

सेंद्रल ट्रांसमिशन यूटिलिटी ऑफ इंडिया लिमिटेड

(पावर ग्रिड कॉर्पोरेशन ऑफ इंडिया लिमिटेड के स्वामित्व में)

(भारत सरकार का उदयम)

**CENTRAL TRANSMISSION UTILITY OF INDIA LTD.**

(A wholly owned subsidiary of Power Grid Corporation of India Limited)

(A Government of India Enterprise)

Ref: CTUW/07/WR & SR Joint Study

19<sup>th</sup> Jan, 2022

As per Distribution List

**Sub: Joint study meeting on Transmission Planning for Western Region and Southern Region held on 16.12.2021 – Minutes of Meeting**

Sir,

Please find enclosed the minutes of the Joint study meeting on Transmission Planning for Western Region and Southern Region held on 16.12.2021 (through video conferencing) to discuss ISTS Network Expansion beyond Kolhapur for export of surplus power during High RE scenario in Southern Region and Constraints at Raigarh (Kotra) under various operating conditions.

Thanking you,

Yours faithfully,



**(Partha Sarathi Das)**  
**Sr. General Manager**

**Encl: Minutes of Meeting**

**Distribution List:**

|     |   |     |   |
|-----|---|-----|---|
| 1.  | <b>Chief Engineer (PSP&amp;A - I)</b><br>Central Electricity Authority<br>Sewa Bhawan, R.K.Puram<br>New Delhi-110 066   | 2.  | <b>Chief Engineer (PSP&amp;A - II)</b><br>Central Electricity Authority<br>Sewa Bhawan, R.K.Puram<br>New Delhi-110 066  |
| 3.  | <b>Director (SO)</b><br>POSOCO<br>B-9, Qutab Institutional Area,<br>Katwaria Sarai, New Delhi-110 016   | 4.  | <b>Member Secretary</b><br>Western Regional Power Committee<br>MIDC area, Marol, Andheri East,<br>Mumbai 400 093  |
| 5.  | <b>Chief General Manager I/C</b><br>Western Regional Load Despatch Centre<br>F-3, M.I.D.C. Area, Marol,<br>Andheri East, Mumbai-400 093   | 6.  | <b>Member Secretary</b><br>Southern Regional Power Committee<br>152, Madhava Nagar, Gandhi Nagar,<br>Bengaluru, Karnataka 560001  |
| 7.  | <b>Executive Director</b><br>Southern Regional Load Despatch Centre<br>29, Race Course Cross Road, Bangalore-<br>Karnataka-560009   | 8.  | <b>Managing Director</b><br>Gujarat Energy Transmission<br>Corp. Ltd,<br>Sardar Patel Vidyut Bhawan,<br>Race Course, Vadodara -390 007  |
| 9.  | <b>Director (Operation)</b><br>Maharashtra State Electricity Transmission<br>Co. Ltd.,<br>4 <sup>th</sup> Floor, "Prakashganga", Plot No. C-19, E-<br>Block, Bandra – Kurla Complex, Bandra<br>(East), Mumbai- 400051 | 10. | <b>Managing Director</b><br>Chhattisgarh State Power Transmission Co.<br>Ltd.,<br>Dangania, Raipur- 492 013   |
| 11. | <b>Executive Engineer</b><br>Administration of Union Territory of Dadra &<br>Nagar Haveli and Daman & Diu,<br>Secretariat, Moti Daman-395220  | 12. | <b>Chairman &amp; Managing Director</b><br>Madhya Pradesh Power Transmission Co.<br>Ltd.; Block No. 3, Shakti Bhawan,<br>Rampur, Jabalpur-482 008                               |
| 13. | <b>Chief Engineer</b><br>Electricity Department<br>The Government of Goa,<br>Malacca Rd, Patto Colony,<br>Panaji, Goa – 403001  | 14. | <b>Director (Trans. &amp; System Op.),</b><br>Kerala State Electricity Board Ltd.<br>Vidyuthi Bhawanam, Pattom,<br>P.B. No. 1028<br>Thiruvananthapuram – 695 004                |
| 15. | <b>Director (Transmission)</b><br>Transmission Corp. of Andhra Pradesh Ltd.<br>(APTRANSCO)<br>Vidyut Soudha, Gunadala, Eluru Rd,<br>Vijayawada, Andhra Pradesh – 520004   | 16. | <b>Director (Transmission Projects)</b><br>Tamil Nadu Transmission Corporation Ltd<br>(TANTRANSCO)<br>6 <sup>th</sup> Floor, Eastern Wing, 800 Anna Salai,<br>Chennai – 600 002 |
| 17. | <b>Director (Grid Operation)</b><br>Transmission Corp. of Telangana Ltd.<br>Vidyut Soudha Hyderabad – 500 082   | 18. | <b>Director (Transmission)</b><br>Karnataka State Power Transmission<br>Corporation Limited,<br>Cauvery Bhawan,<br>Banglore-560009  |
| 19. | <b>Superintending Engineer –I</b><br>First Floor, Electricity Department<br>Gingy Salai, Puducherry – 605 001   |     |   |

## **Minutes of Joint study meeting for Western Region & Southern Region held on 16.12.2021 over VC regarding ISTS Network Expansion beyond Kolhapur for export of surplus power during High RE scenario in Southern Region and Constraints at Raigarh (Kotra) under various operating conditions**

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The Joint Study Meeting on Transmission Planning for Western Region & Southern Region was held on 16.12.2021 over Video conferencing amongst CEA, CTU, POSOCO, WR, and SR constituents to discuss ISTS Network Expansion beyond Kolhapur for export of surplus power during High RE scenario in Southern Region and Constraints at Raigarh (Kotra) under various operating conditions. List of participants is enclosed at **Annexure-I**. Sr.GM, CTUIL welcomed the participants. Thereafter, deliberations as per the agenda commenced and the gist of deliberations are as given below.

