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भारत सरकार  
केन्द्रीय विद्युत प्राधिकरण  
प्रणाली योजना एवं परियोजना मूल्यांकन प्रभाग  
सेवा भवन, रामकृष्णपुरम्, नई दिल्ली 110066

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क्र. सं.: 26/10/2002/प्रयोपमू/

दिनांक: 23.12.2003

- 1 सदस्य सचिव,  
पश्चिमी क्षेत्रीय विद्युत बोर्ड, एम. आई. डी. सी क्षेत्र,  
मेरोल, अंधेरी पूर्व, मुम्बई-400094  
फैक्स सं. 022-28370193
- 2 कार्यपालक निदेशक (अभियांत्रिकी),  
पावरग्रिड कार्रपोरेशन ऑफ इंडिया लि,  
सौदामिनी, प्लॉट सं. 2, सैक्टर-29, गुडगाँव-122001  
फैक्स सं. 95124-2571802
- 3 कार्यपालक निदेशक (अभियांत्रिकी),  
नेशनल थर्मल पावर कॉरपोरेशन लि,  
इंजीनियरिंग ऑफिस कॉम्प्लेक्स, ए-8, सैक्टर-24,  
नोएडा-201301 फैक्स सं. 95120 2410201
- 4 महा प्रबन्धक (पारेषण),  
न्यूक्लीयर पावर कॉरपोरेशन ऑफ  
इंडिया लि, 12वीं मंजिल, नॉर्थ विंग,  
वीएस भवन, अणुशक्ति नगर, मुम्बई-400094  
फैक्स सं. 022-25563350
- 5 सदस्य (विद्युत),  
नर्मदा नियंत्रण प्राधिकरण,  
113-बीजी, स्कीम सं. 74-सी, विजय नगर,  
इंदौर-452010 फैक्स सं. 0731 2559888
- 6 मुख्य अभियंता (पारेषण),  
जी.ई.बी. सरदार पटेल विद्युत भवन,  
रेस कोर्स, बड़ोदा-390007  
फैक्स सं. 0265 2338221, 2337918/2338164
- 7 मुख्य अभियंता (पा एवं यो स),  
म. प्र. रा. वि. बोर्ड, ब्लॉक सं. 3,  
शक्ति भवन, रामपुर, जबलपुर-482008  
फैक्स सं. 0761 2664141
- 8 मुख्य अभियंता (पारेषण),  
छत्तीसगढ़ रा. वि. बोर्ड,  
क्वार्टर सं. बी-1, गुधियारी, रायपुर-492009  
फैक्स सं. 0771 5066900
- 9 मुख्य अभियंता (पारेषण आयोजना),  
महाराष्ट्र राज्य विद्युत बोर्ड, 'प्रकाशगढ़',  
प्लॉट सं. जी-9, बांद्रा - पूर्व, मुम्बई-400051  
फैक्स सं. 022 26472868
- 10 मुख्य अभियंता,  
विद्युत विभाग, गोवा सरकार, पणजी  
फैक्स सं. 0832 2222354
- 11 निदेशक (प्रचालन),  
पी. टी. सी. लि., द्वितीय तल,  
15 एन बी बी सी टावर, भीका जी कामा प्लेस,  
नई दिल्ली-110066  
फैक्स सं. 011 51659504

विषय : पश्चिमी क्षेत्र विद्युत प्रणाली योजना की 19वीं स्थाई समिति की बैठक के कार्यवृत्त।

पश्चिमी क्षेत्र विद्युत प्रणाली योजना की 19वीं स्थाई समिति की बैठक के कार्यवृत्त संलग्न है।

संलग्न - उपरोक्त

जी. के. पाहवा  
23.12.03  
(पी. के. पाहवा)  
निदेशक (प्रयोपमू)

Government of India  
Central Electricity Authority  
System Planning & Project Appraisal Division  
Sewa Bhawan: R.K.Puram  
New Delhi-110066

No.26/10/2002-SP&PA/

Dated 23<sup>rd</sup> Dec. 2003


- 1 The Member Secretary,  
Western Regl. Electricity Board,  
MIDC Area, Marol, Andheri East, Mumbai  
**Fax 022 28370193**
- 2 The Executive Director (Engg.),  
Powergrid Corp. of India Ltd., "Saudamini",  
Plot No. 2, Sector-29, Gurgaon-122001  
**Fax 0124-2571760**
- 3 The Executive Director (Engg.),  
NTPC Ltd., Engg. Office Complex,  
A-8, Sector-24, NOIDA 201301  
**Fax 91 4410201**
- 4 Shri N.S.M. Rao, GM (Transmission),  
Nuclear Power Corp. of India Ltd.,  
12<sup>th</sup> Floor, North Wing, VS Bhavan, Anushakti  
Nagar, Mumbai-400094  
**Fax 022 25556513**
- 5 Member (Power),  
Narmada Control Authority, 113-BG, Scheme  
No.74-C, Vijay Nagar, Indore-452010  
**Fax 0731 2559888**
- 6 The Chief Engineer (Tr.),  
GEB, Sardar Patel Vidyut Bhawan,  
Race Course, Baroda-390007  
**Fax 0265 2337918 / 2338164**
- 7 The Chief Engineer (Trans. & Plan co-ord.),  
MP State Electricity Board, Block No.3,  
Shakti Bhawan, Rampur, Jabalpur-482008  
**Fax 0761 2665593**
- 8 Chief Engineer (Tr.),  
Chhatisgarh State Electricity Board,  
Qrt. No. B-1, Gudhiyari, Raipur-492009  
**Fax 0771 2593271**
- 9 The Chief Engineer (Tr. Plg.),  
MSEB, 'Prakashgad', Plot No.G-9, Bandra-  
East, Mumbai-400051  
**Fax 022 26452868**
- 10 The Chief Engineer,  
Electricity Department,  
The Government of Goa, Panaji  
**Fax 0832 222354**
- 11 The Director (O)  
PTC Ltd., 2<sup>nd</sup> Floor, 15 NBCC Tower,  
Bhikaji Cama Place, New Delhi-66  
**Fax 011 28659502**

**Subject: Minutes of 19<sup>th</sup> Standing Committee meeting on Power System Planning in Western region**

Sir,

Minutes of the 19<sup>th</sup> Standing Committee meeting on Power System Planning in Western region held on 15<sup>th</sup> December 2003 at WREB, Mumbai are enclosed.

Encl. As above

  
(P. K. Pahwa)  
Director (SP&PA)

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**Minutes of the 19<sup>th</sup> meeting of the Standing Committee on Power System Planning for Western Region held on 15<sup>th</sup> December 2003 at WREB Mumbai.**

1. The 19<sup>th</sup> meeting of the Standing Committee on Power System Planning for Western Region was held on Monday, the 15<sup>th</sup> December 2003 at Mumbai. The list of the participants is enclosed at Annex-I.
  - 1.1 CE (SP&PA), CEA welcomed Director (Projects), POWERGRID and other participants to the meeting and thanked WREB for making arrangements for the meeting at short notice. He stated that there were two grid disturbances on 5<sup>th</sup> and 7<sup>th</sup> November 2003. In the meantime another grid disturbance had also occurred on 6<sup>th</sup> December 2003. In a meeting taken by Secretary (Power) on 12<sup>th</sup> November 2003, to review these grid disturbances it was decided that Standing Committee on Power System Planning of Western Region should meet and identify transmission lines with critical loading and suggest short term, medium term and long term measures for augmentation /strengthening of transmission system in WR. In view of these grid disturbances and subsequent analysis done by WREB and WRLDC, this meeting was primarily to discuss and analyze the cause of these Grid Disturbances and identify the remedial measures.
  - 1.2 Thereafter, the agenda items were taken up for discussions.
2. **Confirmation of the minutes of the 18<sup>th</sup> meeting of the Standing Committee on Power System Planning for Western Region.**
  - 2.1 CE (SP&PA), CEA stated that the minutes of the 18<sup>th</sup> meeting of Standing Committee on Power System Planning for Western Region held on 31-10.2003 at Mahabaleshwar, were circulated vide CEA letter no.26/10/2002-SP&PA/911-21 dated 25.11.2003. Corrigendum was subsequently issued vide letter of even no dated 4-12-2003. No comments from any of the constituents had been received. The minutes of the 18<sup>th</sup> meeting were thereafter confirmed.
- 3.0 **Review of Grid disturbance in Western Region that occurred on 5-11-2003 and 7-11-2003.**
  - 3.1. Giving a brief background Member Secretary WREB stated that before 20<sup>th</sup> October 2003 the voltage profile in the grid was reasonably good and all generating stations that were under scheduled maintenance during low demand monsoon period had come up but with onset of Rabi season and consequent increase in agriculture load there was deterioration in voltage levels.. This coupled with low generation at gas based stations located in western part of Maharashtra due to inadequate availability of gas, there was heavy flow on the lines connecting eastern to western part of the grid. Prior to the disturbances on 5<sup>th</sup> and 7<sup>th</sup> November 2003 the voltage profile in western part of MP was very low.

Due to heavy power flows most of the 400 kV lines were consuming reactive power. Outage of one pole of Chandrapur-Padghe HVDC further added to the problem. The voltage at Indore 400 kV bus was of the order 324 kV and MVAR requirements at Indore were being met from Dhule end. He opined that reactive compensation in western part of Madhya Pradesh was inadequate and suggested the need for reactive compensation as one of the short-term measures to improve voltage profile.

3.2. Executive Engineer WREB made a presentation on the studies carried out by WREB simulating the system conditions prevalent just prior to the disturbance on 5-11-2003. Copy of the presentation is enclosed at Annex-II. The highlights of the studies carried out by WREB as intimated during the meeting was as under:

a.) Studies carried out by WREB simulating the system conditions prior to disturbance on 5-11-2003 indicated that with increased import from ER the loading of several 400 kV lines increased and some of them exceeded their SIL. This then resulted in lines absorbing MVAR adversely affecting the voltage profile. The voltage profile and system losses under various import conditions from Eastern Region to Western Region as per studies was as under

<b>Quantum of ER Import</b>	700 MW	825 MW	950 MW	1100 MW	1250 MW	1430 MW	1540 MW
<b>System losses</b>	806 MW	833 MW	870 kV	905 MW	958 MW	1087 MW	1164 MW
<b>Voltage at Indore</b>	379 kV	375 kV	372 kV	367 kV	356 kV	326 kV	320 kV
<b>Voltage at Itarsi</b>	393 kV	386 kV	383 kV	380 kV	371 kV	353 kV	350 kV
<b>Voltage at Dhule</b>	389 kV	390 kV	388 kV	384 kV	378 kV	362 kV	355 kV

b.) Simulation studies had shown that for improvement of voltages, load shedding by Gujarat Electricity Board and Madhya Pradesh State Electricity Board would have been most effective while Maharashtra State Electricity Board was lesser effective and Chhatisgarh State Electricity Board had practically no effect on voltages. The system losses were also found to increase substantially with load additions in MPSEB and GEB.

c.) It was observed that there was a substantial improvement of voltage profile on provision of capacitor banks at Indore. The voltage at 400 kV Indore with 300 MVAR capacitors at 220 kV level was observed to be 380 kV and at Itarsi 382 kV.

- d.) The effect of outage of one pole of HVDC on 5-11-2003 was studied and it was noted that had the pole been available Indore voltage would have been 359 kV and Itarsi voltage 372 kV.
- e.) Effect of increased VAR generation at Vindhyachal was studied. Vindhyachal VAR generation was increased by keeping VAR generation at Satpura as full at about 500 MVAR and it was observed that initially there was improvement in voltage profile at Itarsi and Indore when VAR generation was increased from reference value of 350 MVAR to 374 MVAR. However subsequently not much improvement was observed in voltage levels.

The main recommendations based on studies were:

- i) Under the prevalent conditions import from ER should be restricted to 1100 MW.
- ii) Reactive compensation of 300 MVAR should be provided at Indore at 220 kV.
- iii) Augmentation of gas supply at Uran, Kawas and Gandhar gas stations and also enhancement of generation availability in Western Maharashtra by utilizing the unutilized capacity would help in reducing flows from Eastern to Western part and add to stability of grid.
- iv) Chandrapur Padghe HVDC pole was not available since 18-1-2003. The availability of this pole would improve voltage profile and security of the system and hence early action was required to bring this in to service.
- v) Voltage relays at strategic locations to shed load where voltage profile was low would help to improve voltage.

3.3 General Manager, WRLDC made a presentation on the present scenario underlying the reasons for recent disturbances and preventive measure. A copy of the presentation is enclosed at Annex-III. GM, WRLDC highlighted that demand of Western grid during evening peak was 30000 MW and there was shortfall of about 5000 MW. The scheduled drawl from ER was 1100 MW but actual drawls were much more and the constituents were not able to control the demand. The average import from Eastern Region was of the order of 1600 MW. Efforts were required by SEBs for improvement of voltage profile and there was need for additional 1800 MVAR capacitor requirement over and above 4000 MVAR at 33 kV level. He stated that reasons for recent disturbances were import of 2400 MW from neighboring regions causing loading of the lines above SIL and low voltage conditions in the grid. The voltage at Indore was as low as 320 kV, the grid was operating at critical limits and sudden onset of load could lead to power swings and disturbances. He suggested that as a preventive measure EHV capacitors of at least 300 MVAR were required. Further immediate installations of capacitors as per targets in MPSEB, GEB and MSEB were required and some of the lines, which were S/C, should be made D/C to provide additional corridor. There was also a need for dynamic compensation at some of the strategic locations.

3.4 CE (SP&PA) stated that under outage of one pole of Chandrapur-Padghe HVDC the schedule of import from Eastern Region on Rourkela-Raipur 400 kV D/C should be limited to 800 MW. Prior to commissioning of Rourkela-Raipur 400 kV D/C line CEA had carried out simulation studies, which had established that total import, should be kept below 1200 MW because import above that level would not be conducive for secure system operation. The WR transmission system was planned to cater to delivery of power from Korba and Vindhyachal and no separate transmission was planned for import of power from ER. This line was initially built on request of MPSEB, as other constituents were not agreeable to bear transmission charges. This line was not meant for transfer of firm imports of such heavy magnitude. Studies carried out by WREB also indicated that import beyond 1100 MW from ER was highly sensitive to voltage levels and it was not economical to draw power beyond this level. As per WREB studies for increase in import level from 1250 MW to 1430 MW (180 MW) the increase in system transmission losses was from 958 MW to 1087 MW (129 MW). This showed that more than 70 % of the incremental imports above 1200 MW level was lost in incremental losses in the EHV transmission system. In addition there would be substantial increase in sub transmission and distribution losses. Hence, the beneficiaries would be paying for increased losses without getting any actual benefit. As per data made available by EREB prior to the disturbance, the central generating stations in ER were operating at a level close to schedule. However, there appeared to be mismatch in estimation of load requirements in ER as export by ER was quite high compared to the schedule and suggested that WRLDC should convene a meeting of load dispatchers and ERLDC to ensure that inter regional tie was operated as per schedule.

