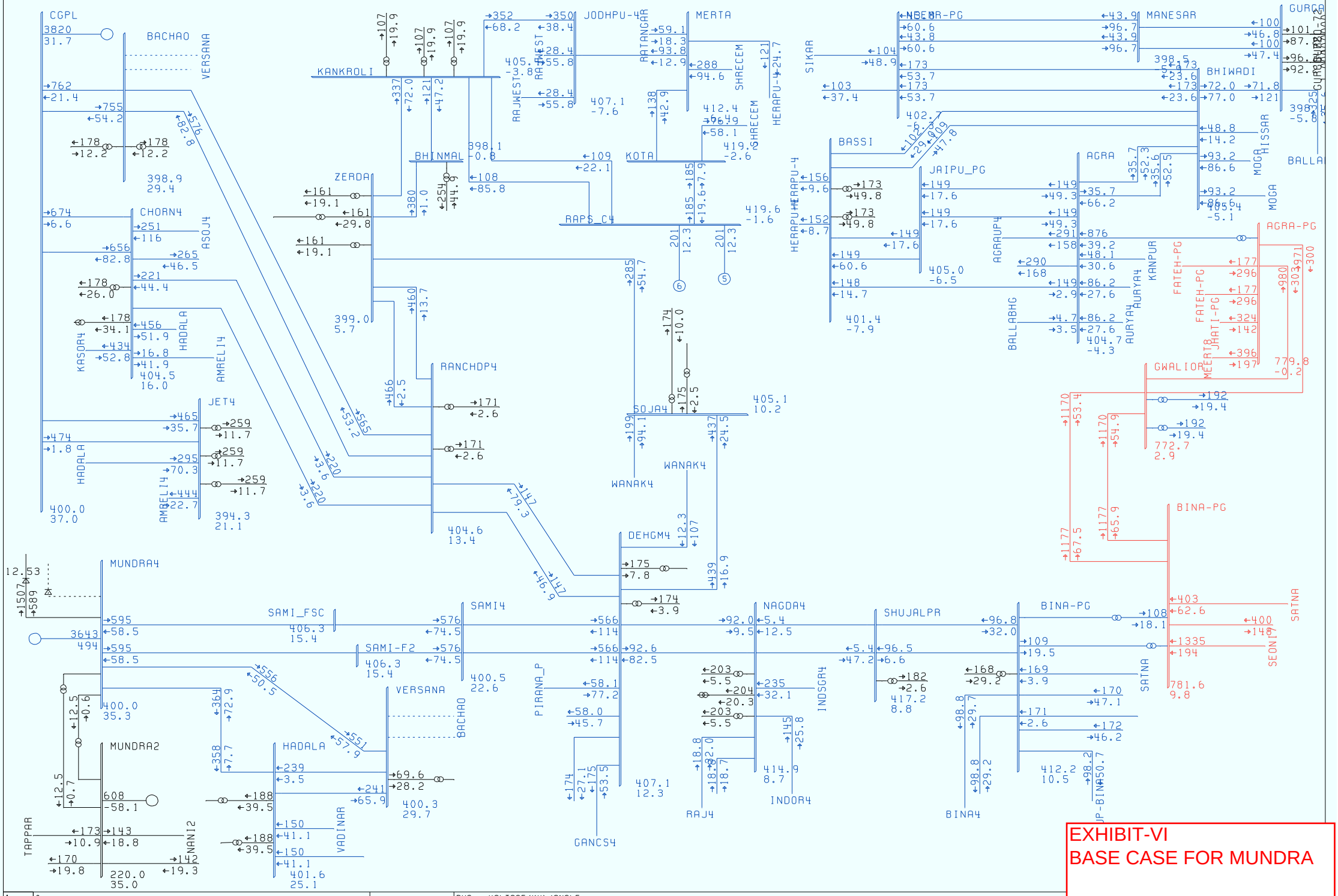