### **A. ISTS Network Expansion beyond Kolhapur for export of surplus power during High RE scenario in Southern Region**

#### **i. Background:**

The following transmission system was agreed in the 2<sup>nd</sup> SR Standing Committee on Transmission held on 10.06.2019 for evacuation of power from Phase-II Solar Energy Zone in Gadag, Karnataka:

#### **Gadag SEZ (2500 MW)**

- i. Establishment of 400/220 kV, 5x500 MVA Gadag Pooling Station.
- ii. Gadag PS-Koppal PS 400 kV (high capacity equivalent to quad moose) D/C Line.
- iii. Gadag PS-Narendra (New) PS 400 kV (high capacity equivalent to quad moose) D/C Line.
- iv. 220 kV line bays for interconnection of solar projects (8 nos.)
- v. 1x125 MVA (400 kV) bus reactor at Gadag PS.
- vi. Upgradation of Narendra (New) to its rated voltage of 765 kV level alongwith 2x1500 MVA transformer and 1x330 MVA Bus Reactor.
- vii. Upgradation of Kolhapur (PG) to its rated voltage of 765 kV level alongwith 2x1500 MVA transformer and 1x330 MVA Bus Reactor.
- viii. Upgradation/charging of Narendra new - Kolhapur (PG) 765 kV D/c line (initially charged at 400 kV) to its rated voltage of 765 kV along with 1x330 MVA switchable Line Reactor on Kolhapur (PG) end of each circuit.

It was also noted that the proposed system strengthening in the inter-regional corridors and system strengthening beyond Kolhapur in Western region shall require all-India study.

Subsequently, study was carried out to check the adequacy of existing IR corridors between WR & SR to cater to export of power from REZs in Southern Region to Western Region under high SR export scenario. The same was discussed in the 3<sup>rd</sup> WRPC(TP) meeting held on 14.06.2021 and after deliberations, the following was agreed in the meeting:

- Re-conductoring of Kolhapur (PG) – Kolhapur 400 kV D/c line with conductor of minimum capacity of 2100 MVA/Ckt at nominal voltage along with bay

upgradation work at Kolhapur (MSETCL) – **Being implemented under RTM by POWERGRID**

(Anticipated: Mar'23)

- The strengthening requirement beyond Kolhapur other than reconductoring of Kolhapur (PG) – Kolhapur 400 kV D/c line would be studied in a separate joint study meeting with CEA, CTU, WRPC & POSOCO.

## ii. Deliberations and decisions taken in the meeting

CTU informed that NLDC as part of Operational Feedbacks vide its letter dated 02.02.2021 has highlighted high loadings beyond Kolhapur which is attributable to multiple factors viz. high generation at Kudgi TPS, low generation at plants in southern Maharashtra, high load around Kolhapur area, high renewable (Solar) generation in Southern Region etc. (copy of letter enclosed at **Annexure-II**). CTU further informed that comprehensive studies have been carried out to evolve network expansion schemes for addressing the high loadings beyond Kolhapur and also enabling export of power from REZs in Southern Region to Western Region and further to Northern Region under high SR export scenario. Important considerations for carrying out the study are enclosed at **Annexure-III**.

CTU presented the various alternatives studied for evolving above network expansion schemes. Details of the alternatives alongwith outcomes based on studies are given below:

| Alternative/Case |  | Outcomes based on studies  |
|------------------|--|--|
| I                | Base case: (Kolhapur (PG) – Kolhapur (MH) reconductoring) (MW)   | Constraints are observed under N-1 contingency of Kolhapur (PG) – Kolhapur(MSETCL) 400kV D/c line, Kolhapur(MSETCL) – Karad 400kV D/c line.  |
| II               | Case-I + Upgradation of Narendra New – Kolhapur (PG) to 765kV  | Constraints are observed under N-1 contingency of Kolhapur (PG) – Kolhapur(MSETCL) 400kV D/c line, Kolhapur(MSETCL) – Karad 400kV D/c line, Kolhapur(PG) 765/400kV, 2X1500MVA ICTs and Narendra New 765/400kV, 2X1500MVA ICTs.   |
| III              | Case-II + Kolhapur (PG) – Pune (PG) 765kV D/c line   | Under N-1 contingency of Narendra (New) – Kolhapur(PG) 765kV D/c line, about 3855MW flow is observed on other circuit.   |
| IV               | Case-I + Narendra (New)-Kolhapur 400kV D/c line + Narendra New – Solapur 765kV D/c line  | Under N-1 contingency of Narendra (New) – Solapur 765kV D/c line, about 3600MW flow is observed on other circuit. Further, high fault level (~ 48A) is observed at 400kV Narendra (New) GIS which is designed for 50kA leaving no margin for future and may possibly cross the design limits with further interconnections.  |
| V                | Case-I + Narendra-Kolhapur (400kV D/c line) + Establishment of 2X1500MVA, 765/400 kV Jejuri S/s + Narendra New – Jejuri 765kV D/c line + Jejuri 765kV – Pune (PG) GIS D/c line + Jejuri – Jejuri (MSETCL) 400kV D/c line | Power flows and SC levels are generally in order. Further, it provides additional feed at Jejuri (MSETCL) which leads to improved voltage profile of Jejuri and adjoining areas which generally remain on lower side during peak demand period. Further, reliability of supply w.r.t Jejuri and adjoining areas is improved and in future, any additional drawl requirement of Maharashtra can also be met by LILO or direct feed to nearby loads (Kesurdi, Hinjewadi, |