3.5 CE (GEB) stated that voltage profile at Indore was a cause of concern and there was heavy drawl of MVAR from GEB and requested for solution to this.

3.6 CE (MSEB) stated that flow on Itarsi-Dhule was of the order of 400 to 450 MW throughout the year. However flow of MVAR was from Dhule towards Itarsi.

3.7 General Manager, WRLDC stated that there was mismatch in availability and demand and the grid was operating at critical levels. It was cheaper for the constituents to draw power from the grid as UI even at 49.8 Hz. The states were not adhering to the schedules and RLDC had no mechanism to control UI due to the commercial nature of the UI transaction.

3.8 Chief Engineer (SP&PA) stated that it was not correct to state that RLDC could not regulate UI. If the grid was operating at critical level then demand had to be reduced even under normal frequency conditions to prevent collapse. The load dispatcher must appreciate that grid was to be operated as per IGEC. Before charging of Rourkela-Raipur D/C line it was known that any import beyond 1100 MW would be critical. There was also an urgent need to put capacitors in Indore area and restrict the drawls. Further, expediting of Nagda-S.Sarover 400 kV D/C

line would help in providing additional corridor. The completed portion of this line could be charged in radial mode to provide MVAR support to the grid.

- 3.9 To a query from members regarding time frame required for installation of EHV capacitors, Executive Director POWERGRID informed that procurement and installation of Capacitors at EHV level took a period of 8 to 10 months.
- 3.10 General Manager, NTPC desired that planning criteria needed revision to take care of double pole contingency. Chief Engineer (SP&PA) stated that double pole outage criteria could be considered provided the constituents agreed to bear the increase in transmission charges, which would be quite substantial, if such criteria were adopted.

**4. Remedial measures and improvement Plan.**

- 4.1 A presentation was made by Director, CEA that highlighted the various short, medium and long-term measures / plan.

SHORT TERM MEASURES

- 4.2 Director (SP&PA) stated that keeping in view the gestation period required for building transmission project, that in the short term the only option available was to maintain the tie line flows to scheduled values. With only one pole of Chandrapur-Padghe HVDC in service, the maximum import from other regions including UI should not exceed 1200 MW. After discussions the following short term measures were agreed:

- a. The total import by the Western Region Grid be limited as per the capacity of the transmission network.
- b. With one pole of Chandrapur-Padghe HVDC and all 400 kV trunk route lines in service, the import by WR should be limited in the following manner:

	Maximum scheduled	Maximum including UI
FROM ER	1000	1200
FROM NR	400	500 +
FROM SR	200*	300* +
Total from ER+NR+SR	1000	1200

\* Import from SR+ Gen at Chandrapur should not exceed 2000 MW.

+ In case of SR and NR there would be no UI. Normally the schedule should not exceed 200/400 MW limits and the margin of additional 100 MW to be used only under specific contingencies.

- c.) With any outage in trunk 400 kV network the import should be suitably reduced.
- d.) With both the poles of Chandrapur-Padghe HVDC available, maximum import may be increased by 300 MW.
- e.) MSEB should make efforts to put back HVDC pole in service immediately, which is out of service for quite some time. SE (MSEB) stated that the converter transformer was under repair at the manufacturers works and the pole was expected back in service only by March, 2004.
- f.) Installation of shunt capacitors should be taken up on priority. Member Secretary WREB would also take up in the Board meeting for installations of capacitors from the pooled fund available.

4.3. Chief Engineer (SP&PA) stated that efforts should be made to expedite Nagda-S.Sarover 400 kV D/C as it would provide additional corridor. The completed portion could be charged in radial mode to provide MVAR support.

#### MEDIUM-TERM MEASURES/PLAN:

4.4 Director (SP&PA) highlighted the various medium term measures considering various transmission schemes already agreed and under implementation and also considering fresh inputs from POWERGRID. He stated that establishment of Khandwa 400/220 substation would help in improving voltage profile around Indore. However action was required on part of MPSEB to shift loads from Indore substation to this station. This substation presently scheduled to come by January 2005 could be expedited. Chief Engineer (SP&PA) stated that Raipur-Bhadrawati 400 kV D/C line scheduled for December 2005 could be preponed by 3 months so that it was available prior to Rabi sowing season.

4.5 Director (Projects) agreed to expedite Khandwa sub-station as well Raipur-Bhadrawati 400 kV D/C line so that they were available in September prior to beginning of peak demand period.

4.6 After discussions the following medium term measures were agreed:

Import to be regulated as per system capacity taking into account the increase with those lines, which add to the import handling capacity of WR grid. The medium-term plan of strengthening the transmission network is as following:



Description of Scheme	Est. Cost (Rs Cr.)	Status/ Target	Utility of the scheme.	Total import handling capacity of WR after this scheme (MW)	Action required.
1. Khandwa 400/220kV, 2x315MVA s/s by LILO of Itarsi-Dhule	110	Ongoing 01/2005	Improve voltage profile around Indore.	1200	MPSEB to shift loads from Indore to new s/s at Khandwa
2. Series Comp + TCSC on Rourkela-Raipur 400kV D/C	140	Ongoing 01/2005	Improve stability of ER-WR link	1200	
3. Associated Tr. System of TAPP 3&4 a) Tarapur-Boisar 400kV D/C b) Tarapur-Padghe 400kV D/C c) Boisar & Vapi 400/220kV, each 2x315MVA s/s by LILO of Gandhar-Padghe line	237	Ongoing 06/2005	TAPP 3&4 power evacuation. Would also improve stability of WR grid.	1300	MSEB and GEB to reconfigure their 220kV network at Boisar and Vapi S/S respectively.
4. Raipur-Bhadrawati 400kV D/C	244	Ongoing 12/2005	Increase import capability.	1500*	
5. Bhadrawati-Chandrapur 400kV D/C	40	New proposal for this 19 <sup>th</sup> meeting. 12/2005	Improve reliability	1700	May be agreed and Powergrid to take expeditious action.

\* Assuming both poles of Chandrapur-Padghe HVDC are available.

4.7 Chief Engineer (SP&PA) stated that under outage of any pole on Talcher-Kolar HVDC additional power gets injected in to the ER-WR system causing jerks because of change in load-generation balance. In order to isolate WR from contingency originating in Southern Region a run back scheme at Talcher should be put in place so that Talcher generation does not get injected in to ER-WR grid under outage of pole in Talcher-Kolar HVDC. This runs back scheme may be developed by either tripping the units or isolating and putting them on house load. He requested NTPC to work out a suitable scheme and send the same for finalization.

Long Term Measures

4.8 DGM, POWERGRID made a presentation highlighting the agreed proposals and the new proposals proposed by them. A copy of the presentation is enclosed at Annex-IV.

4.9 Director (SP&PA) stated that the long-term plan mentioned in the agenda for this meeting was agreed proposals in the Standing Committee and new proposals received from Powergrid. He stated that one of the long-term measures was Kahalgaon-Ranchi-Sipat 400 kV D/C line included under Kahalgaon transmission, which had already been agreed during the last Standing Committee meeting. This would enhance the import capability of Western grid to 2500 MW as per following.

Description of Scheme	Est. Cost (Rs Cr.)	Status/ Target	Utility of the scheme.	Total import handling capacity of WR after this scheme (MW)	Action required.
1. Associated Tr. System of Vindhyachal-III (2x500 MW) a) Vindhyachal-Satna-Bina 400 kV D/C b) Raigarh 400/220 kV 2x315 MVA s/s by LILO of Rourkela-Raipur D/C line c) Bina (PG) 400/220kV Sw. s/s by LILO Satna-Bina (MPSEB) D/C line	570	Agreed in 17 <sup>th</sup> meeting held on 21-02-2003  03/2007	Vindh.-III power evacuation. Would also strengthen East-West corridor of WR grid.	1700	CSEB to reconfigure their 220kV network at Raigarh.
2. Vindhyachal-Korba 400 kV S/C line (2 <sup>nd</sup> ckt.)	160	Agreed in OCC meeting of WREB on 24-4-2002 and endorsed by Standing Committee in 17 <sup>th</sup> meeting on 21-2-2003.  03/2007	Improve stability of western grid	1700	
3. Bina-Nagda 400 kV D/C line	260	Agreed in 15 <sup>th</sup> meeting held on 20-3-2002 as Sys. Str. Scheme  03/2007	Improve power transfer capability from eastern to western part of grid.	1800	MPSEB to reconfigure their network around Nagda

<p>4. Associated Tr. System of Sipat-I (3x660 MW)</p> <ul style="list-style-type: none"> <li>a) Sipat-Seoni 765 kV 2X S/C</li> <li>b) Seoni-Khandwa 400 kV D/C</li> <li>c) Nagda-Dehgam 400 kV D/C</li> <li>d) LILO of Korba-Raipur at Sipat</li> <li>e) Seoni 765/400 kV 7x500 MVA and 400/220 kV 2x315 MVA s/s</li> <li>f) Rajgarh 400/220 kV 2x315 MVA s/s by LILO of S. Sarover-Dhule D/C line</li> </ul>	1655	<p>Agreed in 15<sup>th</sup> meeting held on 20-03-2002</p> <p>03/2007</p>	<p>Sipat-I evacuation system. Would also strengthen East-West corridor of WR grid</p>	1800	<p>MPSEB to reconfigure their 220 kV network at Rajgarh</p>
<p>5. 40 % Series Comp. on Seoni-Khandwa 400kV D/C</p>	30	<p>Agreed in 18<sup>th</sup> meeting held on 31-10-03. Covered under Sys Str-I</p> <p>3/2007</p>	<p>Improve stability and import capability</p>	1800	<p>Powergrid to take expeditious action.</p>
<p>6. Associated Tr. System of Sipat-II (2x500 MW)</p> <ul style="list-style-type: none"> <li>a) Khandwa-Rajgarh 400 kV D/C</li> <li>b) Bina-Gwalior 765 kV S/C (initially op. at 400 kV)</li> <li>c) Seoni 765/400 kV 3x500 MVA (Aug.)</li> <li>d) Bhatapara 400/220 kV 2x315 MVA s/s by LILO of Korba-Raipur line</li> </ul>	596	<p>Agreed in 16<sup>th</sup> meeting held on 6-09-02.</p> <p>03/2007</p>	<p>Improve voltage profile around Gwalior, Indore and Bhatapara</p>	1800	<p>MPSEB and CSEB to reconfigure their 220 kV network at Gwalior and Bhatapara</p>
<p>7. Sipat-II Supplementary Tr. System</p> <ul style="list-style-type: none"> <li>a) Seoni-Wardha 765 kV S/C (initially op. at 400 kV)</li> <li>b) Wardha-Akola 400 kV D/C</li> <li>c) Akola-Aurangabad 400 kV D/C</li> <li>d) Wardha 400/220 kV 2x315 MVA s/s</li> </ul>	500	<p>Agreed in 18<sup>th</sup> meeting held on 31-10-2003.</p> <p>03/2007</p>	<p>Improve voltage profile in southern part of Maharashtra</p>	1900	<p>MSEB to reconfigure their 220 kV network at Wardha</p>

8.	a) Sipat-Raipur 400 kV D/C line b) Wardha-Bhadrawati 400 kV D/C line <i>deleted</i>	250	Agreed in 18 <sup>th</sup> meeting held on 31-10-2003 as sys. Str. scheme  03/2007	Would strengthen 400 kV corridor from Korba complex	1900	
9.	Associated Tr. System of Kahalgaon-II (3x500 MW) a) Ranchi-Sipat 400 kV D/C with 40 % series compensation b) Agra-Gwalior 765 kV S/C (initially op. at 400 kV)	375	Agreed in 18 <sup>th</sup> meeting held on 31-10-2003 as sys. Str. scheme  03/2007	Would enhance import capacity of WR	2500	
10	Associated Tr. System of Barh a) Seoni-Bina 765 kV S/C line (initially op. at 400 kV)	240	Agreed in 17 <sup>th</sup> meeting held on 21-02-2003 as a part of evacuation from Barh  03/2009		2500	

- 4.10 Chief Engineer (SP&PA) stated that for any additional import capability beyond 2500 MW required by WR would need to be planned and the constituents should also firm up their proposals based on their requirements so that all the proposals could be integrated and discussed in the next meeting which could be held around middle of next month.
- 4.11 Director (Projects), POWERGRID desired that long-term proposals should be firmed up as early as possible.
- 4.12 It was decided that the constituents would send their proposals by 23<sup>rd</sup> December 2003 to CEA and the next meeting would be convened by middle of next month.
- 4.13 CE (SP&PA) thanked the participants for attending the meeting and arriving at decision regarding short and medium term measures. He stated that based on discussions in the meeting CEA would send a report to Ministry of Power

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## Annexure-I

List of participants during the 19<sup>th</sup> Standing Committee Meeting on power system planning held on 15<sup>th</sup> Dec. 2003 at WREB, Mumbai

<u>S.No.</u>	<u>Name</u>	<u>Designation</u>
	<u>CEA (SP&amp;PA)</u>	
1.	V. Ramakrishna	Chief Engineer
2.	A. K. Asthana	Director (AI)
3.	P. K. Pahwa	Director (WR)
	<u>WREB</u>	
4.	A. Velayutham	Member Secretary
5.	Manjit Singh	Suptd. Engineer (op.)
6.	S. G. Tenpe	Suptd. Engineer (op.)
7.	S. D. Taksande	Suptd. Engineer (pl.)
8.	S. S. Kalsi	Exec. Engineer
9.	S. Satyanarayan	Exec. Engineer
10.	M. G. Gupta	Assistant Director
11.	V. K. Gupta	Assistant Director
	<u>MSEB</u>	
12.	B. N. Farkade	Chief Engineer (L. D.)
13.	N. J. Katekar	Suptd. Engineer (Tr. Plg)
14.	N. R. Sonkavday	Dy. EE (Tr. Plg)
	<u>MPSEB</u>	
15.	Smt. Deshrajju Rekhi	Executive Engineer
16.	V. K. Bhikonde	Executive Engineer
	<u>GEB</u>	
17.	J. V. Vyas	Chief Engineer (L. D.)
18.	R. B. Bhrambhatt	Suptd. Engineer (Tr.)
	<u>CSEB</u>	
19.	B. K. Sharma	Chief Engineer (Tr.)
	<u>NTPC</u>	
20.	N. N. Misra	General Manager (Proj. Engg.)
21.	V. K. Aggarwal	DGM (SE)
22.	P. B. Behere	DGM (OS)
	<u>NPCIL</u>	
23.	N. S. M. Rao	CE
24.	Sandeep Sarwate	Scientific Officer / F
	<u>POWERGRID</u>	
25.	S. C. Mishra	Dir. (Proj.)
26.	R. N. Nayak	Executive Director (Engg.)
27.	Anjan Roy	GM (WRLDC)

28.	D. K. Valecha	Asstt. General Manager (WRTS)
29.	Y. K. Sehgal	Dy. General Manager (SEF)
30.	R. K. Mediratti	Manager (WRLDC)
31.	V. K. Veluetham	DGM (GM)
32.	P. Pantaiya	DGM (GM)

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## Grid Disturbance of 5.11.2003 and 7.11.2003

WELCOME

## Introduction

- There were two grid disturbances on 5.11.03 and 7.11.03 in WR that led to partial disturbances in WR system

## Pre fault conditions on 5.11.2003

- WR Demand around 21326 MW
- ER import 1500 MW
- Low voltage profile

## Grid Disturbance of 5.11.2003

- On 1024 hrs there was a grid disturbance which resulted in the splitting of WR grid in two parts.
- The first part comprising Eastern Maharashtra, MPSEB, CSEB along with ER survived with generator tripping.