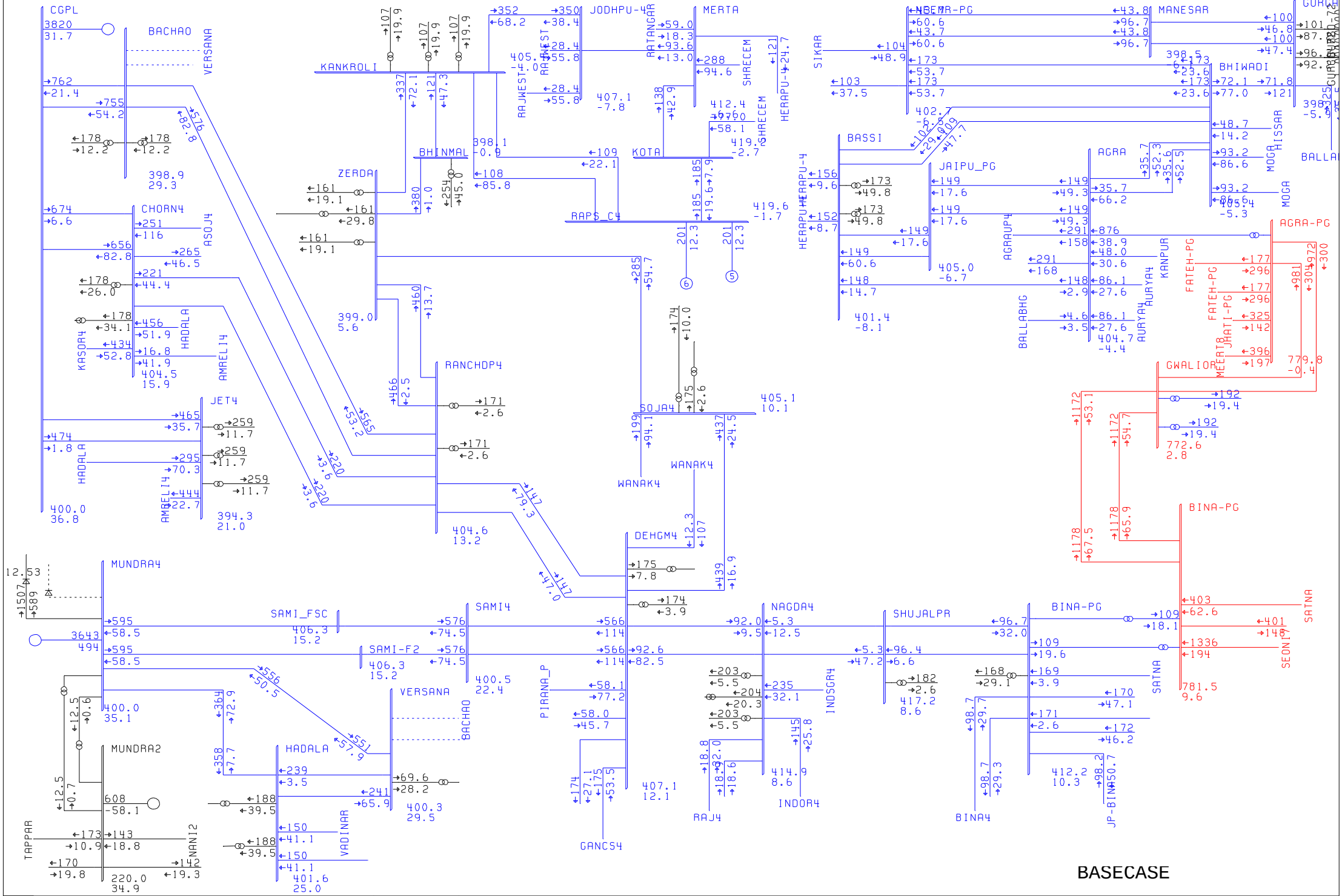