| Alternative/Case |  | Outcomes based on studies  |
|------------------|--|--|
|                  |  | Lonikhand etc). Four Nos. of 765/400kV, 2X1500MVA. ICTs at Narendra (New) S/s is required.   |
| VI               | Case-II + Kolhapur – Jejuri (New) 765kV D/c line + Jejuri (New) 765kV – Pune (PG) GIS D/c line + Jejuri (New) – Jejuri (MSETCL) 400kV D/c line | Under N-1 contingency of Narendra (New) – Kolhapur (PG) 765kV D/c line, about 3830MW flow is observed on other circuit. Four Nos. of 765/400kV, 2X1500MVA. ICTs at Narendra (New) S/s is required.   |
| VII              | Case-I + Narendra (New) - Kolhapur (400kV D/c line) + Narendra (New) – Pune (GIS) 765kV D/c line   | Power flows and SC levels are generally in order. There would be no additional feed to Maharashtra. However, in case such additional feed is required by MSETCL, Narendra New (GIS) – Pune 765kV D/c line can be LILoed in future at a suitable location as per requirement of MSETCL. |

Summary of power flow results for different alternatives along with 3-Phase Short Circuit levels are enclosed at **Annexure-IV**.

WRLDC representative informed that providing additional ISTS feed to west Maharashtra would help improving the voltage profile, which generally remains in the lower side during peak demand period inter alia improving the reliability of power supply for Jejuri and adjoining areas. He added that Jejuri met around 1200 MW of load during peak condition with only two nos. 400kV infeed and N-1 non-compliance was observed in past. He, further added that low voltage and N-1 non-compliance issues in Western Maharashtra area was reported in operational feedbacks of WRLDC. He stated that considering the above facts, Alternative-V would be help in relieving the constraints and the same can be implemented in compressed time frame.

Representative from SRLDC informed that alternative-V & alternative-VII are both feasible. However, considering long length of 765kV Narendra(New)-Pune D/c line and the constraints in Western Maharashtra as informed by WRLDC, Alternative-V would be more beneficial. SRLDC enquired about up-gradation of 765kV Narendra-Kolhapur D/c line which is presently charged at 400kV level. CTU informed that same would be continued at 400kV level presently; however in future if need arises, the corridor would be reviewed for upgradation.

NLDC mentioned that in present scenario also, SR to WR TTC is limited due to constraints in evacuation beyond Kolhapur PG and hence implementation of this scheme on urgent basis would help in relieving transmission constraints.

MSETCL representative stated that thermal and RE generations dispatches at Narendra (New) have been taken on the higher side. They further enquired regarding the feasibility of Narendra (New) to Raichur 765kV D/c interconnection. It was clarified that worst-case scenario has been simulated to check the adequacy of the ISTS system under stressed conditions. Regarding, proposal for Narendra (New) to Raichur 765kV D/c interconnection, it was informed that the option had already been studied and high fault level at Narendra(New) 400kV S/s has been observed with the interconnection due to which the alternative was not found technically feasible and accordingly has not been included in the proposal.

Further, MSETCL informed that LILO of Karad- Lonikand 400kV is now being proposed at Jejuri (MSETCL) S/s instead of earlier planned Kesurdi S/s along with some changes in downstream network. CTU stated that with the proposed changes of MSETCL, there shall not be significant change in the load flows. However, the same shall be incorporated in the studies and revised studies shall be made part of the minutes.

In order to mitigate operational constraints being observed in Western Maharashtra, representative of MSETCL agreed with Alternative-V and stated that location of Jejuri S/s should be close to Jejuri (MSETCL) to take care of ROW issues in that area.

TANTRANSCO representative stated that they need some time for studying the proposal. Towards this CTU informed that they have already received applications in the month of November 2021 of the order of 620 MW seeking transfer of power from SR to NEW Grid and same are to be taken-up for discussions in the upcoming meeting to be held in December. In case the network expansion schemes for enabling export of power from REZs in Southern Region to Western Region are not identified timely, it may not be possible to grant LTA to these applicants and generation may get stranded. Further, in respect of TANTRANSCO observations regarding diversity factors and generation dispatches considered in the System Studies, it was clarified that diversity factors and generation dispatches have been considered as per the methodology finalized in a meeting held in CEA on 11.03.2021 regarding Load Generation Balance for All India Studies for 2024-25 for integration of RE projects (9 scenarios). Further, the worst case scenario (Solar Max (Jun'24 Afternoon Peak)) has been considered for the system studies wherein maximum export is expected from Southern Region.

TANTRANSCO enquired about the LTA applications received in Southern Region. CTU informed that about 4200 MW LTA has been granted from SR to NEW grid with availability of Transmission System for Evacuation of Power from various REZ's in SR and System Strengthening in WR (Reconductoring of Kolhapur (PG) – Kolhapur (MSETCL) 400kV D/c line. Further, additional LTA applications of 620 MW has been received in the month of November 2021.

Representative from APTRANSCO agreed for the proposal. On a specific query from TSTRANSCO, it was clarified that the Import capability of Southern region shall not be hampered and instead the same shall be enhanced with addition of the proposed inter-regional link. TSTRANSCO agreed for the proposal and requested for impact on ATC to be included along with the analysis. CTU further informed that the link shall be taken into consideration for calculation of TTC/ATC once the proposal is approved. APTRANSCO and TSTRANSCO agreed for the proposal.