## Cont'd

- The second part, of GEB and Western Maharashtra including TPC, Goa and BSES separated from the rest of the grid.
- Subsequently Western Maharashtra system was affected while TPC and BSES islanded and survived. GEB survived with AUFLS and df/dt relays operation. Goa Collapsed

## Initiating Cause

- The system was operating at a very low voltage profile. Indore 320 kV Dhule 348 kV, Itarsi 352 kV.
- The Itarsi-Dhule I tripped on load encroachment due to an additional 65 MW load per ckt in MSEB system. [ 2 x 507 + 2 x 65 ]

## Cont'd

- Such tripping on load encroachment due to a routine load coming in the system indicates that the system was dangerously low on voltage security. Normal power system operations like load changes are causing a relay to operate indicates the load encroachment.

## Cont'd

- The operation of the relays was checked and it operated correctly.

## Causes for low voltage

- Usually most 400 kV lines generate VAR for low MW loading. Due to VAR Consumption of important lines like Ind-Itarsi, Ind Asoj, Sat-Bhil, Bhil-Kora situation was bad, as this VAR generation is lost. (Some lines were still generating MVAR)
- The heavy import of ER power is the a major cause for line loadings. Major lines absorbing MVAR gave less VAR support for system

## Other Aspects of the disturbance on 5.11.2003

- No maloperations of protection found from evidence
- System islanding of TPC and BSES worked satisfactorily. In spite of tripping of Trombay 7a and 7B during islanding, TPC survived successfully
- Restoration done in good time
- UFLS in MSEB, MPSEB and CSEB needs to be reviewed as there is scope for improvement

## Simulation Studies

- System studies conducted to check the system state prior to collapse and ascertain exact causes
- System simulated for conditions of 5.11.2003

## Simulation of 5.11.2003

- Demand same as met- Topology as was on 5.11.2003 [ 21326 MW]
- Flows are close to actual within tolerances for most cases



**Good matches in Simulation and Actual flows ( Some important lines)**

- Itarsi-Indore 986 + j 236 [ 998 + j280]
- Indore-Asoj 512 - j156 [496-j176]
- B'vati-C'pur 1070-j266 [ 1134 - j228]
- Dhule-Kasor 300-j192 [ 294-j172]
- Jhanor-Padghe 82-j86[72 -j 115]
- Bhilai-Koradi -627 + j 106 [ -654 + j54]

**Cont'd**

- Voltages
- Indore 320 [ 320],
- Itarsi 352 [ 352],
- Dhule 348[355]

**Bad mismatches**

- Dhule-Itarsi -1014+j356[ 1134 - j228]
- Koradi-Satpura 102+j22 [ 2 + j33]

**Reasons for mismatch**

- SCADA error
- Auxillaries may be slightly different at Generators ( 8%, 8.5%etc)
- Microlevel data not available
- For ER import less than 1248 MW no artificial help like syn condensors required and cases are clean load flow files

**Effect of varying ER Import**

Indore	379	375	372	367	356	326
Dhule	393	390	388	384	378	362
Itarsi	389	386	383	380	371	352
ER	700	825	950	1100	1250	1540

**.Cont'd**

Loss	806	833	870	905	958	1087
Var *	Nil	Nil	Nil	Nil	Nil	140

### . Statements on ER Import study

- Severe Voltage dips as import > 1000 MW
- Sensitive to fluctuations in demand
- Restriction of Import is only major way to improve voltage profiles by operating with VAR gen on lines
- Or addition of lines to bring similar effect

### Effect of load shedding or adding.

- ER import assumed is around 1100
- 100 MW load shedding does not give same results .
- In GEB 367 to 351 and 373 for I/s ( -16 kV / 5 kV) Indore Voltage
- In MP 380 to 368 kV [12kV] and increases to 385[5 kV] Indore Voltage

### .Cont'd

- In MSEB 367 to 359 ( -8 ) and 371 ( 5)
- In CSEB system No effect
- Exaggerated effects due to extremely low VAR margins from lines. Normally a 100 MW load shedding is not even perceptible!! Abnormally High Sensitivity to load changes due to operation at knee point before collapse

### Effect of Gen at Uran, Kawas and Jhanor

- Gas availability at Uran raises Indore volt 369 kV from 320 kV
- Gas availability at Jhanor raises 366 kV
- Usually such changes do not have profound effect in a normal grid. Generation packet changes affecting the is an grid indicator of operation close to voltage collapse

### Effect of HVDC Pole II

- Improves Indore 359 and Itarsi 375
- Confirms that transmission system is weak.

### Capacitor Installation

- Addition of 300 MVAR at Indore improves Indore Voltage to 380 kV from 356 kV. Losses improves to 983 MW from 905 MW for case under study.

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### Effect of VAR gene at VSTPS and SGTPS

- As MVAR is increased from 350 to 417 at VSTPS Indore volt 356 to 369 kV
- For SGTPS 174 to 226 MVAR Ind volt 356 to 361 kV

### System Strenthening

- Restriction of ER Import to not more than 1100 MW.
- Alternatively Line additions like Nag-Bina-Dehgam, In-It T/c may be studied by the Standing Committe

### Grid Disturbance of 7.11.2003

- Similar to 5.11.2003
- ER Import 1800 MW
- Initiated by load encroachment and similar system splitting

### Conclusions & Recommendations

- Conclusion:
- Cause of low voltage profile is-
- High quantum of ER import
- Highly reactive agricultural load in Rabi season
- Wide gap between WR demand and availability

### Conclusions & Recommendations

- Recommendations:-
- EHV shunt capacitors to be installed as per WREB study report.
- Providing voltage relays at strategic locations. Regulatory measures till such time.
- 300 MVAR EHV capacitor at Indore as immediate requirement
- Need for FACT compensators for long EHV lines to be evaluated by WR SC on PSP

### Conclusions & Recommendations

- Recommendations:-
- Total ER import to be restricted to 1100MW and review of UI scheme for ER-WR exchngs
- Need to augment gas supply to full reqts for Kawas-Gandhar and Uran power stations
- Need to maximise power availability in WR
- WR SC on PSP to draw up short, medium and long term plan for system strengthening on priority

11/11/11

**System Strengthening**

- Review of 60 hours in last year
- 100% NW
- Classify 1 on activities report
- Don-Debrah In-It The way on working
- In the Student Committee

**Final of Year Report - VETA and 2012**

- 2012 Report - 100% NW
- 2012 Report - 100% NW
- For 2012 - 100% NW
- 100% NW

**Conclusion & Recommendations**

- 100% NW
- 100% NW
- 100% NW
- 100% NW
- 100% NW
- 100% NW

**Grid Difference of 1.1.2009**

- 100% NW
- 100% NW
- 100% NW
- 100% NW

**Conclusion & Recommendations**

- 100% NW
- 100% NW
- 100% NW
- 100% NW
- 100% NW
- 100% NW

**Conclusion & Recommendations**

- 100% NW
- 100% NW
- 100% NW
- 100% NW
- 100% NW
- 100% NW



5/12/03

# Standing Committee Meeting

on 15<sup>th</sup> December, 2003

WRLDC, Mumbai



# Present Scenario

- Year-wise capacity additions ☹️ **See Ann-1 for details** 

	Added Installed Capacity	Increased Peak Demand
2000-01	818 MW	882 MW
2001-02	173 MW	914 MW
2002-03	50 MW	2227 MW
2003-04	68 MW	2187 MW (anticipated)

- Large addition in Demand whereas insignificant capacity additions in last 3 years
- Demand is increasing @5.4% p.a. (CAGR since 1999-2000)
- Meeting additional demand through imports from neighbouring regions.
- Imports to the extent of
  - 1600MW from ER,
  - 400 MW from NR
  - 400 MW from SR
  - Total 2400 MW additional injection (about 35% of total ISGS injection)



# Present Scenario

- Additional power flow of 2400MW due to parallel operation of WR-ER and bilateral power trading
- Less load shedding in November this year as compared to last year due to
  - Increased availability due to imports from other regions
  - Rabi season loads higher due to good monsoon
  - Elections in MP and Chhattisgarh
- Good Frequency profile as compared to last year
- Same transmission network carrying additional 2000MW, equivalent to one Super Thermal Power Stations in Eastern part of grid with loads in the West. *Ann-2* ▶
- Result:
  - **Low Voltage Profile across the region** *Ann-3* ▶
  - **Critical Line loadings** *Ann-4* ▶
  - **High transmission losses (average 6%)**
  - **Incremental losses for ER import is as high as 12%**



# Present Scenario

- 2400MW STPS requires Rs.9600 Crs investment
- Generation and T&D investments should be 50:50 ( Rajadhyaksha Committee)
- Transmission Investment required Rs. 4800Crs.
- No transmission line added even under system strengthening schemes. **(Ann-2)**
- Lines associated with 2100MW Korba STPS
  - Korba-Bhilai-Raipur 3 ckts 640 ckm
  - KSTPS-Korba(W) 1 ckt 20 ckm
  - KSTPS-VSTPS 1 ckt 280 ckms
  - Bhilai-Koradi 1 ckt 280 ckms
  - Bhadravati-bhila/raipur 2 ckts 640 ckms
  - Satpura-Itarsi-Indore 1 ckt 310 ckms
  - Indore-Asoj 1 ckt 290 ckms
  - » **TOTAL 2460 ckms**





# Present Scenario

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- Lines associated with 2260MW Vindhyachal STPS
  - Vindhyachal-Jabalpur-Itarsi 4 cksts 2480 ckms
  - Itarsi-Dhule 2 cksts 808 ckms
  - Itarsi-Indore-Asoj 1 ckt 495 ckms
  - VSTPS-Satna-Bina 2 cksts 1070 ckms
  - Korba-Raipur 1 ckt 210 ckms
  - **TOTAL 5063 ckms**
- Total for KSTPS+VSTPS
  - 4360 MW 7523 ckms
  - 1.7 ckms /MW was added for Generation capacity added in Eastern part of the grid
- Therefore, at least 4135 ckms should have been added with additional import from ER/SR and NR.
- Open Access Requirement needs further capacity addition so as to replace costlier power with cheaper power.
- **5200 ckms transmission capacity to be added alongwith transformation capacity of 6000MVA.**



# Present Scenario

- Further efforts required by SEBs for voltage improvement at the receiving points due to this import in the form of keeping all the capacitor banks in service.
- 1800 MVARs additional capacitors required at 400kV or over 4000MVARs at 33kV level required at load centres, considering p.f. 0.8.
- This apart from fast acting dynamic VARs at strategic locations

# Underlying reasons for recent disturbances

- Evacuation of 2400 MW import from neighbouring regions causing loading of the lines above SIL which is causing voltage dips.
- Voltage profile further worsened due to agricultural loads due to Rabi season with voltage at Indore going down as low as 320 KV. Nagda, Satna, Bina, Satpura, Parli, Bableshwar, Dhule etc., are the other low voltage pockets.
- Poor low voltages and higher loading on lines causing load encroachment of distance relays and power swings on lines.
- High reactive power losses on lines due to high voltage gradients due to inadequate reactive power support at the receiving ends .
- The grid is operating at voltage stability and dynamic stability limits. Even sudden load onset can lead to power swings and eventual disturbance

# Preventive Measures - Medium-term

- EHV Capacitors of atleast 300MVAR at Indore
- Immediate installation of more capacitor banks as per targets in MPSEB, GEB and MSEB
- Expediting transmission projects
  - 400kV Bhilai-Koradi S/C
  - 400kV Bhadravati-Chandrapur S/C
  - LILO of 400kV Wanakbori-Soja at Dehgam
  - 400kV Bina-Nagda-Dehgam

	Base- Case - 1	Case- 2	Case- 3	Case- 4
	Ch-Padg-700, NR-500, SR-500, ER-1600, Bhi-Kor-S/C	Ch-Padg-700, NR-500, SR-500, ER-1600, Bhi-Kor-D/C,	Ch-Padg-700, NR-500, SR-500, ER-1600, Bhi-Kor-S/C,Rai-Bhad.D/C	Ch-Padg-700, NR-500, SR-500, ER-1600, Bhi-Kor-D/C Rai-Bhad.D/C
Bhilai-Koradi-1	737	562	631	493
Bhilai-Koradi-2	OUT	562	OUT	493
Rai-Rourkela-1 & 2	625 x 2	629 x 2	632 x 2	634 x 2
Kstps-VSTPS	376	303	315	261
Bhi-Bh'vati-1	491	393	313	256
Rai-Bh'vati-1	477	389	306	256
Rai-Bh'vati-2 & 3	OUT	OUT	306 x 2	256 x 2
C'pur-Bh'vati-1 & 2	708 x 2	621 x 2	842 x 2	743 x 2
C'pur-Bh'vati-3 & 4	OUT	OUT	OUT	OUT
C'pur-Parli-1, 2 & 3	600 x 3	599 x 3	628 x 3	622 x 3
Itarsi-Indore-1	594	589	588	584
Itarsi-Indore-2	574	569	568	565
Sat-Indisgr-Ind	516 - 746	521 - 750	513 - 743	518 - 747
Bhilai-Raipur-1 & 2	569 x 2	635 x 2	385 x 2	473 x 2
Bhilai-Satpura-1	598	500	548	489
Itarsi-Dhule-1 & 2	403 x 2	394 x 2	390 x 2	384 x 2
Indore-Asoj-1	338	337	332	331
Indore-Asoj-2	358	357	351	352
Losses	1159.3	1120.1	1127.1	1100.1
Ko(E)&Rairgh	110x2+128=348	107x2+125=339	106x2+124=336	104x2+122=330
B'vati-A'bad 1&2	OUT	OUT	OUT	OUT
A'bad-B'blshwr	117→B'bleswar	129→B'bleswar	114→B'bleswar	129→B'bleswar
A'bad-Bhuswl	488→A'bad	511→A'bad	419→A'bad	510→A'bad
Tapp-Boisor D/C	OUT	OUT	OUT	OUT
Boisor-Padghe S/C	OUT	OUT	OUT	OUT
Boisor-Vapi S/C	OUT	OUT	OUT	OUT
Vapi-Jhanor S/C	OUT	OUT	OUT	OUT
TAPP-Padghe D/C	OUT	OUT	OUT	OUT
Bina-Nagda S/C	OUT	OUT	OUT	OUT
Nagda-Dehgam	OUT	OUT	OUT	OUT