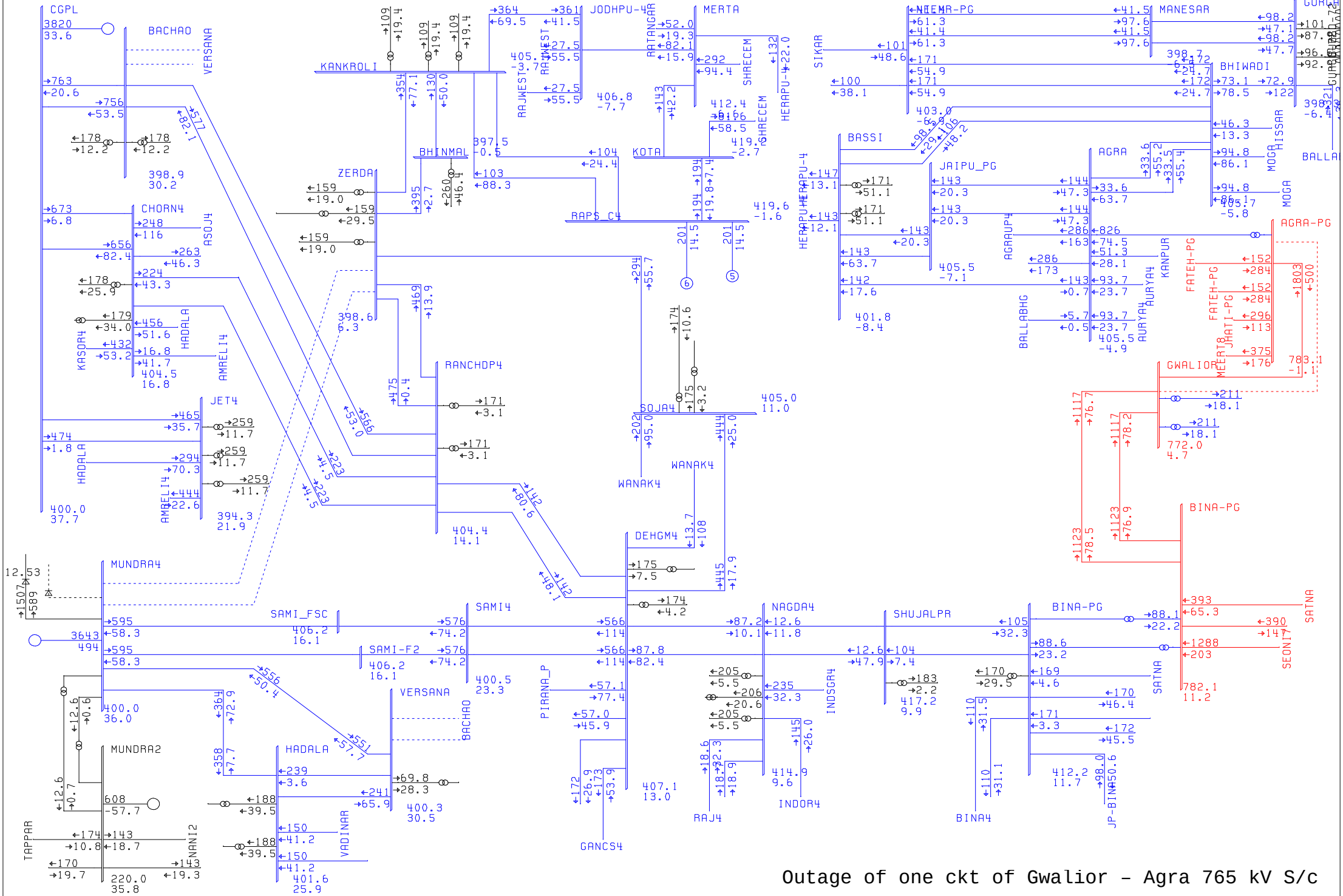