Representative from KPTCL stated that they need some time for studying the proposals and to submit their comments on the shared study files, however the proposal is agreeable in-principally and comments/observations if any, shall be forwarded separately.

Representative from KSEB found the proposal generally in-order and agreed for the same. However, in case of any specific comments/observations, same shall be submitted separately.

Representative from SRPC stated that the proposal is in-principally agreeable.

CEA stated that creation of Jejuri may be feasible only with consent of MSETCL. In case MSETCL does not agree to the LILO at Jejuri, the direct link viz. Narendra (New)-Pune

765kV D/C may be considered. Upon enquiry from CEA regarding whether the generation in Southern Region can be consumed within the region, CTU stated that export of power from SR is being visualized in present time-frame itself and the same is expected to only increase upon commissioning of more RE generation in Southern Region.

In view of the above deliberations, the following two alternatives were found to be technically in order:

- i) Narendra(New) – Pune (GIS) 765kV D/c line(Alternative-VII)
- ii) Narendra(New) – Jejuri – Pune (GIS) 765kV D/c line wherein a new S/s at Jejuri was proposed for improved reliability and for mitigating low voltage issues in Jejuri and adjoining areas.(Alternative V)

The merits of the above two alternatives over total 7 nos. alternatives studied in the meeting were observed as below:

- Power flows are generally in order
- Fault level at Narendra(New) is well within its design limits
- Four Nos. of 765/400kV, 1X1500MVA ICTs at Narendra (New) S/s are required (as against 5x1500MVA ICTs required in some of the other alternatives).
- System losses are also low as this alternative results in direct feed of power from generation pockets in SR to load centres in WR
- The alternative of LILO of Narendra(New) – Pune 765kV D/c line at Jejuri improves reliability of power supply as well as leads to improvement in voltage profile of Jejuri and adjoining areas.

It was clarified that the scheme is basically Narendra(New) – Pune (GIS) 765kV D/c line with LILO at Jejuri which is envisaged for increased reliability of power supply and for improvement of voltage profile at Jejuri and adjoining areas. In case MSETCL does not presently require the LILO, the alternative of Narendra(New) – Pune (GIS) 765kV D/c line would be confirmed and LILO at a suitable location as per requirements of MSETCL would be planned in future as a separate scheme.

The matter was further deliberated and MSETCL stated that they are agreeable for both the proposals. However, they agreed to the alternative involving LILO at Jejuri considering the merits and also agreed principally for Jejuri–Jejuri (MSETCL) 400kV D/c interconnection. MSETCL further stated that they would be seeking approval of their higher management in respect of the LILO and interconnection with MSETCL network but are otherwise in agreement with the rest of the proposal, viz. Narendra(New)-Pune(GIS) 765kV D/c line.

After deliberations in the Joint Study meeting, Alternative-V (Establishment of 2X1500MVA, 765/400 kV Jejuri S/s, Narendra New – Jejuri 765kV D/c line , Jejuri 765kV – Pune (PG) GIS D/c line & Jejuri – Jejuri (MSETCL) 400kV D/c line) was technically **agreed in-principle** by all constituents with implementation time-frame of **18 months** from date of allocation to implementing agency / SPV Transfer (as the case may be).

It was further concluded that MSETCL would confirm regarding approval of higher management w.r.t LILO at Jejuri and interconnection with MSETCL.

However, in the 2nd Consultation Meeting for Evolving Transmission Schemes (CMETS) in Western Region was held on 28.12.2021, MSETCL stated that they are yet to obtain approval of higher management. MSETCL added that barring the LILO at Jejuri and interconnection with MSETCL, they in agreement with the rest of the proposal, viz.765kV Narendra(New)-Pune D/c line.

CTU stated that the subject scheme is required on urgent basis considering the export requirement from SR under high RE scenario as well as to mitigate operational constraints being faced w.r.t line loadings of Kolhapur – Kolhapur(MSETCL) 400kV D/c line in real-time. MSETCL was requested to expedite approval from higher management and confirm regarding 400kV interconnection(s) from the proposed 765/400kV Jejuri S/s within 2 weeks of the meeting. MSETCL agreed for the same.

Subsequently, MSETCL vide e-mail dated 11.01.2022 informed that at present MSETCL does not require any 400 kV bays from the proposed 765/400 kV Jejuri (PG) S/s.

It may be noted that during the joint study meeting, the alternative of direct interconnection of Narendra(New) with Pune(GIS) through 765kV D/c line was found to be technically in order. However, in order to address low voltage issue as well as for improved supply reliability for Jejuri and adjoining areas, it was suggested that Maharashtra may be given an additional feed at Jejuri, vide LILO of the above line and establishment of a new ISTS Substation at Jejuri. However, since 400kV outlets from the proposed Jejuri S/s are now not required by MSETCL, it was agreed that the same shall be dropped and instead of Narendra(New) – Jejuri – Pune(GIS) 765kV D/c corridor, the Narendra(New) – Pune(GIS) 765kV D/c line shall be implemented under above scheme with implementation time-frame of **18 months** from date of allocation to implementing agency / SPV Transfer (as the case may be).