	Base-Case - 1	Case- 2	Case- 3	Case- 4
	Ch-Padg-700, NR-500, SR-500, ER-1600, Bhi-Kor-S/C	Ch-Padg-700, NR-500, SR-500, ER-1600, Bhi-Kor-D/C,	Ch-Padg-700, NR-500, SR-500, ER-1600, Bhi-Kor-S/C,Rai-Bhad.D/C	Ch-Padg-700, NR-500, SR-500, ER-1600, Bhi-Kor-D/C Rai-Bhad.D/C
Raipur	384.50	386.77	391.88	392.10
Bhilai	384.44	386.89	391.36	391.89
Koradi	392.40	392.40	392.40	392.40
Bhadravati	409.96	410.604	410.39	405.89
Chandrapur	404.0	404.0	404.0	404.0
Parli	388.40	388.42	386.04	386.67
Satpura	374.0	374.00	374.00	380.00
Itarsi	358.06	361.14	361.69	367.82
Indore	344.70	348.37	349.73	357.74
Dhule	381.30	382.25	383.42	385.46
Asoj	388.90	389.68	390.07	391.67
KSTPS	410.0	410.0	410.0	410.0
VSTPS	408.0	408.0	408.00	408.00
Jabalpur	368.52	371.78	371.95	376.69
Au'Bad	391.38	390.50	392.01	391.84
Bhusawal	389.83	388.30	390.14	389.26
B'blshwar	396.73	396.37	397.52	397.84
Vapi	OUT	OUT	OUT	OUT
Bina	356.61	361.08	361.36	367.88
Nagda	335.49	339.72	341.25	350.34
Dehgam	402.99	403.04	403.08	403.28
Boisor	OUT	OUT	OUT	OUT
Padghe	414.43	414.294	414.37	414.496
Bhopal	354.88	358.71	359.15	365.73



	Case-5	Case-6	Case-7	Case-8
	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-S/C Rai-Bhad.D/C ,B`vati-A`bad D/C, Tapp3&4	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-D/C Rai-Bhad.D/C,B`vati-A`bad, Tapp3&4	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-S/C Rai-Bhad.D/C, Tapp3&4, Bina-Nagda-Dehgam, Bhad-A`bad	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-D/C Rai-Bhad.D/C, Tapp3&4, Bina-Nagda-Dehgam, Bhad-A`bad
Bhilai-Koradi-1	595	465	574	451
Bhilai-Koradi-2	OUT	465	OUT	451
Rai-Rourkela-1 & 2	826 x 2	829 x 2	822 x 2	826 x 2
Kstps-VSTPS	316	271	394	343
Bhi-Bh`vati-1	409	351	380	328
Rai-Bh`vati-1, 2 & 3	395 x 3	345 x 3	368 x 3	323 x 3
C`pur-Bh`vati-1 & 2	525 x 2	441 x 2	497 x 2	420 x 2
C`pur-Bh`vati-3 & 4	OUT	OUT	OUT	OUT
C`pur-Parli-1, 2 & 3	524 x 3	520 x 3	502 x 3	500 x 3
Itarsi-Indore-1	554	557	456	454
Itarsi-Indore-2	535	538	441	438
Sat-Indirasgr-Ind	484 - 715	497 - 728	427 - 661	434 - 668
Bhilai-Raipur-1 & 2	426 x 2	513 x 2	442 x 2	522 x 2
Bhilai-Satpura-1	520	475	539	485
Itarsi-Dhule-1 & 2	348 x 2	349 x 2	307 x 2	302 x 2
Indore-Asoj-1	293	303	262	262
Indore-Asoj-2	310	321	278	277
Losses	1080.0	1033.6	1010.0	990.5
Ko(E)&Rairgh	109x2+128=346	107x2+126=340	112x2+131=355	110x2+129=349
B`vati-A`bad 1&2	486 x 2	474 x 2	466 x 2	455 x 2
A`bad-B`blshwr	603 → B`bleswar	607 → B`bleswar	564 → B`bleswar	568 → B`bleswar
A`bad-Bhuswl	181 → A`bad	208 → A`bad	167 → A`bad	194 → A`bad
Tapp-Boisor D/C	299 x 2	299 x 2	270 x 2	271 x 2
Boisor-Padghe S/C	50 → padghe	50 → Padghe	103 → Padghe	102 → Padghe
Boisor-Vapi S/C	399 → Vapi	398 → Vapi	292 → Vapi	293 → Vapi
Vapi-Jhanor S/C	235 → Jhanor	235 → Jhanor	124 → Jhanor	126 → Jhanor
TAPP-Padghe D/C	151 x 2 → Padghe	151 x 2 → Padghe	180 x 2 → Padghe	179 x 2 → Padghe
Bina-Nagda S/C	OUT	OUT	565 → Nagda	556 → Nagda
Nagda-Dehgam	OUT	OUT	351 → Dehgam	348 → Dehgam
A`bad-Nasik	OUT	OUT	OUT	OUT
Nasik-Jhanor	OUT	OUT	OUT	OUT
Nasik-Boisor	OUT	OUT	OUT	OUT
Nasik-Dhule	OUT	OUT	OUT	OUT
B`vati-Koradi	OUT	OUT	OUT	OUT

	Case-5	Case -6	Case-7	Case-8
	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-S/C Rai-Bhad.D/C ,B'vati-A'bad D/C, Tapp3&4	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-D/C Rai-Bhad.D/C,B'vati-A'bad,Tapp3&4	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-S/C Rai-Bhad.D/C,Tapp3&4 ,Bina-Nagda-Dehgam,Bhad-A'bad	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-D/C Rai-Bhad.D/C,Tapp3&4,Bina-Nagda-Dehgam,Bhad-A'bad
Raipur	384.23	385.96	386.17	387.85
Bhilai	384.83	386.68	386.85	388.67
Koradi	394.16	392.94	397.24	395.98
Bhadravati	403.296	403.97	404.03	404.64
Chandrapur	404.0	404.0	404.00	404.0
Parli	393.94	394.06	395.41	395.51
Satpura	390.00	390.00	398.00	398.00
Itarsi	380.60	381.86	391.60	392.30
Indore	380.98	382.04	394.91	395.32
Dhule	393.11	393.49	400.31	400.36
Asoj	395.85	396.06	399.22	399.32
KSTPS	410.00	410.0	410.0	410.00
VSTPS	408.00	408.0	408.00	408.00
Jabalpur	384.28	385.80	392.09	393.19
Au'Bad	395.04	395.09	399.31	399.23
Bhusawal	397.19	396.15	400.68	399.61
B'blshwar	400.65	400.55	404.90	404.66
Vapi	405.09	405.07	405.83	405.82
Bina	374.44	376.45	383.22	384.14
Nagda	377.28	378.45	392.65	393.18
Dehgam	402.80	402.81	400.15	400.34
Boisor	408.05	408.0	409.20	409.14
Padghe	412.36	412.30	413.62	413.54
Bhopal	376.18	377.81	386.87	387.65
Nasik	OUT	OUT	OUT	OUT



	Case- 9	Case- 10	Case- 11	Case- 12
	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-S/C Rai-Bhad.D/C	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-D/C Rai-Bhad.D/C.	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-S/C Rai-Bhad.D/C, B'vati-A'bad D/C	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-D/C Rai-Bhad.D/C, B'vati-A'bad D/C
Bhilai-Koradi-1	689	541	614	482
Bhilai-Koradi-2	OUT	541	OUT	482
Rai-Rourkela-1 & 2	824 x 2	827 x 2	829 x 2	832 x 2
Kstps-VSTPS	401	340	304	259
Bhi-Bh'vati-1	348	286	430	374
Rai-Bh'vati-1	341	287	414	365
Rai-Bh'vati-2 & 3	341 x 2	287 x 2	414 x 2	365 x 2
C'pur-Bh'vati-1 & 2	909 x 2	801 x 2	538 x 2	454 x 2
C'pur-Bh'vati-3 & 4	OUT	OUT	OUT	OUT
C'pur-Parli-1, 2 & 3	651 x 3	645 x 3	543 x 3	540 x 3
Itarsi-Indore-1	591	588	572	569
Itarsi-Indore-2	571	568	553	549
Sat-Indisgr-Ind	537 - 766	543 - 772	494 - 725	500 - 731
Bhilai-Raipur-1 & 2	492 x 2	589 x 2	418 x 2	506 x 2
Bhilai-Satpura-1	604	539	527	468
Itarsi-Dhule-1 & 2	454 x 2	448 x 2	382 x 2	376 x 2
Indore-Asoj-1	384	384	349	348
Indore-Asoj-2	406	406	369	369
Losses	1200.6	1167.0	1076.8	1060.1
Ko(E)&Rairgh	111x2+129=351	108x2+127=343	107x2+125=339	105x2+123=333
B'vati-A'bad 1&2	OUT	OUT	513x2	501x2
A'bad-B'blshwr	126→B'bleswar	142→B'bleswar	671→B'bleswar	676→B'bleswar
A'bad-Bhuswl	510→A'bad	531→A'bad	204→A'bad	233→A'bad
Tapp-Boisor D/C	OUT	OUT	OUT	OUT
Boisor-Padghe S/C	OUT	OUT	OUT	OUT
Boisor-Vapi S/C	OUT	OUT	OUT	OUT
Vapi-Jhanor S/C	OUT	OUT	OUT	OUT
TAPP-Padghe D/C	OUT	OUT	OUT	OUT
Bina-Nagda S/C	OUT	OUT	OUT	OUT
Nagda-Dehgam	OUT	OUT	OUT	OUT



	Case- 9	Case- 10	Case- 11	Case- 12
	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-S/C Rai-Bhad.D/C	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-D/C Rai-Bhad.D/C.	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-S/C Rai-Bhad.D/C, B'vati-A'bad D/C	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-D/C Rai-Bhad.D/C, B'vati-A'bad D/C
Raipur	383.95	385.70	382.80	384.77
Bhilai	384.23	386.13	383.35	385.44
Koradi	392.40	392.40	392.40	392.40
Bhadravati	404.33	404.98	402.628	403.39
Chandrapur	404.0	404.0	404.0	404.0
Parli	383.91	384.34	392.98	393.13
Satpura	380.00	380.00	380.00	380.00
Itarsi	364.44	366.51	372.57	373.95
Indore	360.75	362.69	371.95	373.17
Dhule	383.40	383.75	389.19	389.67
Asoj	391.14	391.56	394.08	394.35
KSTPS	410.00	410.00	410.0	410.0
VSTPS	408.00	408.00	408.00	408.00
Jabalpur	372.47	374.83	379.15	380.75
Au'Bad	390.92	389.81	392.35	392.54
Bhusawal	388.55	386.86	395.00	394.19
B'blshwar	396.95	396.34	398.93	398.91
Vapi	OUT	OUT	OUT	OUT
Bina	360.63	363.88	369.96	372.07
Nagda	355.66	357.82	368.07	369.41
Dehgam	402.98	403.00	403.27	403.29
Boisor	OUT	OUT	OUT	OUT
Padghe	414.58	414.408	415.64	415.59
Bhopal	360.51	363.18	369.44	371.19



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	Case-13	Case -14	Case-15	Case-16
	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-S/C Rai-Bhad.D/C ,C'pur-Bhad 3,Bhad-Kor s/c	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-D/C Rai-Bhad.D/C,C'pur-Bhad 3,Bhad-Kor s/c	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-S/C Rai-Bhad.D/C ,C'pur-Bhad 3,Bhad-Kor s/c,Bhad-A'bad D/C	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-D/C Rai-Bhad.D/C,C'pur-Bhad 3,Bhad-Kor s/c,Bhad-A'bad D/C
Bhilai-Koradi-1	620	497	586	472
Bhilai-Koradi-2	OUT	497	OUT	472
Rai-Rourkela-1 & 2	825 x 2	828 x 2	830 x 2	833 x 2
Kstps-VSTPS	375	326	304	254
Bhi-Bh'vati-1	385	317	439	377
Rai-Bh'vati-1 ,2 & 3	373 x 3	315 x 3	421 x 3	367 x 3
C'pur-Bh'vati-1 & 2	518 x 2	476 x 2	326 x 2	290 x 2
C'pur-Bh'vati-3	518	476	326	290
C'pur-Bh'vati-4	OUT	OUT	OUT	OUT
C'pur-Parli-1 ,2 & 3	638 x 3	635 x 3	538 x 3	537 x 3
Itarsi-Indore-1	584	583	569	565
Itarsi-Indore-2	564	563	550	546
Sat-Indirasgr-Ind	536 - 766	544 - 773	502 - 733	505 - 737
Bhilai-Raipur-1 & 2	454 x 2	553 x 2	410 x 2	503 x 2
Bhilai-Satpura-1	576	528	529	478
Itarsi-Dhule-1 & 2	454 x 2	451 x 2	390 x 2	384 x 2
Indore-Asoj-1	372	376	347	346
Indore-Asoj-2	394	396	368	366
Losses	1179.5	1142.9	1050.1	1026.3
Ko(E)&Rairgh	110x2+128=348	108x2+126=342	107x2+124=338	105x2+123=333
B'vati-A'bad 1&2	OUT	OUT	491 x 2	484 x 2
A'bad-B'bshwr	132 → B'bleswar	143 → B'bleswar	648 → B'bleswar	655 → B'bleswar
A'bad-Bhuswl	521 → A'bad	534 → A'bad	220 → A'bad	241 → A'bad
Tapp-Boisor D/C	OUT	OUT	OUT	OUT
Boisor-Padghe S/C	OUT	OUT	OUT	OUT
Boisor-Vapi S/C	OUT	OUT	OUT	OUT
Vapi-Jhanor S/C	OUT	OUT	OUT	OUT
TAPP-Padghe D/C	OUT	OUT	OUT	OUT
Bina-Nagda S/C	OUT	OUT	OUT	OUT
Nagda-Dehgam	OUT	OUT	OUT	OUT
A'bad-Nasik	OUT	OUT	OUT	OUT
Nasik-Jhanor	OUT	OUT	OUT	OUT
Nasik-Boisor	OUT	OUT	OUT	OUT
Nasik-Dhule	OUT	OUT	OUT	OUT
B'vati-Koradi	392 → Koradi	289 → Koradi	179 → Koradi	88 → Koradi