EXHIBIT-VI
BASE CASE FOR MUNDRA

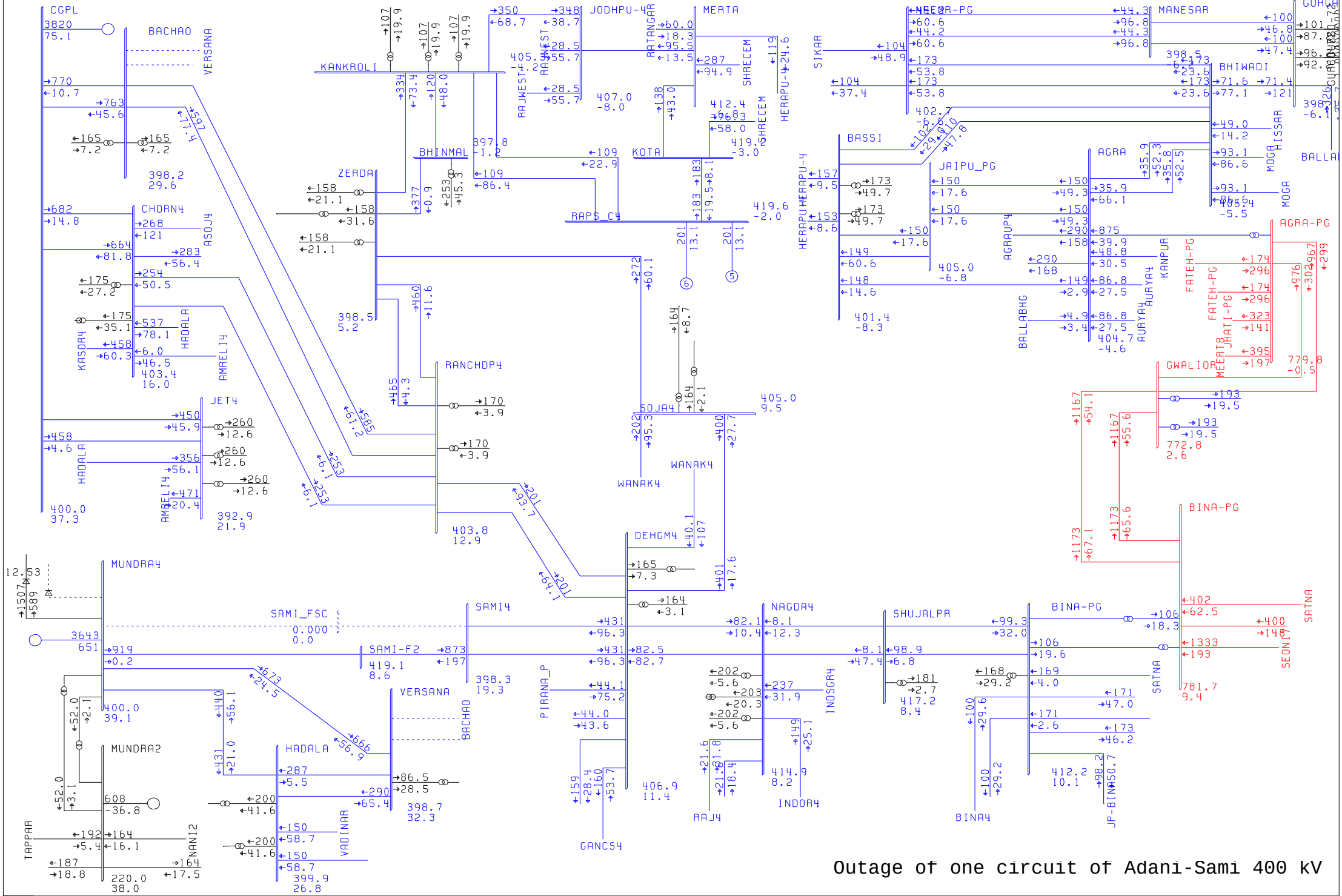
EXHIBIT-VII


CGPL
BACHAO
VERSANA
KANKROLI
JODHPU-4
MERTA
BHINMAL
ZERDA
RAPS_C4
KOTA
SHREECEM
HERAPU-4
SIKAR
NEEMR-PG
MANESAR
GURGA
BHIWADI
BASSI
JAIPU_PG
AGRA
AGRA-PG
HISSAR
MOGA
BALLAB
CHORN4
ASOJ4
KASOR4
HADALA
AMARELI4
JET4
RANCHDP4
SOJA4
WANAK4
DEHGM4
GWALIOR
FATEH-PG
JHATI-PG
MEERT8
KANPUR
AURYA4
BALLABHG
AGRAUP4
BINA-PG
SATNA
SEONI8
MUNDRA4
MUNDRA2
SAMI_FSC
SAMI-F2
SAMI4
VERSANA
HADALA
VADINAR
TAPPAR
NANI2
PIRANA_P
GANCS4
NAGDA4
INDOR4
RAJ4
SHUJALPR
BINA4
JP-BINA
BASECASE