In view of the above, the details of the finally agreed scheme (Alternative-VII) are given below:

**ISTS Network Expansion scheme between Western Region & Southern Region for export of surplus power during high RE scenario in Southern Region**

| <b>Sl. No.</b> | <b>Scope of the Transmission Scheme</b>   | <b>Capacity /km</b>   |
|----------------|---|---|
| 1.             | Narendra New (GIS) – Pune(GIS) 765kV D/c line with 1x330MVAr switchable line reactor on each ckt at both ends | 340 km<br>765 kV line bays -2 (GIS) (at Narendra New)<br>765 kV line bays -2 (GIS) (at Pune)<br>765 kV, 330 MVAr SLR – 2 nos (7 X 110 MVAr incl. 1 switchable spare unit) at Pune |

| <b>Sl. No.</b> | <b>Scope of the Transmission Scheme</b>  | <b>Capacity /km</b>  |
|----------------|--|--|
|                |  | 765 kV, 330 MVA SLR – 2 nos (6 X 110 MVA) at Narendra (New)  |
| <b>2.</b>      | Upgradation of Narendra (New) (GIS) to its rated voltage of 765 kV level alongwith 4x1500 MVA transformer and 2x330 MVA Bus Reactor. | 765/400 kV, 1500 MVA- 4 no. (13 X 500 MVA incl. 1 spare unit)<br>765 kV ICT bays- 4 nos.(GIS)<br>400 kV ICT bays- 2 nos.(GIS)^<br>765 kV, 330 MVA BR – 2 nos. (7 X 110 MVA inc. 1 switchable spare unit to be used for both bus/line reactors)<br>765 kV Bus Reactor bays – 2 nos. (GIS) |

*\*Narendra (New)(GIS) - Kolhapur 765kV D/c line to be kept charged at 400kV level*

*^Two nos. equipped 400kV bays (opposite Koppal line bays) under implementation under TBCB route (Koppal WEZ scheme) to be utilised for 400kV side of 2 nos. 765/400kV Transformers*

The Narendra New (GIS) – Pune 765kV D/c line may be LILLOed in future at a suitable location as per requirement of MSETCL.

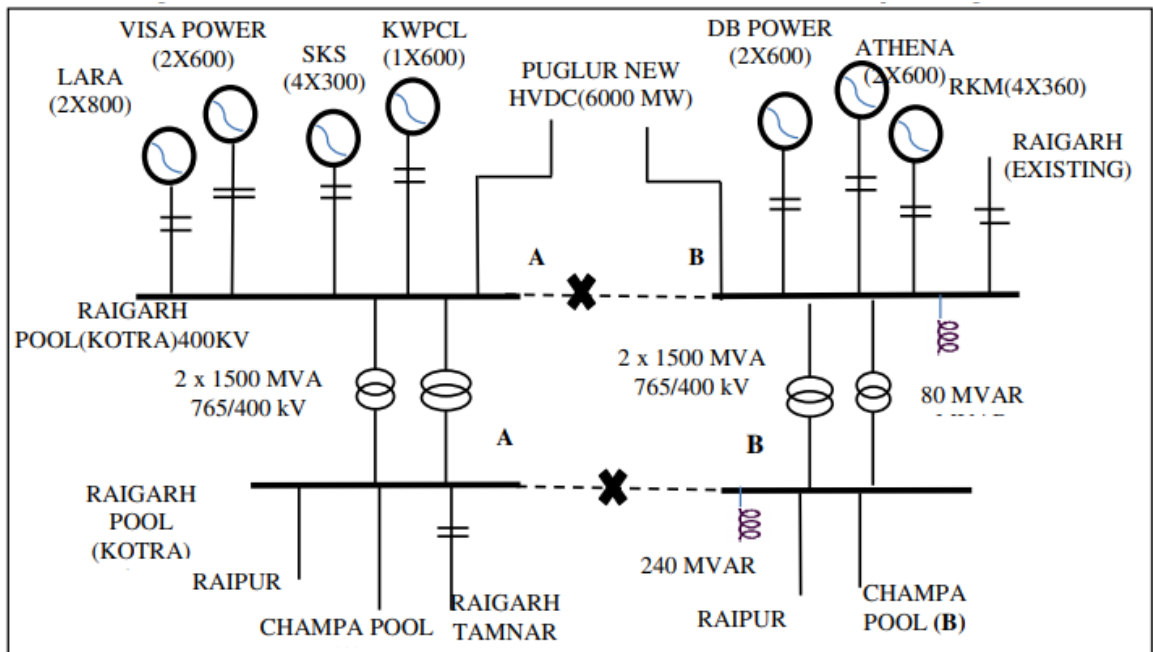
Study exhibits are enclosed at Annexure-V.

## **B. Constraints at Raigarh (Kotra) under various operating conditions**

### **i. Background:**

CTU representative informed that in order to contain high fault level at 765/400 kV Raigarh (Kotra) PS due to large number of thermal generating units expected to be connected in the vicinity of Raigarh (Kotra), bus split arrangement at 400 kV and 765kV at Raigarh (Kotra) PS was agreed in the 39<sup>th</sup> Standing Committee Meeting of Western Region held on 30<sup>th</sup> Nov 2015. Raigarh Pool (Kotra) to Raigarh (Existing) 400 kV D/c line was also agreed to be operated as normally open and may be switched on as per operational requirement of grid.

Schematic of the splitting arrangement at Raigarh (Kotra) PS is shown below:



At present, some of the generating stations planned to be connected at Raigarh PS viz., Athena Power (2x600 MW – Bus Section-B) and Visa Power (2X600 MW – Bus Section-A) have been abandoned and are unlikely to come up in the future.

It was informed that  $\pm 800$ kV, 6000 MW HVDC Raigarh-Pugalur link between Western region and Southern Region has the provision to operate in reverse mode with 3000MW power order. However, the splitting arrangement was proposed considering WR as surplus and SR as deficit region.