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	Case-13	Case -14	Case-15	Case-16
	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-S/C Rai-Bhad.D/C ,C'pur-Bhad 3,Bhad-Kor s/c	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-D/C Rai-Bhad.D/C,C'pur-Bhad 3,Bhad-Kor s/c	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-S/C Rai-Bhad.D/C ,C'pur-Bhad 3,Bhad-Kor s/c,Bhad-A'bad D/C	Ch-Padg-700, NR-500, SR-500, ER-2000, Bhi-Kor-D/C Rai-Bhad.D/C,C'pur-Bhad 3,Bhad-Kor s/c,Bhad-A'bad D/C
Raipur	384.07	386.16	385.12	387.78
Bhilai	384.50	386.73	385.93	388.80
Koradi	392.40	392.40	400.00	402.00
Bhadravati	404.308	404.844	404.07	404.73
Chandrapur	404.0	404.0	404.0	404.0
Parli	385.06	385.26	395.50	396.46
Satpura	382.00	386.80	400.0	402.00
Itarsi	366.41	372.97	387.80	390.19
Indore	363.81	371.05	389.61	391.46
Dhule	384.07	386.47	397.12	398.17
Asoj	391.87	393.35	397.72	398.13
KSTPS	410.00	410.0	410.00	410.0
VSTPS	408.00	408.0	408.00	408.0
Jabalpur	372.78	377.83	387.44	389.69
Au'Bad	390.45	390.54	398.36	398.85
Bhusawal	387.67	387.08	402.38	402.47
B'blshwar	396.81	397.35	404.25	404.65
Vapi	OUT	OUT	OUT	OUT
Bina	362.64	370.09	381.73	383.77
Nagda	358.94	367.00	387.08	389.03
Dehgam	403.11	403.28	403.94	403.99
Boisor	OUT	OUT	OUT	OUT
Padghe	414.68	414.81	417.50	417.63
Bhopal	362.61	370.02	384.04	386.39
Nasik	OUT	OUT	OUT	OUT



# Additional Transmission Planning Criteria

- Participation/ Feedback from System Operator should be made essential
- Margins required for Open Access to be kept
- Ample reactive power sources including FACTS devices with damping controllers to be provided
- Automations for network safety to be provided
- Anchorage at each substation to be provided
- Controllability of active and reactive power flows through FACT devices to relieve unforeseen constraints

# Low Voltage Profile

## Minimum Voltages in November,2003

Ann-3

### - MP

- Indore/ Nagda 320kV Min
- Itarsi 345 kV
- Satna 370 kV
- Bina/ Bhopal 340kV
- Jabalpur 360 kV
- Satpura (generator) 350 kV
- VSTPS 388kV
- KSTPS 392 kV

### - Maharashtra

- Karad / Parli 375 kV
- Bableshwar 380 kV
- Dhule 368 kV

### - Gujarat

- Asoj 366 kV
- Chorania 360 kV
- Jetpur 335 kV



# Critical Line loadings

## November, 2003

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Ann-4

	MW/ckt
– Raipur-Roukela	630
– Bhilai-Koradi	670
– Bhilai-Bhadravati	550
– Itarsi-Indore	600
– Indore -Asoj	525
– Itarsi-Dhule	525
– Satpura-Indore	600
– Koradi-Bhusawal	550
– Chandrapur-Parli	580
– Parli-Lonikhand	520
– B'vati-Chandrapur	500

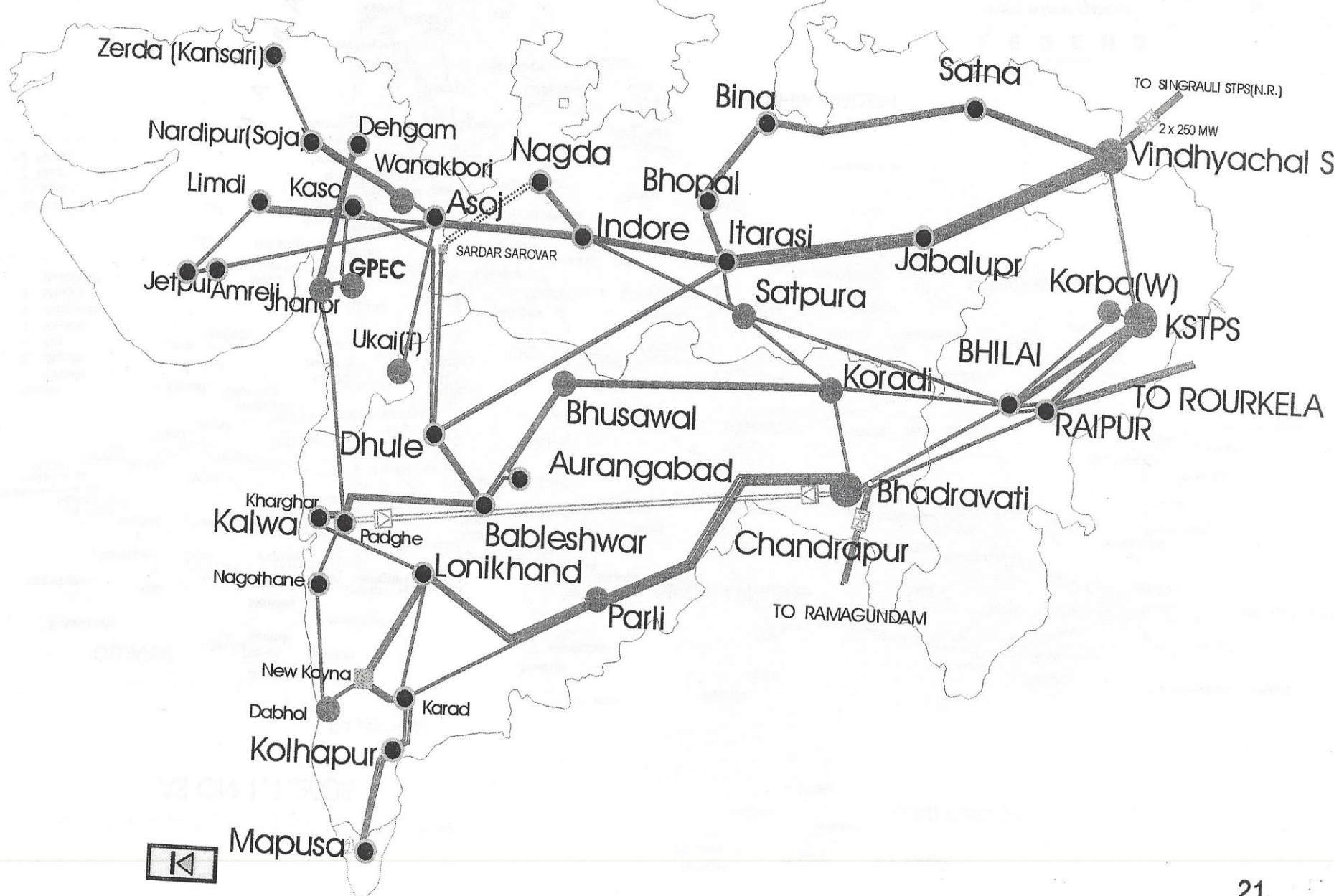




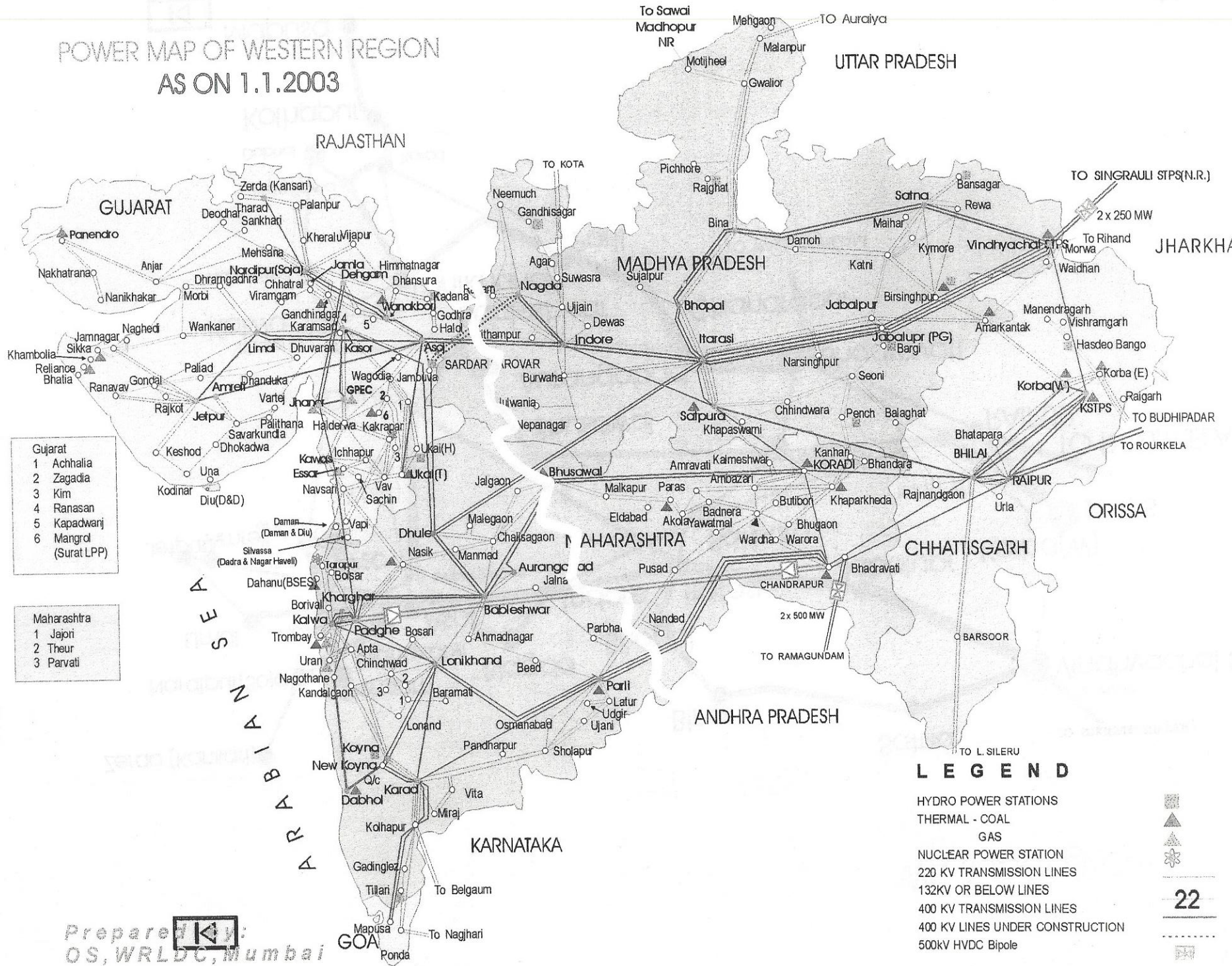


WR super grid

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# POWER MAP OF WESTERN REGION AS ON 1.1.2003



- Gujarat
- 1 Achhalia
  - 2 Zagadia
  - 3 Kim
  - 4 Ranasan
  - 5 Kapadwanj
  - 6 Mangrol (Surat LPP)

- Maharashtra
- 1 Jejori
  - 2 Theur
  - 3 Parvati

- ### LEGEND
- HYDRO POWER STATIONS
  - THERMAL - COAL
  - GAS
  - NUCLEAR POWER STATION
  - 220 KV TRANSMISSION LINES
  - 132KV OR BELOW LINES
  - 400 KV TRANSMISSION LINES
  - 400 KV LINES UNDER CONSTRUCTION
  - 500KV HVDC Bipole

Prepared by:   
OS, WRLDC, Mumbai

# Angular differences

(System stability margins)

- Angular difference on 400kV Itarsi-Dhule Ckts

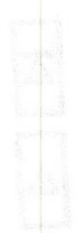
$$P = (V_1 \times V_2 / X) \times \sin \delta$$

$$P = 525 \text{ MW}, V_1 = 346 \text{ kV}, V_2 = 338 \text{ kV} \&$$
$$X = 404 \text{ km} \times 0.3 \text{ ohms/km}$$

$$\delta = 33^\circ$$

Transmission planning criteria specifies angular difference to be not more than  $30^\circ$ .





... ..

$$g = 33$$

$$X = 400 \text{ km} \times 0.3 \text{ opm} = 120 \text{ km}$$

$$B = 252 \text{ mm} \cdot V^1 = 340 \text{ km} \cdot V^1 = 338 \text{ km} \cdot 8$$

$$P = (V^1 \cdot V^5 \cdot X) \cdot 2 \text{ m} \cdot 2$$

OKta

Angular difference on 400km itarsi-Dume

(system stability margins)

Angular differences

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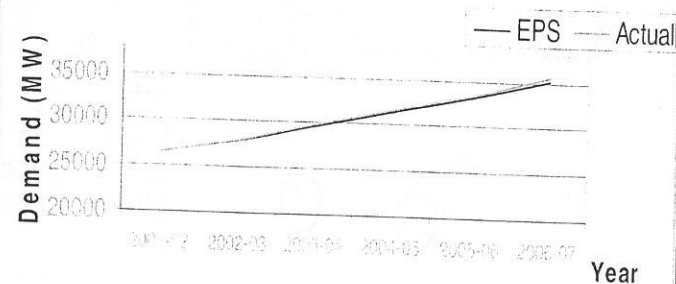
## Western Region Grid Strengthening Schemes

### Need

- During last 4-5 years, substantial growth in demand – about 6000MW
- Capacity addition meager – 1000-1100 MW
- Level of import from other regions increased considerably-
  - Import from ER about 1600-1700 MW, as against envisaged 900-1000 MW
  - 500 MW import from SR, as envisaged otherwise