EXHIBIT=VII-01

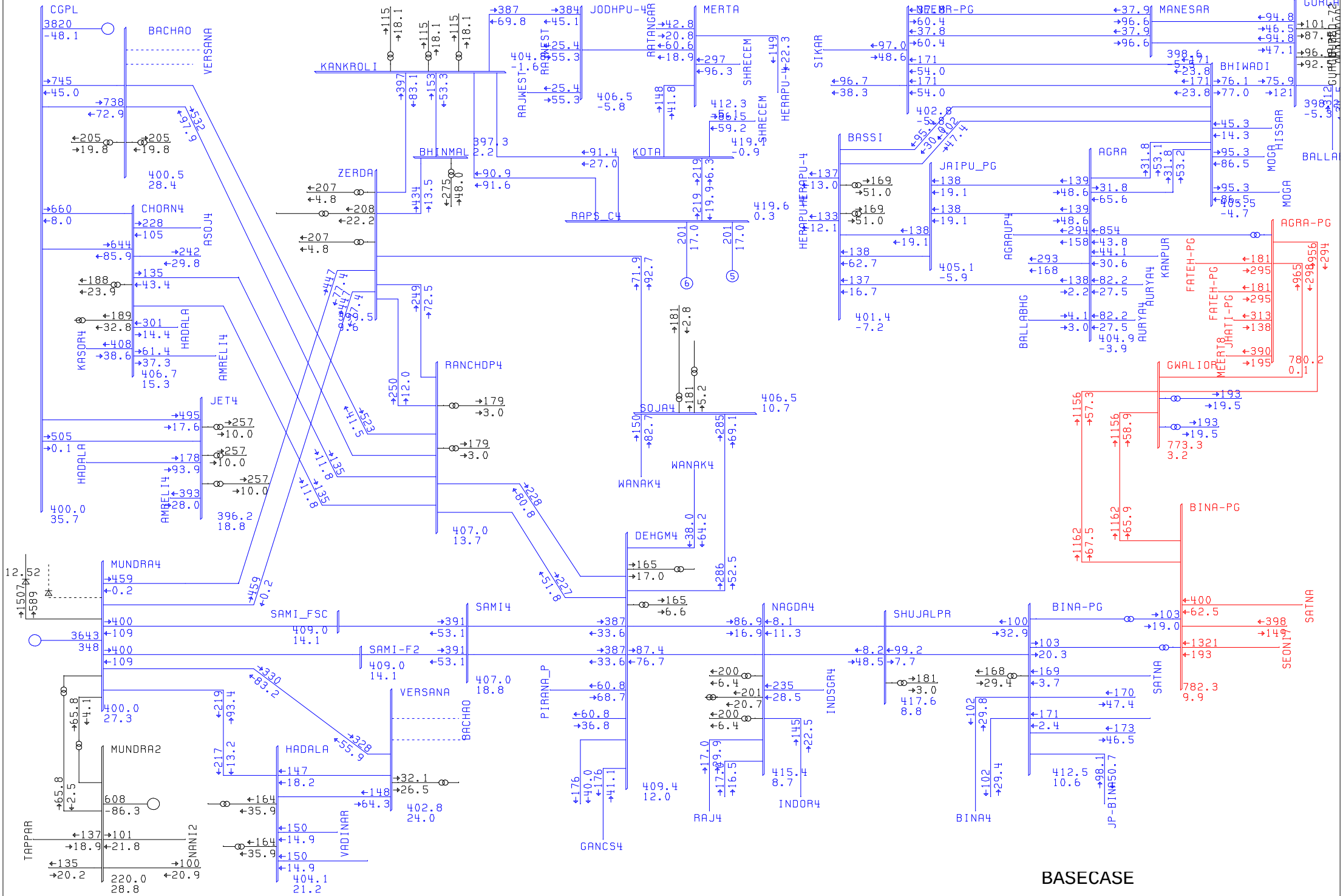


Outage of one ckt of Gwalior – Agra 765 kV S/c