In view of the above, following issues are observed:

- a. With HVDC operating under blocked mode or reverse mode during high renewable generation in southern region and high generation at Raigarh (Kotra) PS, 2x1500 MVA, 765/400 kV ICTs at Raigarh PS Bus sections (A & B) may become N-1 non compliant.
- b. With HVDC operating under forward mode and under low generation at either of the buses, 2x1500 MVA, 765/400 kV ICTs at Raigarh PS Bus sections (A & B) may become N-1 non compliant

It was further informed that the matter at (a) above (reversal mode) was deliberated in 1<sup>st</sup> SRPC (TP) meeting held on 16.12.2019, wherein, SR constituents insisted on a tangible plan to bring the Raigarh-Pugalur-Trissur HVDC corridor in to beneficial use so as to avoid the up-gradation of the existing ISTS corridors. Further, the matter was also deliberated in 38<sup>th</sup> SRPC meeting held on 23.12.2020, wherein, SR constituents expressed concern on beneficial utilization of the HVDC Raigarh (Chhatisgarh)-Pugalur (TN)-Trissur (KER) corridor in view of present surplus scenario and optimistic RE capacity addition projections in SR. SRLDC stated that in view of surplus scenario and optimistic RE capacity addition projections, this HVDC system could also be used for export of power. It was deliberated that Raigarh-Pugalur HVDC system can operate in the reverse mode by minor investment at Raigarh vide augmentation of ICTs.

The issue was also highlighted by WRLDC during the testing of HVDC Raigarh – Pugalur Bipole – II i.e. (Pole- 3 & 4) for which operationalization of the approved bus split arrangement at 400 kV Raigarh (Kotra) PS was required.

The HVDCs can be operated at various power orders during the day as per the grid requirement. Accordingly, operation of Raigarh – Pugalur HVDC in both the directions needs to be facilitated. Considering the above, study has been carried out to identify strengthening requirement beyond Raigarh (Kotra) PS under various operating conditions.

### iii. Deliberations and decisions taken in the meeting

CTU representative briefed the participants that studies have been carried out to evolve a scheme for enabling operation of Raigarh-Pugalur HVDC link in reverse mode from Southern Region to Western Region under high SR export scenario. Important considerations for carrying out the study are enclosed at **Annexure-VI**. Details of the studies are given below and schematic of study results are enclosed at **Annexure-VII**:

- In reverse flow case, in order to make the Raigarh (Kotra) 765/400kV ICTs N-1 compliant on each section, 1x1500MVA ICT is proposed at Section-A and 2x1500MVA ICTs are proposed at Section-B.
- N-1 ICT Flows – Section A: 2x1335MW; Section B: 3x1304MW. Section A ICTs remain N-1 compliant (2x1485MW) [Champa – Kurukshetra Bipole-1 Dispatch of 2000MW has been considered i.r.o the Bus section with which Lara is connected].
- Raigarh (Kotra) (Sec-B) – Champa 765kV S/c line flow of 3900MW is observed under outage of Raigarh (Kotra) (Sec-B) – Raipur Pool 765kV line. Similar flow is observed on Raigarh (Kotra) (Sec-B) – Raipur Pool 765kV line under outage of Raigarh (Kotra) (Sec-B) – Champa 765kV S/c line. However, the thermal limit and angular difference of the lines are within limits. It is proposed that under such outage conditions, the 765kV bus sectionalizer may be kept closed to ensure system reliability till the outage is restored.
- The proposed ICTs shall also help to maintain N-1 compliancy under forward flow case (full dispatch of 6000MW) and under low generation at either of the Raigarh (Kotra) 400kV bus sections
- With the above proposed ICTs on both the sections, fault level at 400kV Section-A is about 45kA and Section-B is about 30kA.

WRLDC representative informed that as per standing committee decision, 400kV bus sectionalizer breakers at Kotra would be opened shortly. However, that would result in constraint in HVDC operation at full capacity and hence two 765/400kV ICTs at Kotra Section-B and one 765/400kV ICT at Section-A may be agreed as mentioned by CTU.

WRLDC further informed that opening of 765kV Bus sectionalizer breaker under the present scenario could be reviewed. He further added that in Chhattisgarh, Pooling stations at Champa, Kotra, Tamnar etc. were planned to evacuate large quantum of power from coal based thermal generating stations but at present only around 50% of

the capacity has been commissioned and the same are also not expected to come up in near future as various projects have got abandoned. Considering the present circumstances, short circuit level at 400kV Kotra is required to be addressed and in future opening of 765kV bus sectionalizer may be reviewed.

CTU informed that Raigarh-Puglur HVDC was planned with bus sectionalizer breakers in open condition at 765kV as well as 400kV level and hence it may not be possible to keep breakers at 765kV level in closed condition as this may require separate studies w.r.t various controller settings at Kotra viz. Sub Synchronous Damping Control (SSDC), Reactive Power Control (RPC), Runback Control/Frequency Control of each Bipole, etc which are designed considering network elements connected at respective AC buses with bus split arrangement.

WRLDC representative informed that the purpose of sectionalizing bus section was to address the issue of high short circuit level but presently with 765kV Bus sectionalizer closed and that at 400kV open, the actual short circuit level at 765kV is much below the design level. He further added that recently opening of 765kV & 400kV Bus sectionalizer breakers at Champa PS had been done to control the SC level. This had resulted in severe high voltage beyond IEGC operating band despite having bus reactors at 765kV & 400kV levels. Further, opening of 765kV bus sectionaliser would lead to less reliability for evacuation of power from 765kV Kotra PS.

On enquiry, CTU informed that under reverse mode of HVDC operation with 3000MW power order in Raigarh-Pugalur HVDC link, in case of tripping of one 765kV line from Section-B, the other circuit would be loaded to around 3900MW and hence during such contingencies, modulation of HVDC link, 765kV bus sectionalizer closing or any other appropriate measures can be taken.