### Growth in Demand

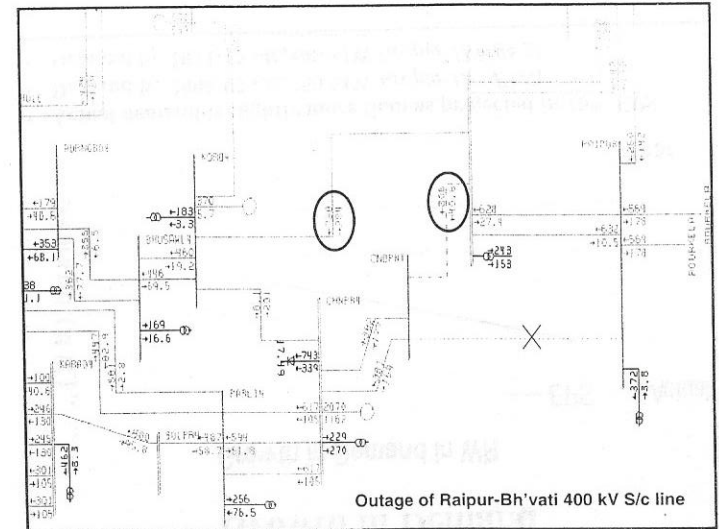
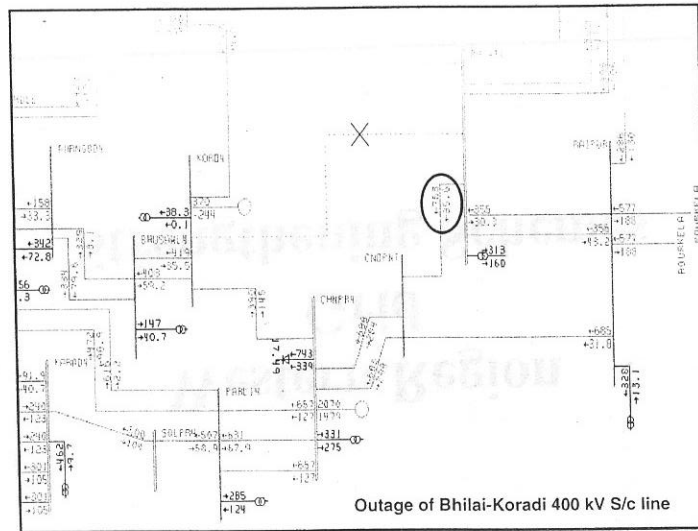
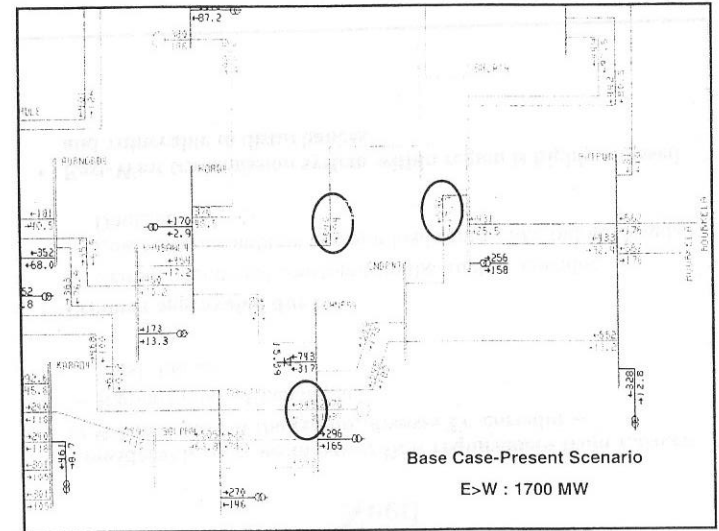
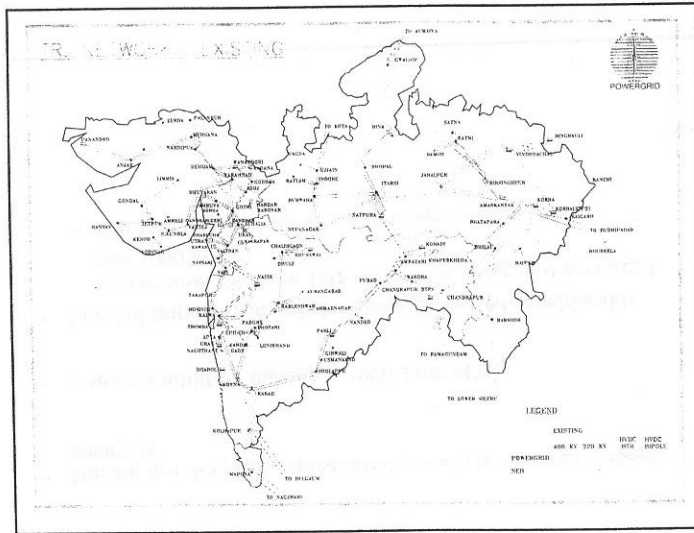
#### Growth in Demand in WR



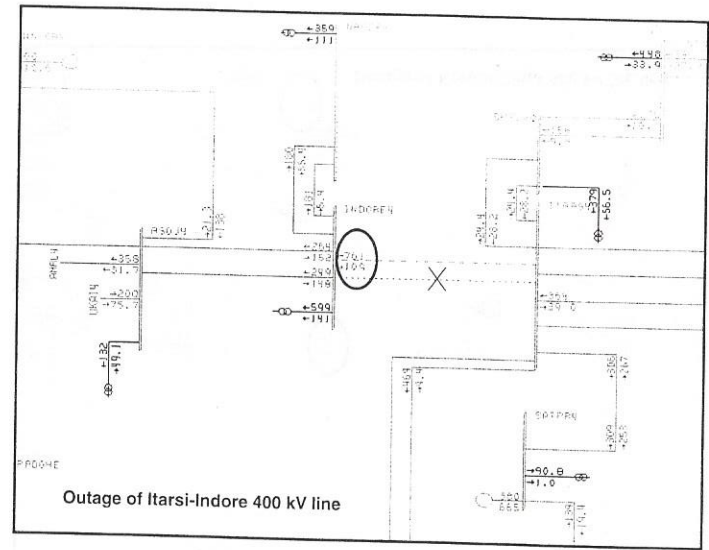
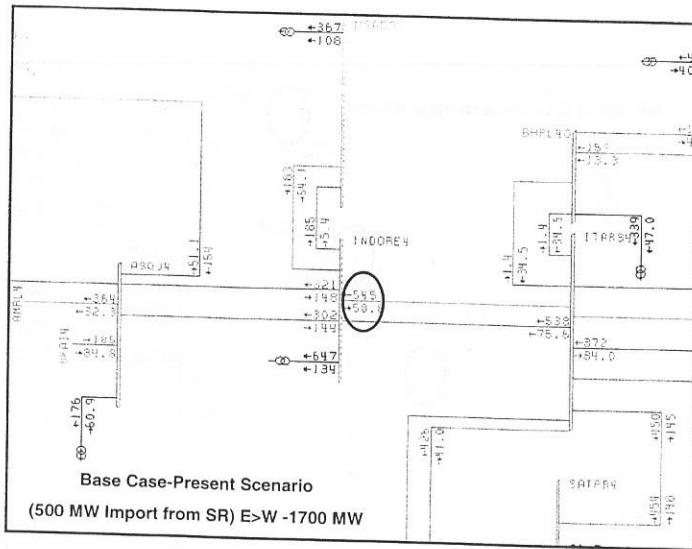
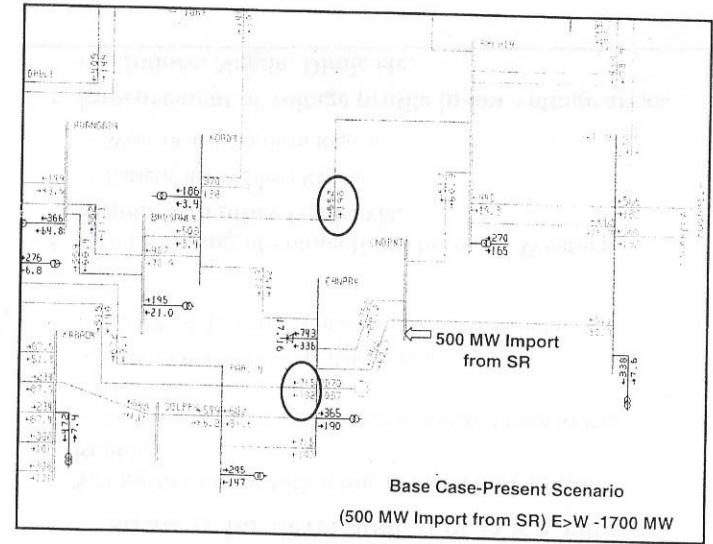
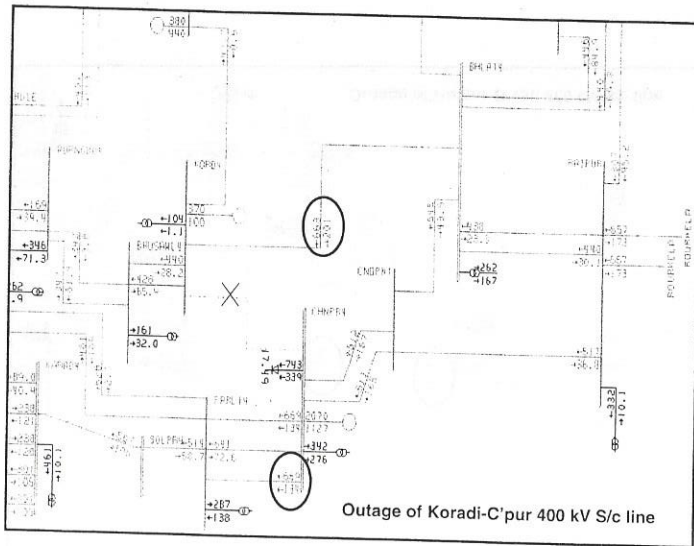
- Actual demand is slightly more than as projected in 16<sup>th</sup> EPS
- Demand by 2006-07 -35,300 MW (as per 16<sup>th</sup> EPS)
- Demand by 2011-12 -46,800 MW (as per 16<sup>th</sup> EPS)

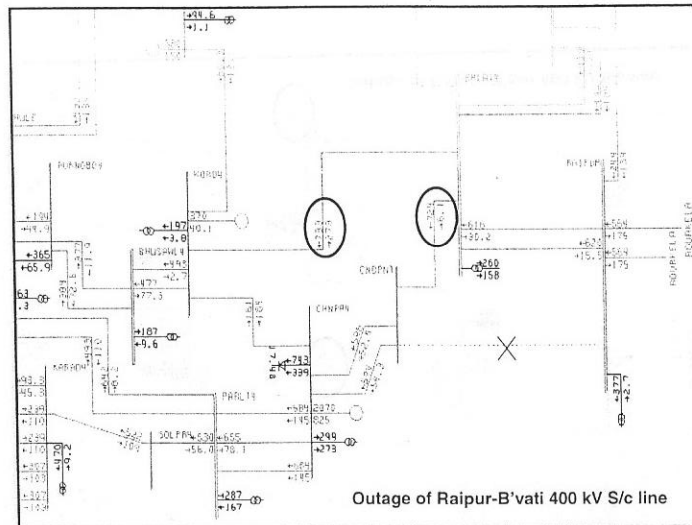
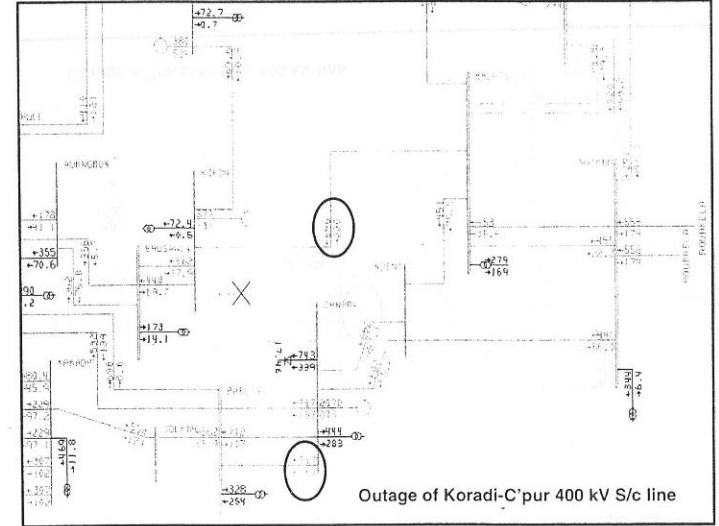
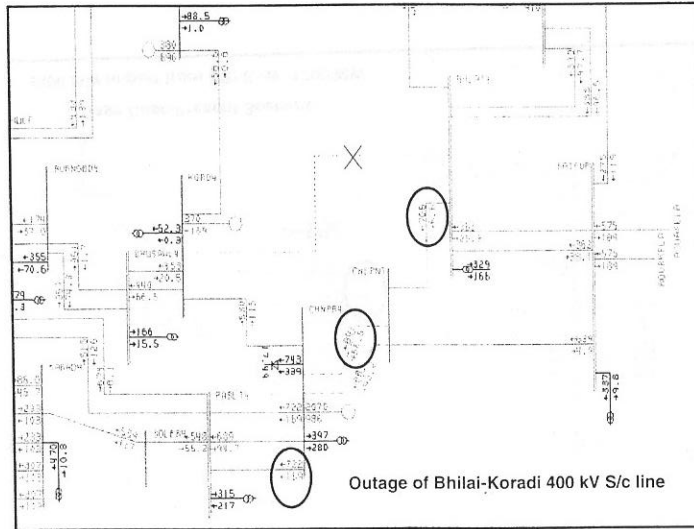
### Need

- Considerable increase in power flow requirement from Eastern to Western part of the region, stresses Tr. corridor –
  - Raipur/Bhilai – Chandrapur
  - Itarsi- Indore
- Problem aggravated due to-
  - Certain operational constraints in the trunk tr. corridor
  - Low voltage condition at major load centres like Indore, Nagda, Dhule etc.
- East-West transmission system within region is highly stressed and vulnerable to disturbances



1A





### Strategy for development of WR Grid

- **Strengthening of following Tr. corridor in the Region –**
  - East-West Tr. corridor in upper part of WR from M.P to Gujarat
  - East – West corridor in Maharashtra
  - East-West Tr. corridor interconnecting Maharashtra and Gujarat
- **Strengthening of connectivity between Western Region with other Grids, viz.**
  - Eastern and Western Region
  - Western and Northern Region
- **Improvement of voltage profile in low voltage areas, viz. Indore, Nagda, Dhule etc.**



### Action Taken – Ongoing Schemes

- Various Tr. schemes evolved – which are under different stages of approval/implementation

#### On-going schemes

- Establishment of 400/220kV substation at Khandwa by LILQ of Itarsi-Dhule line
  - Would reduce loading on Itarsi-Indore section by enabling shifting of Indore load, thereby improving voltage