Outage of one circuit of Adani-Sami 400 kV

EXHIBIT-VIII



BASECASE

EXHIBIT-VIII-01

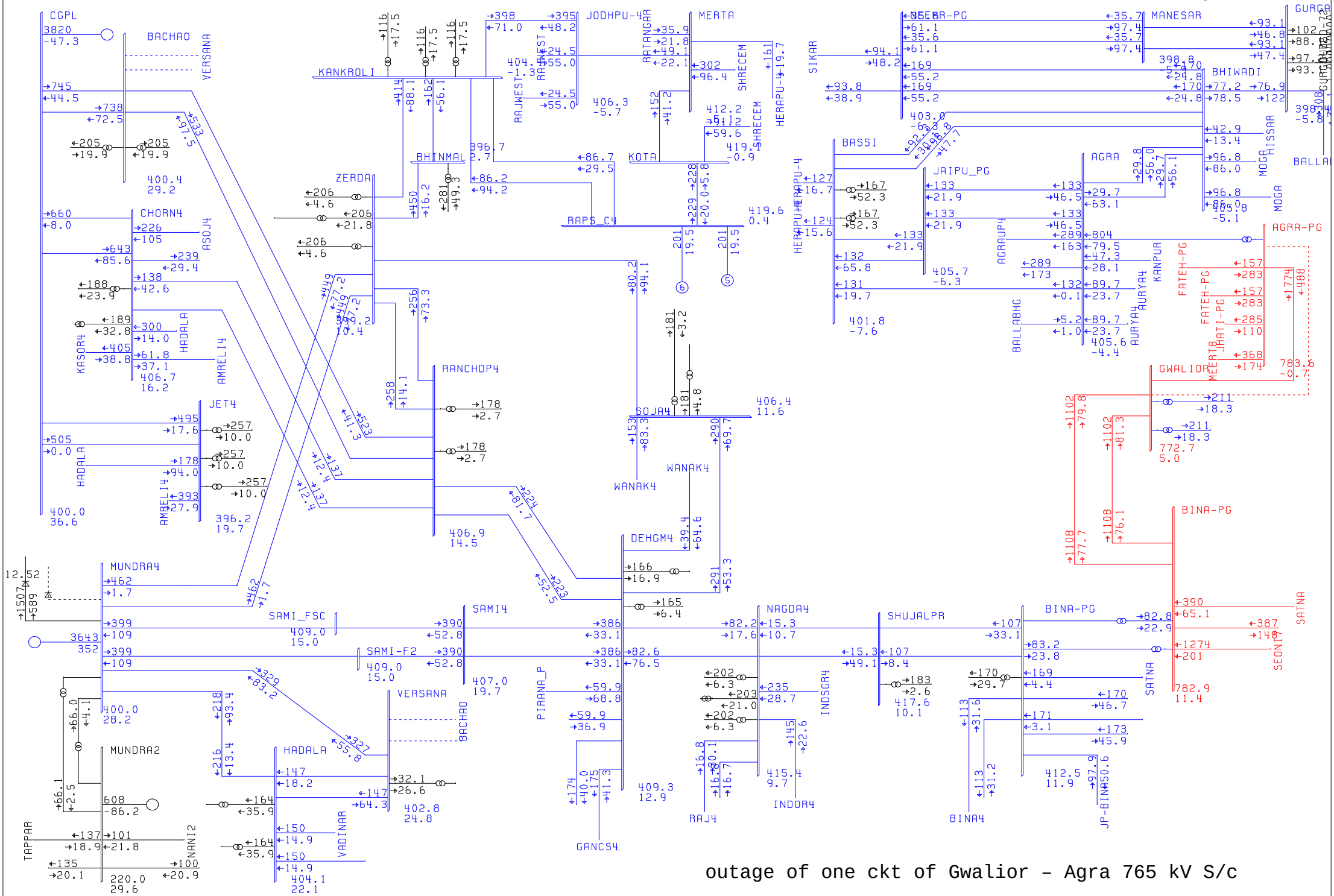