CTU stated that reduction of TTC/ATC by NLDC in WR to SR direction with the operationalization of Bus split arrangement at Raigarh (Kotra) is not agreeable as calculations are not in line with transmission planning criteria and NLDC has considered highly skewed generation dispatches on both the sections.

NLDC representative informed that capacity connected at 400kV Section-A is about 2800MW and that at Section-B about 2640MW and the generation considered while assessing the export TTC/ATC based is based on past generation data only. He added that when generation is below 1500MW in Section-B, ICTs would be N-1 non-compliant when HVDC Raigarh-Puglur Bipole-1 flow from WR to SR is 3000MW. He further, added that generation in Section-A remains between 0-700 MW most of the time, whereas generation in Section-B generation varies and even a minimum of about 500 MW has also been observed. Hence, considering worst credible contingency scenario and based on generation availability, import TTC is being reviewed by NLDC. Generation trend for past one year was also shown to the forum by NLDC.

After discussions, it emerged that Section-A was having no LTA (excluding LARA STPP) whereas Section-B is having LTA of around 1200MW. However, at Section-A 2800MW capacity of thermal generator is connected and at Section-B around 2640MW capacity of thermal generator is connected. Accordingly, ample amount of generations are available on both the sections.

CEA representative stated that under low generation scenario on Section-A and with Bipole flow of 3000MW, opening of Lara-Champa PS 400kV D/c line may also be

explored so that power from Lara STPS is diverted to Section-A. It was informed that the same needs to be taken up with NTPC as it involves opening of Lara-Champa 400kV D/c lines.

It was informed that under low generation scenario on both the buses, if any contingency of ICT occurs then modulation of Champa-kurukshetra HVDC link, closing of 400kV sectionalizer breaker, opening of Lara-Champa 400kV D/c lines or any other appropriate measures can be taken without reduction in import capability of SR. It was also mentioned that with the implementation of proposed ICTs on both the sections, the constraints under import scenario of SR with skewed generation at Raigarh (Kotra) would also be resolved.

Representative from TANGEDGO stated that the Raigarh – Pugalur HVDC link was approved to facilitate power from NEW Grid to SR Grid for a capacity of 6000 MW. However the same may not be utilized as planned in case of reduction of ATC due to operational constraints. In such a situation, the tariff for the subject scheme may not be approved and the same has been raised by TANGEDCO before CERC. It is also requested to clarify whether the reduction in ATC shall be continued until the referred ICT augmentation is implemented.

Towards this, CTU informed that the scenario has entirely changed from the time the transmission system was planned. A number of generators have either been abandoned or have relinquished their LTA. The generation considered by POSOCO is very skewed and may occur very rarely. Further such occurrences may be considered as operational matter and shall be dealt accordingly. In view of the above, CTU clarified ATC/TTC is not being reduced. The Raigarh – Pugalur HVDC link shall be utilized for 6000 MW; however in case any constraints are observed in export of power to Southern Region, interim measures like modulation of Champa-kurukshetra HVDC link, closing of 400kV sectionalizer breaker, opening of Lara-Champa 400kV D/c lines or any other appropriate measures shall be implemented to ensure the same.

After discussions it was decided that review of opening of bus sectionalizer breakers at 765kV & 400kV Kotra PS would be studied separately amongst CEA, CTU & POSOCO along with PGCIL if required as it is an operational issue.

After deliberations, the following transmission system augmentation was agreed under ISTS with implementation time-frame of 12 months from date of allocation to implementing agency:

#### **Western Region Expansion Scheme-XXV (WRES-XXV)**

- Augmentation of transformation capacity at Raigarh(Kotra) by 1x1500MVA, 765/400kV ICT at Section-A (3rd ICT on Section A) and by 2x1500MVA, 765/400kV ICTs at Section-B (3rd & 4th ICTs on Section B) along with associated ICT bays.

## List of Participants

| Name                   | Organization                  | Designation                               |
|------------------------|-------------------------------|---|
| Vikas Sachan           | Central Electricity Authority | Deputy Director                           |
| J Ganesh Rao           | Central Electricity Authority | Deputy Director                           |
| N S MALINI             | SRPC                          | Executive Engineer                        |
| Pushpa Seshadri        | WRLDC, POSOCO                 | General Manager                           |
| Pradeep Kumar Sanodiya | WRLDC, POSOCO                 | Manager                                   |
| M Venkateswara Rao     | WRLDC, POSOCO                 | Dy. Manager                               |
| Priyam Jain            | NLDC, POSOCO                  | Manager                                   |
| Prabhankar Porwal      | NLDC, POSOCO                  | Dy. Manager                               |
| Goodelli Madhukar      | SRLDC, POSOCO                 | DGM                                       |
| Sanjeev Bhole          | MSETCL                        | CE (STU)                                  |
| Deepak Rokade          | MSETCL                        | Consultant                                |
| Dipak Patel            | GETCO                         | SE (GETCO)                                |
| M. Sheshagiri          | TSTRANSCO                     | Divisional Engineer/<br>System Studies-II |
| G Ramesh Kumar         | TANGEDCO                      | EE, System Studies                        |
| T Sumathi              | TANGEDCO                      | EE, System Studies                        |
| G Rammohan             | APTRANSCO                     | AEE                                       |
| Vishwanath Naik        | KPTCL                         | CE, Planning                              |
| Gayatri Kulkarni       | KPTCL                         | EE, Power System<br>Studies               |
| Meetha Jadav           | KPTCL                         | AEE, Power System<br>Studies              |
| Anu.S.Ramesh           | SLDC, Kerala                  | AE  |
| P.S. Das               | CTUIL                         | Sr GM                                     |
| Anil Kr. Meena         | CTUIL                         | Sr DGM                                    |
| Bhaskar Wagh           | CTUIL                         | Ch. Manager                               |
| Ajay Dahiya            | CTUIL                         | Ch. Manager                               |
| Pratyush Singh         | CTUIL                         | Manager                                   |
| Ankush Patel           | CTUIL                         | Manager                                   |
| Shashank Shekhar       | CTUIL                         | Dy. Manager                               |
| Ajay Kumar             | CTUIL                         | Engineer                                  |