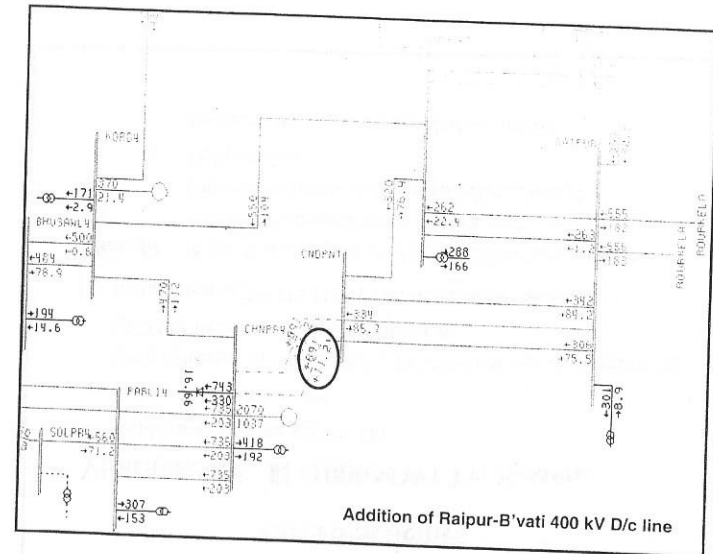
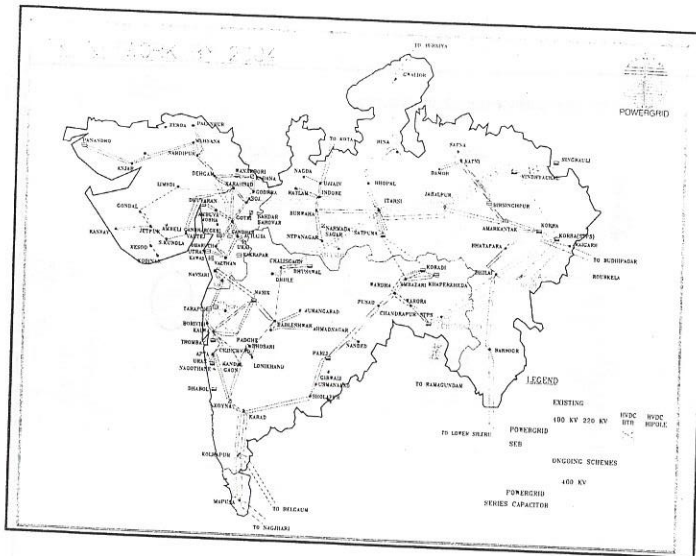
\* MPSEB need to re-orient 220kV lines around Indore to Khandwa for shifting of about 150-200 MW load to Khandwa S/s

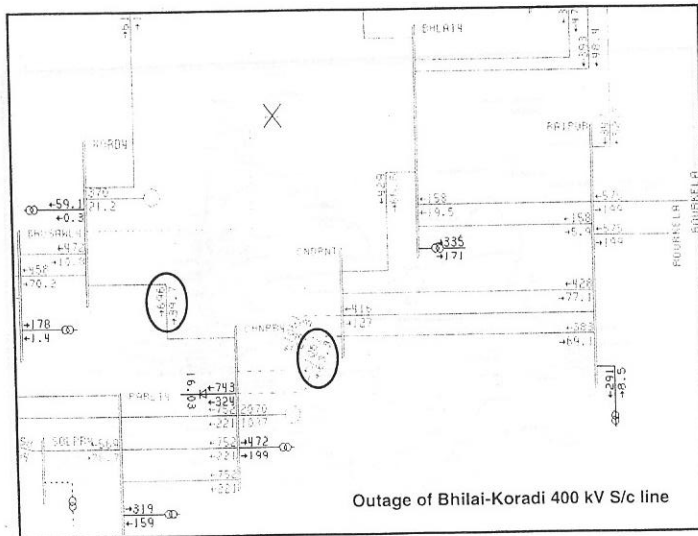
- 400kV Raipur-Chandrapur D/c

➢ Would strengthen Bhilai/Raipur-Chandrapur and Bhilai – Koradi 400kV Tr. Corridor and reduce stress on the existing lines.

### Ongoing Schemes ..... contd.

- Series compensation & TCSC on Rourkela-Raipur line
  - Enhance inter-regional power transfer capacity between ER & WR by 500MW.
- Tarapur 3&4 (1000MW) Tr. system
  - Tarapur 3&4 – Padghe 400kV D/c
  - Tarapur 3&4 – Boisar 400kV D/c
  - Establishment of 400/220kV S/s at Boisar and Vapi by LILQ of Gandhar-Padghe 400kV S/c
- Above schemes would relieve Bhilai/Raipur-C'pur Tr. corridor
- Provide additional tr. capacity between East and West
- Provide direct 400kV touch points to load centres of Gujarat and Maharashtra, thus reduce loading of East-West Tr. corridor to some extent.





### Agreed Schemes

#### • Vindhyachal III (1000MW) Tr. System

- Vindhyachal-Satna 400kV D/c
- Satna - Bina 400kV D/c
- Establishment of 400/220kV, 2x315MVA S/s at Raigarh by LILO of Rourkela-Raipur 400kV D/c
- Installation of 2<sup>nd</sup> (1x315MVA) transformer at Satna

**Benefit** – Helps in development of a parallel tr. corridor of 1200 MW capacity from eastern part towards Gujarat facilitates (along with Bina-Naagda-Dehgam lines )

- Reduces loading on Itarsi-Indore section

### Agreed Schemes

#### • Sipat-I (3x660MW) Tr. System

- Sipat – Seoni 765kV 2xS/c
- Seoni – Khandwa 400kV D/c (quad.)
- Nagda - Dehgam 400kV D/c
- LILO of Bhilai – Satpura 400kV S/c at Seoni
- LILO of Korba-Raipur 400 kV S/c at Sipat
- LILO of Sardar sarovar – Nagda 400kV D/c at Rajgarh
- Establishment of S/s at Seoni & Rajgarh

**Benefit** –

- Development of high capacity (5000 MW) 800kV Tr. corridor, as a part of National Grid
- Facilitate import of power from ER
- Direct touch-point to load centres in M.P. (Seoni, Rajgarh)

### Agreed Schemes ... contd

#### • System strengthening scheme

- Bina - Nagda 400kV D/c
- Vindhyachal- Korba STPP 400kV S/c

#### • Sipat-II (2x500MW) Tr. System

- Khandwa – Rajgarh 400kV D/c
- Bina – Gwalior 765kV S/c (initially to be operated at 400kV)
- Installation of 765/400 kV, 3<sup>rd</sup> transformer (3x500 MVA) at Seoni
- Establishment of S/s at Bhatapara by LILO of Korba- Raipur 400kV S/c

**Benefit** –

- Parallel Tr. corridor to major load centre near Indore through Khandwa-Rajgarh link
- Direct touch-points at load centres of Gwalior & Bhatapara
- Helps in development of 765kV ring of National Grid interconnecting Eastern Western and Northern region to enhance Grid stability and security

SC2

### Agreed Schemes ... contd

- **Sipat-II supplementary Tr. Scheme**
  - Seoni - Wardha 765kV S/c (initially to be operated at 400kV)
  - Wardha - Akola - Aurangabad 400kV D/c
  - Establishment of S/s at Wardha

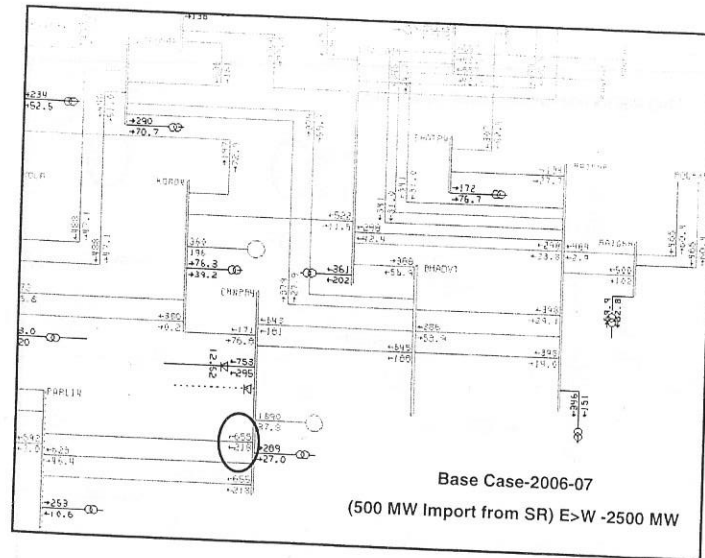
*Benefit - Parallel tr. corridor of 1200MW capacity in Maharashtra*

- **System strengthening schemes**
  - Sipat - Ripur 400kV D/c
  - Wardha - Bhadravati 400kV D/c
  - Series Compensation on Seoni - Khandwa 400kV D/c

*Benefit - Enable loading of Seoni-Khandwa line to the optimal level*

- **Kahalgaon -II (3x500MW) Tr. System - WR portion**
  - Agra - Gwalior 765kV S/c (initially to be operated at 400kV)
  - Ranchi - Sipat 400kV D/c along with series compensation

*Benefit - Enhancement of inter-regional power transfer capacity from WR to ER and NR*



### Agreed Schemes ... contd

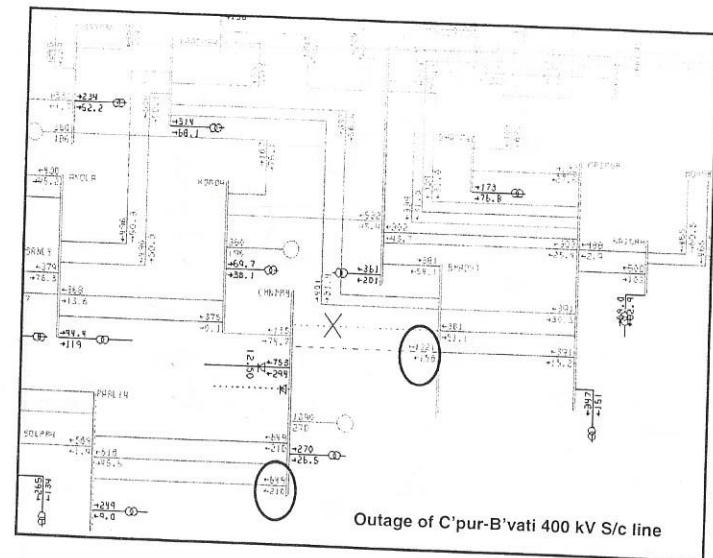
- **Barh (3x500MW) Tr. System - WR portion**
  - Seoni - Bina 765kV S/c (initially to be operated at 400kV)

*Benefit -*

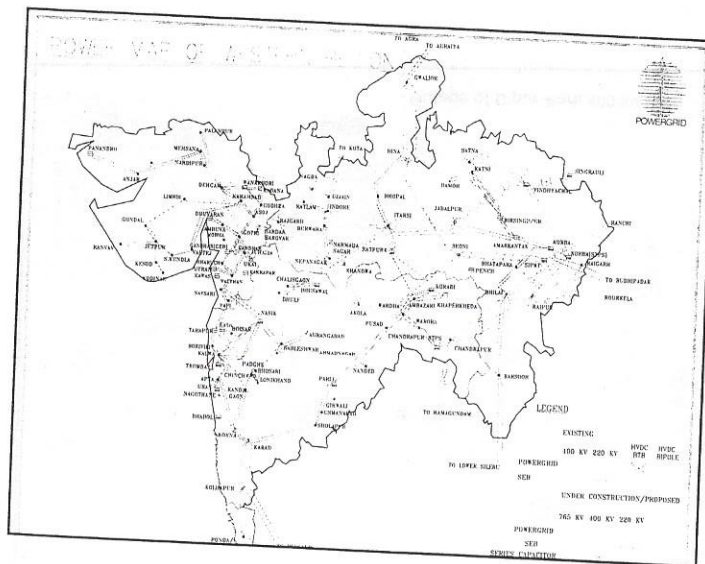
- Helps in development of 765kV ring as a part of National Grid interconnecting ER, WR and NR
- Improves Grid stability and security
- Improvement in reliability of power supply

Above Schemes would facilitate:

- **Development of Three (3) new East-West tr. corridors in WR**
  - Further Relieves Bhilai-Koradi/Raipur-Chandrapur lines
  - Chandrapur-Parli-Lomikhand Corridor need to be strengthened
- **Enhance the inter-regional Tr. capacity to**
  - WR & ER : 2700-2800 MW
  - WR & NR : 2000 MW







## Proposed Strengthening Schemes

### East to Central Tr. corridor

- Bhadravati – Chandrapur 400kV S/c
- Bhadravati – Nanded 400kV D/c
- Nanded – Pune 400kV D/c
- Pune – Aurangabad 400kV D/c
- Nanded – Sholapur – Kolhapur 400kV D/c
- LILO of Parli – Lonikand 400kV D/c at Pune
- Establishment of 400/220kV, 2x315 MVA S/s at Nanded and Pune

*Estimated Cost : Rs. 1050 Cr.*

## System Strengthening Schemes ... contd.

### Benefits

- Provide a parallel Tr. corridor of about 1200MW capacity between Bhadravati and Pune – eastern to western part of the region
- Reduce stress on Bhadravati – Chandrapur – Parli – Lonikand section
- Provide alternate path for power transfer towards Sholapur/Kolhapur area in southern part of Maharashtra
- Completes a strong 400kV ring in Southern part of Maharashtra
- Connectivity to major load centres of Pune, Sholapur, Nanded & Kolhapur would be strengthened.

## System Strengthening Schemes ... contd

### Central to West Tr. corridor

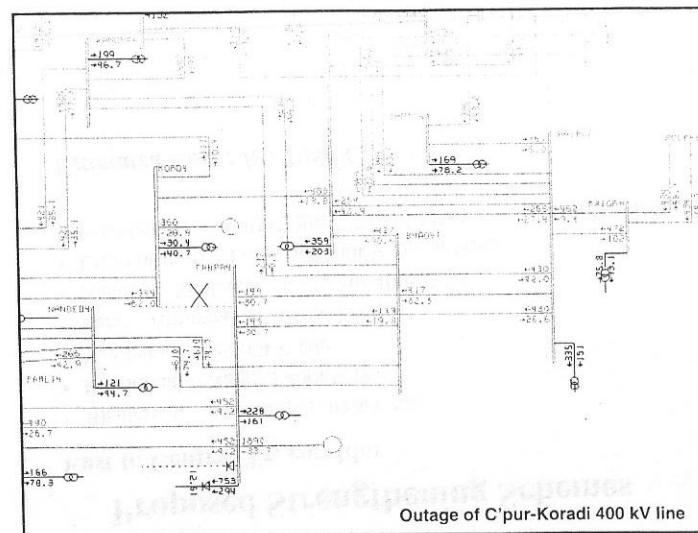
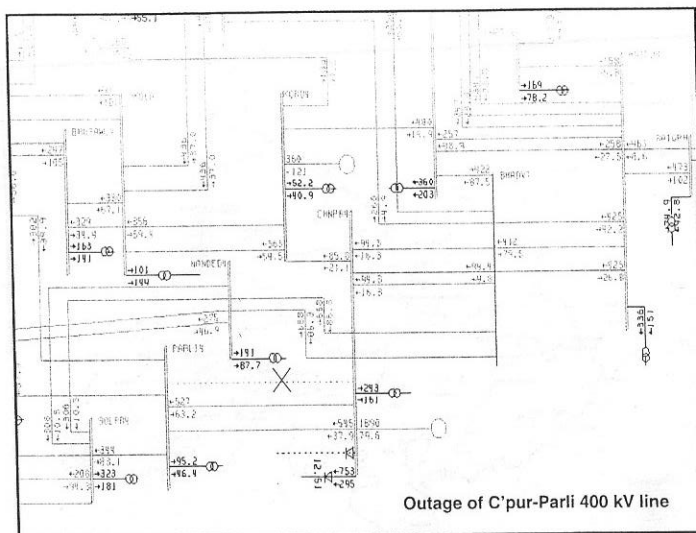
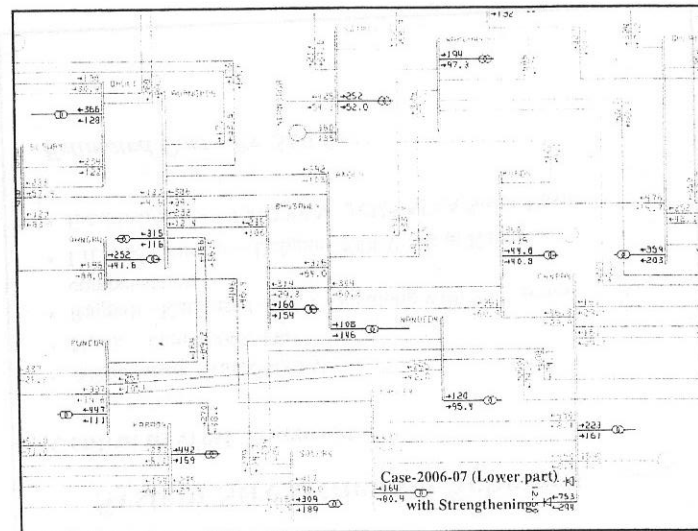
- Aurangabad - Nasik 400kV D/c
- Nasik - Vapi 400kV D/c
- Rajgarh –Karamsad 400kV D/c along with 25% series compensation
- LILO of Gandhar – Dehgam 400kV D/c at Karamsad
- Establishment of 400/220kV, 2x315 MVA S/s at Nasik