EXHIBIT VIII-02

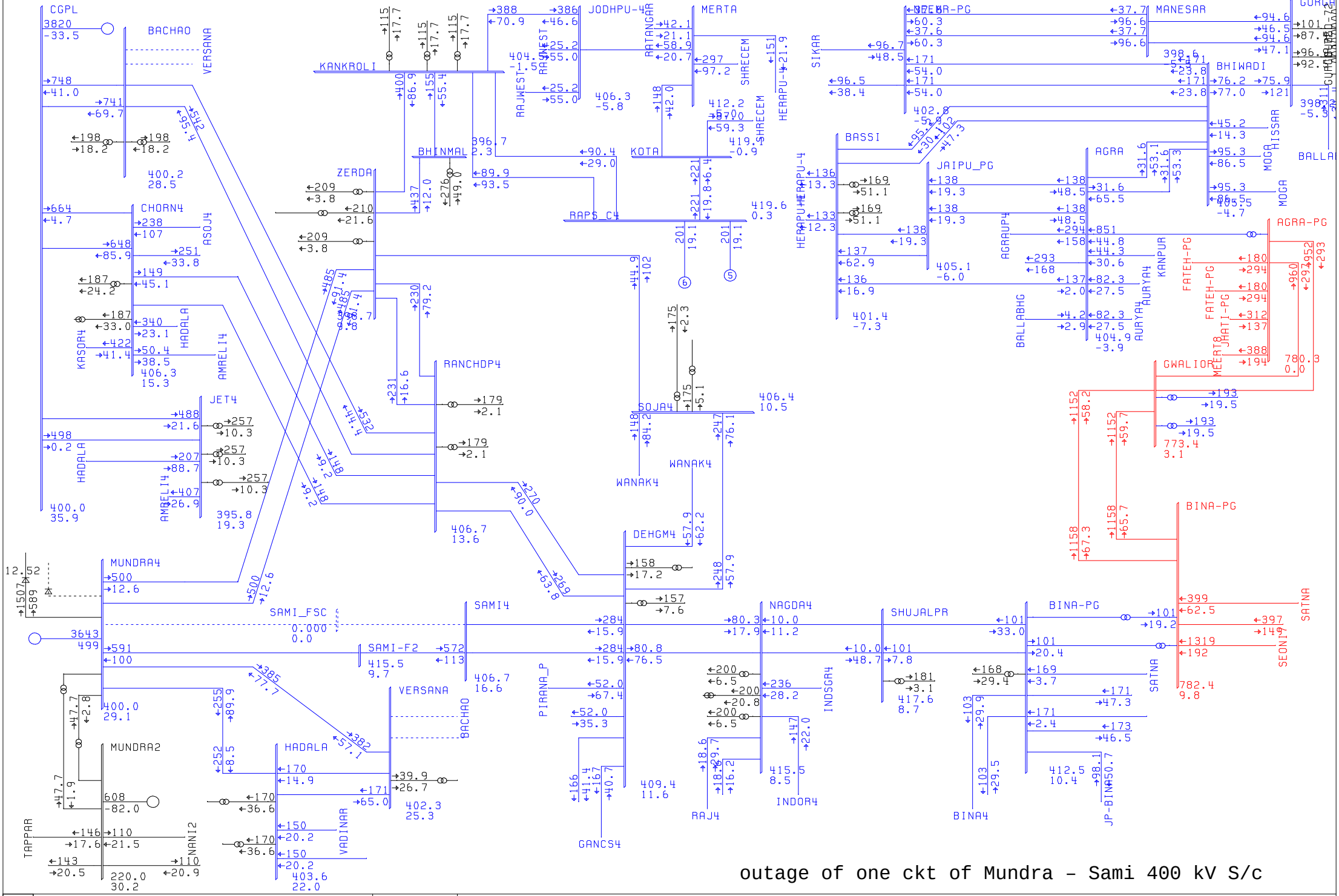
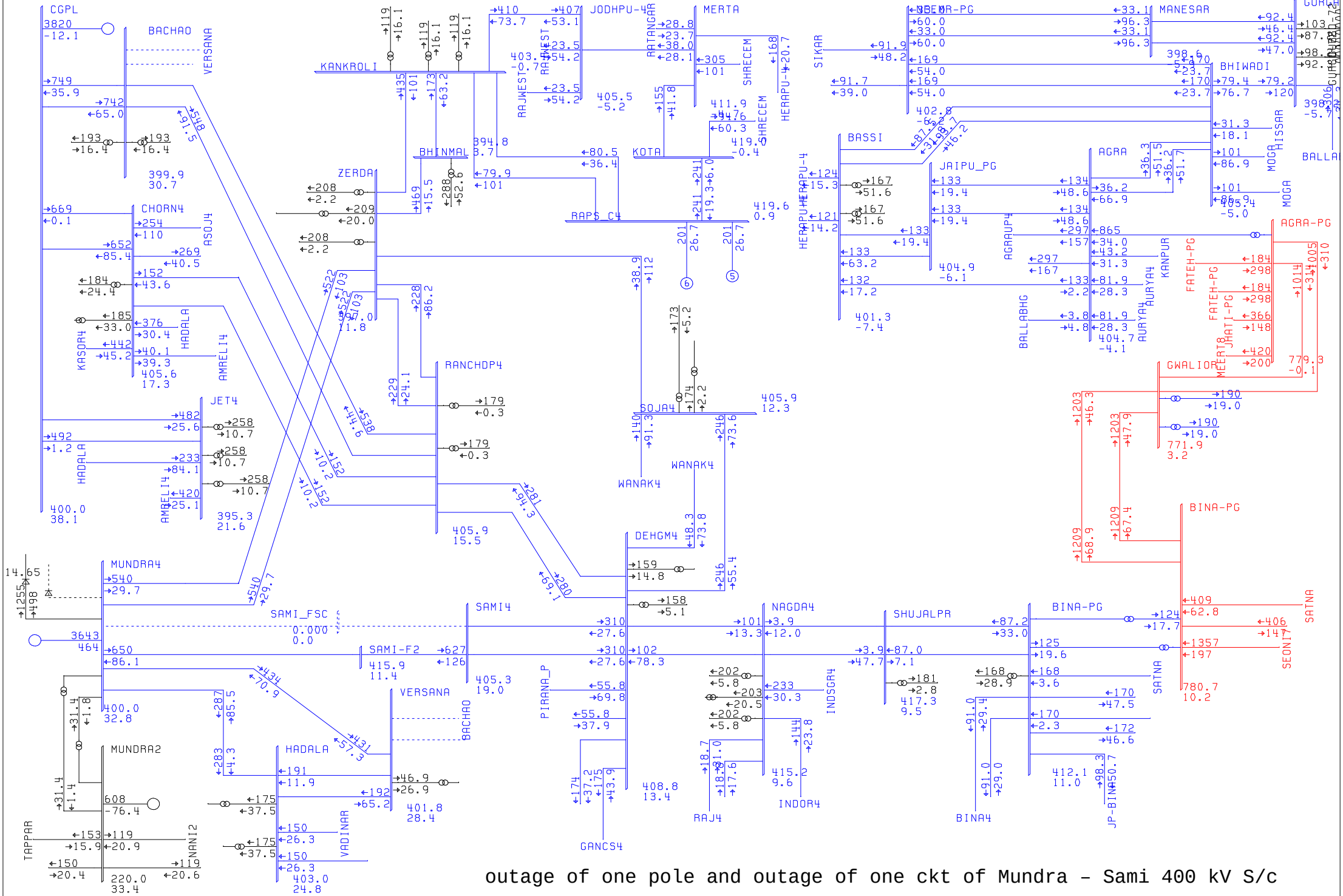