*Estimated Cost : Rs. 560 Cr.*

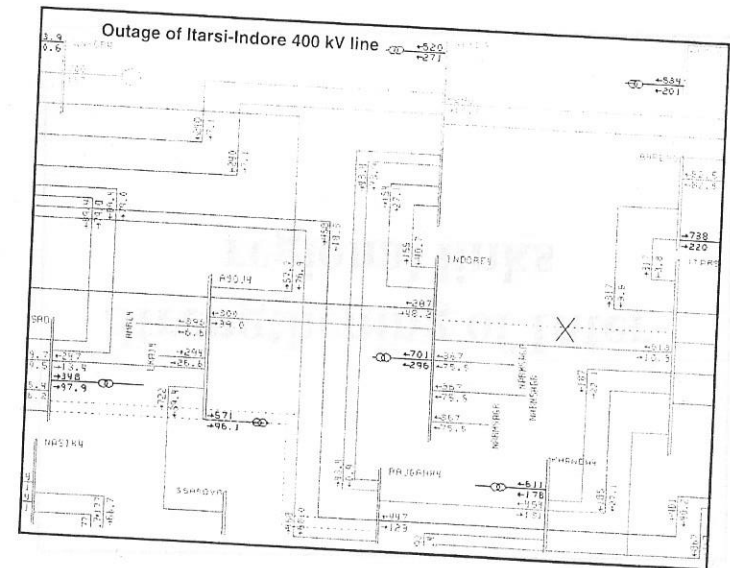
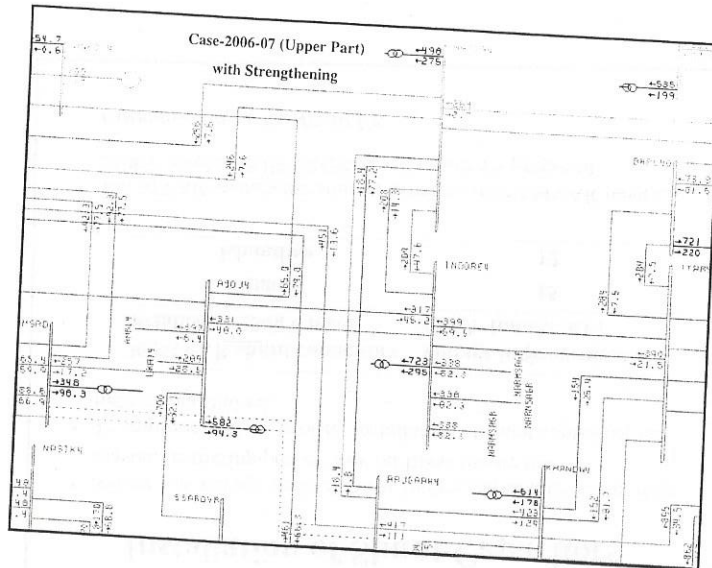
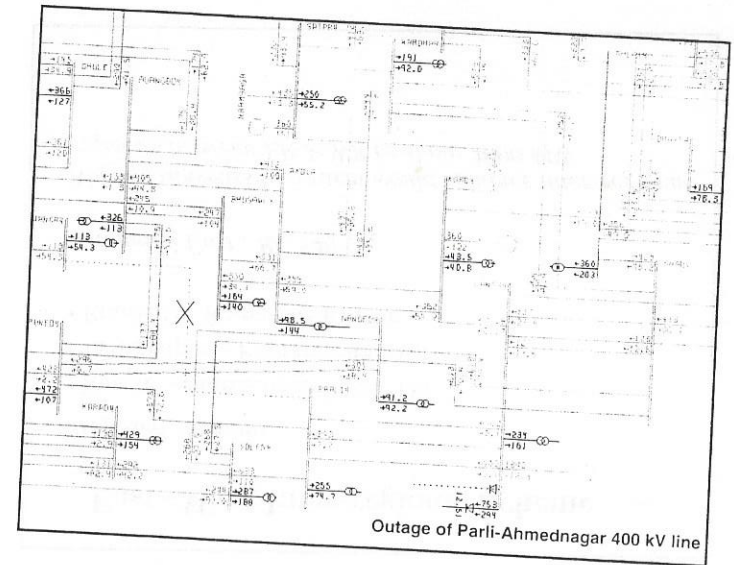
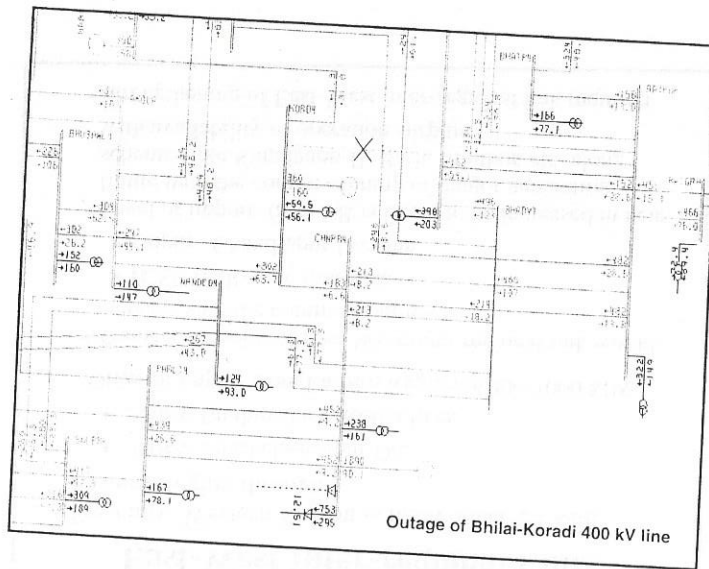
## Strengthening Schemes ... contd

### Benefits

- Develop a new Tr. corridor of 1200MW capacity towards southern part of Gujarat right from Raipur/Bhilai complex and Chandrapur generation complex in eastern part of the region
- 400kV Rajgarh – Karamsad line helps in development of a parallel Tr. corridor between northern part of Gujarat and major generation complex at Sipat/Korba
- Connectivity of Gujarat would be strengthened both in Northern and Southern part



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### Installation of Shunt Capacitors

- Severe low voltage problem near Indore, especially during Rabi season, restricting power flow on Itarsi-Indore line
- To improve voltage profile, installation of shunt capacitors in Indore area studied

300MVAR shunt capacitors installed at 220kV level	Voltage improvement at 400kV Indore (kV)
Rajgarh	15
Khandwa	12

- 300 MVAR switchable shunt capacitors (6x50 MVAR bank) at 220kV level at POWERGRID's Rajgarh S/s proposed.

*Estimated Cost : Rs. 40-50 Cr.*

## Strengthening of Inter-regional links

### East-West Inter-regional Links

Presently, Western Region is interconnected with Eastern Region through -

- 400kV Rourkela-Raipur D/c
- 220kV Budhipadar – Korba lines

Order of import from Eastern Region is 900-1000 MW

- Transfer capacity of East-West inter regional link would increase with the commissioning of -
  - TCSC on Raipur-Rourkela
  - Raipur – Chandrapur D/c line
- Level of import from ER is likely to be increased in near future with the commissioning of major generating schemes like Kahalgaon-II, Barh, Maithon etc. along with availability of operation surplus
- Strengthening of East-West inter-regional link required

### East –West Inter-regional Scheme ...contd

#### *Proposed elements*

- Ranchi – Jamshedpur 400kV D/c
- Jamshedpur – Rourkela 400kV D/c
- Rourkela - Raipur 400kV D/c

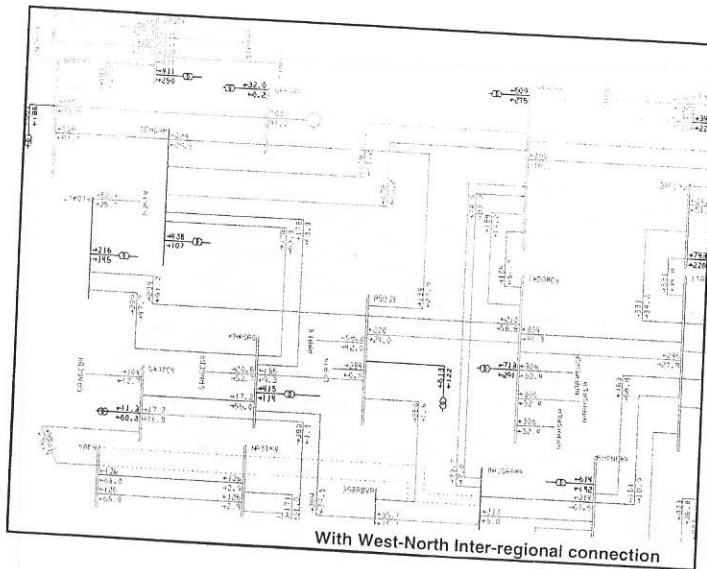
*Estimated Cost : Rs. 540 Cr.*

*Above Transmission system would enhance inter-regional capacity between ER & WR to about 4000 MW*



## North-West Inter-regional Links

- By 2005-06, Eastern, Northern and Western Region would be operating as a single unit
- Eastern Region would be a major source of power
- A no. of inter-regional links planned between Eastern and Northern Regions
- By strengthening the North-West inter-regional link, a new Tr. corridor to bring power from ER to WR need to be developed
- Boundaries of Northern and Western Regions geographically spread, necessitate interconnection of these regions at different locations, to maintain stability & security of both the Grids



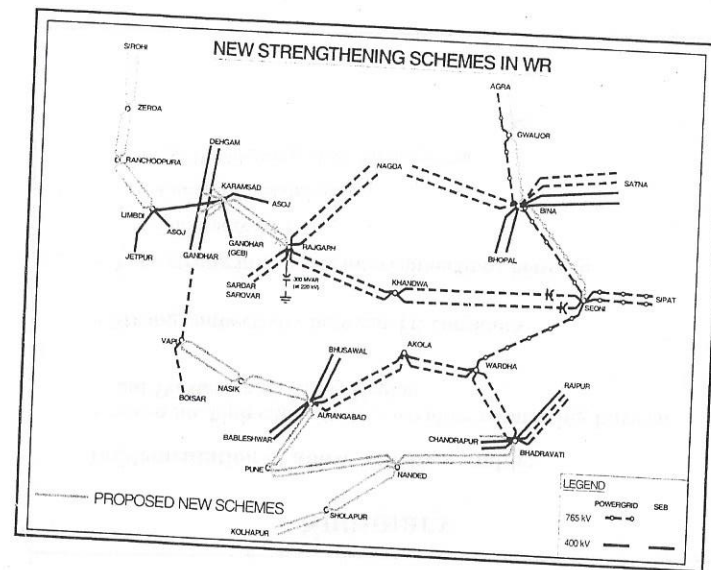
## North -West Inter-regional Scheme

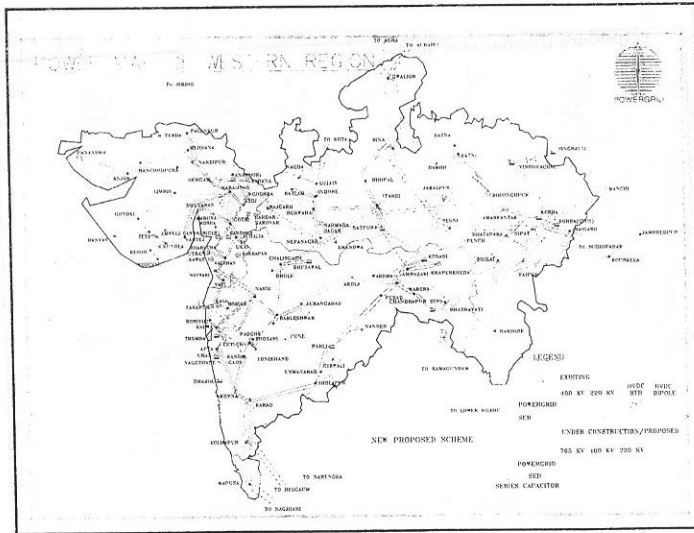
### Proposed elements

- Seoni – Bina – Gwalior – Agra 765kV 2<sup>nd</sup> ckt (initially to be operated at 400kV)
- Limdi – Ranchodpura – Zerda 400kV D/c
- Zerda - Sirohi 400kV D/c

**Estimated Cost : Rs. 840 Cr.**

- Above Transmission system would enhance inter-regional capacity between WR & NR by about 2500 MW and would enhance the security of both WR & NR Grids
- All these Inter-regional links are already proposed in perspective transmission plan
- Considering the criticality, advancement in construction of these links are proposed





## Summary

Implementation of above Schemes enable:

- Seven no. high capacity Tr. corridors connecting Eastern and Western part of the Region
- Strong connectivity between Tr. corridors
- Very strong inter-state interconnections between
  - ✓ Gujarat & M.P.
  - ✓ Gujarat & Maharashtra
  - ✓ M.P./Chhattisgarh & Maharashtra

## Summary

- Overall Voltage improvement by 4-5 kV
- Reduction in angular separation, thereby improvement in grid stability
- Reduction in overall tr. losses by 0.9%
- Improvement in Reliability and Security
- Enhancement of Inter-Regional transfer capacity
  - WR & ER : 4000 MW
  - WR & NR : 4500 MW

**THANK YOU**