EXHIBIT-VIII-03

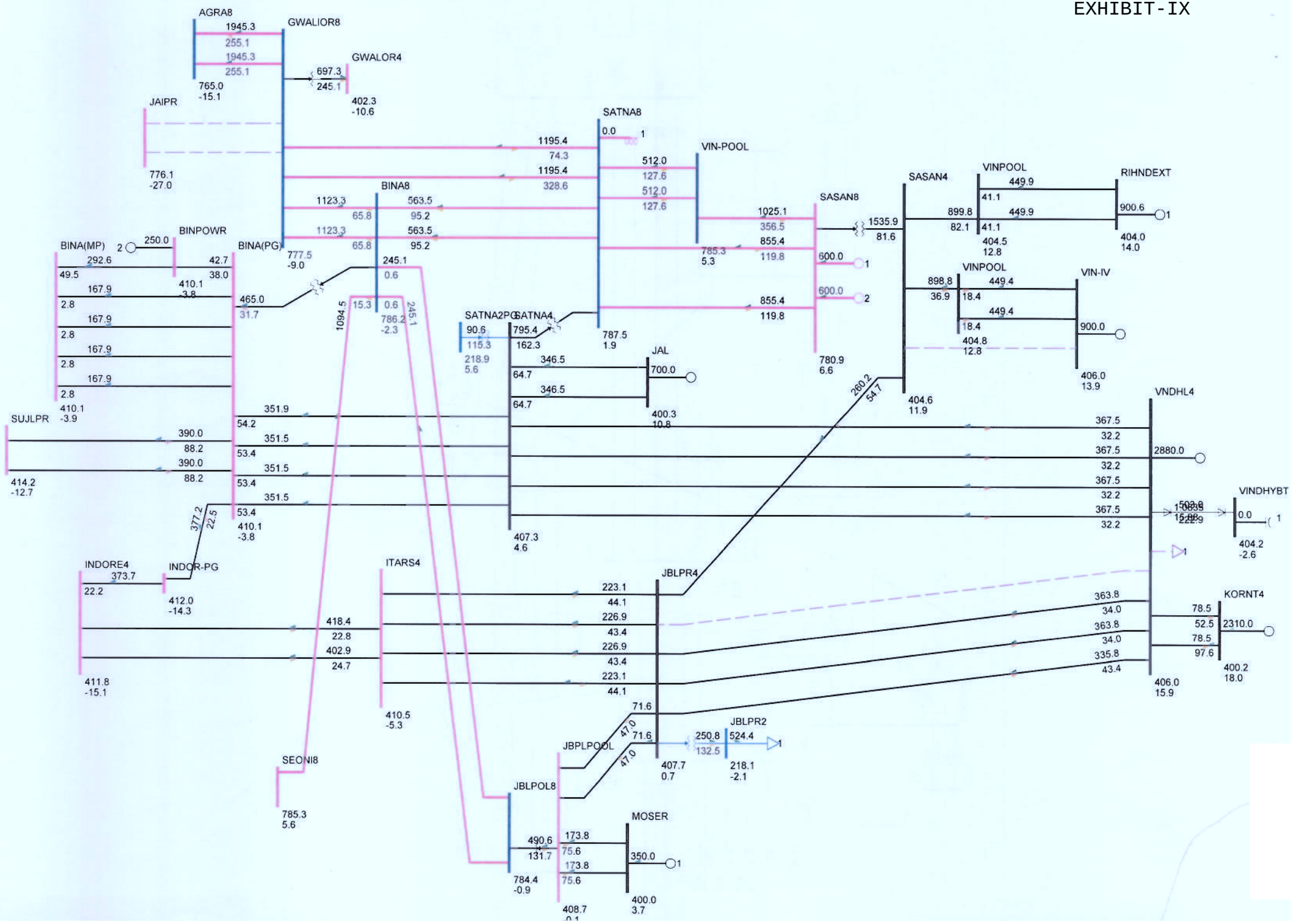


outage of one pole and outage of one ckt of Mundra – Sami 400 kV S/c

TUE, JUL 09 2013 16:54

BUS - VOLTAGE(KV)/ANGLE
BRANCH - MW/MVAR
EQUIPMENT - MW/MVAR

EXHIBIT-IX


AGRA8
GWALIOR8
GWALOR4
JAIPR
SATNA8
VIN-POOL
BINA8
BINA(MP)
BINPOWR
BINA(PG)
SASAN8
SASAN4
VINPOOL
RIHNDEXT
VINPOOL
VIN-IV
SATNA2PG
SATNA4
JAL
SUJLPR
VNDHL4
VINDHYBT
INDORE4
INDOR-PG
ITARS4
JBLPR4
KORNT4
SEONI8
JBPLPOOL
JBLPR2
JBLPOL8
MOSER