पावर सिस्टम ऑपरेशन कॉर्पोरेशन लिमिटेड  
(भारत सरकार उद्यम)  
**POWER SYSTEM OPERATION CORPORATION LIMITED**  
(A Government of India Enterprise)



केन्द्रीय कार्यालय : 61, आई एफ सी आई टावर, 8 एवं 9वीं मंजिल, नेहरू प्लेस, नई दिल्ली-110019  
Corporate Office : 61, IFCI Tower, 8 & 9th Floor, Nehru Place, New Delhi - 110019  
CIN : U40105DL2009GOI188682, Website : www.posoco.in, E-mail : posococc@posoco.in, Tel.: 011-40234672

संदर्भ: NLDC/SO/CEA/RPC/KLHR/

दिनांक: 02<sup>nd</sup> Feb 2021

To,

|   |   |
|---|---|
| <p><b>Member Secretary</b><br/><b>Southern Regional Power Committee</b><br/>152, Madhava Nagar, Gandhi Nagar,<br/>Bengaluru, Karnataka 560001</p> | <p><b>Member Secretary</b><br/><b>Western Regional Power Committee</b><br/>M.I.D.C. Central Road, Seepz, Andheri East,<br/>Mumbai, Maharashtra 400093</p> |
|---|---|

**विषय:- High Loading of 400 kV Kolhapur (PG) – Kolhapur (MS) D/C lines and Remedial Measures – Regarding**

Sir,

400 kV Kolhapur (PG) – Kolhapur (MS) D/C (twin moose) is an important line on the Southern and Western regional boundary of the Indian grid (network diagram enclosed at **Annexure-I**). The line connects southern Maharashtra area in the Western Region with Kudgi TPS (3x800 MW) in the Southern Region and is also important for connecting the Mapusa (Goa) system with Kolhapur (PG).

The high loading of 400 kV Kolhapur (PG) – Kolhapur (MS) D/C has been highlighted by NLDC/RLDCs through its various Operational Feedbacks as well as in different forums. Recently, during Dec'20 – Jan'21 period, the power flow on this line has been observed to be very high with N-1 compliance issues being faced for significant period (trend enclosed at **Annexure-II**). The high loading on the line during this period may be attributed to multiple factors viz., high generation at Kudgi TPS (after revision in its variable charge), low generation at plants in southern Maharashtra region (Koyana HEP, Jaigad, RGPPL etc.), high load around Kolhapur area, high renewable (solar) generation in southern region etc.

NLDC and RLDCs are undertaking various measures in operations horizon such as reduction in power order of HVDCs towards southern region (Talcher – Kolar, Bhadravati, Raigarh - Pugalur) to the extent possible to relieve the loading of 400 kV Kolhapur (PG) – Kolhapur (MS) D/C. HVDC Raigarh-Pugalur is also being reversed (towards WR) during the high loading period. This reversal of HVDC Raigarh - Pugalur is resulting in another constraint in the form of high loading of 400 kV Lara – Raigarh (twin moose) D/C line especially during low generation at Lara TPS. Similarly, during high generation at Lara TPS, loading of 400 kV Lara – Champa D/C line is observed to be on the higher side. Further, reduction in HVDC B'wati after a certain

extent is getting restricted due to high loading of 400 kV Warora (MS) – Wardha (PG) line (details enclosed at **Annexure-III**).

Apart from above, the additional measures that will significantly help in controlling the loading of 400 kV Kolhapur (PG) – Kolhapur (MS) D/C line in both operational as well as long-term horizon are given below:

- a) Operationalization of 220 kV Kolhapur - Chikodi & 220 kV Mudshingi – Chikodi lines in such a way that Maharashtra load gets fed from Karnataka. This will significantly relieve the loading of 400 kV Kolhapur (MS) – Kolhapur (PG) D/C. Therefore, operationalization of these lines may be taken up with the concerned states on priority. Some load rearrangement by MSETCL might be required to keep loading of these 220 kV line within limits.
- b) Bypassing of 400 kV Koradi II - Wardha (PG) line and 400 kV Wardha (PG) – Warora line at Wardha (PG) (forming 400 kV Koradi II – Warora 400 kV line) is already approved in 41<sup>st</sup> WR SCM meeting (minutes enclosed at **Annexure- IV**). Operationalization of this bypass arrangement on priority basis may be ensured to address the high loading constraint on 400 kV Warora (MS) - Wardha (PG) line during reversal of HVDC Bhadrawati.
- c) Restoration of 400 kV Solapur – Karad line (MSETCL) which is under outage since Nov 2017 (subsequently some portion of this line has been utilized for 220 kV Solapur-Jeuri line) will also help in relieving the loading of 400 kV Kolhapur (MS) – Kolhapur (PG) D/C. The early restoration of this line may therefore be taken up with concerned agencies.
- d) The possibility of increase in generation in the Southern/Western Maharashtra and reduction in Southern Region to address the high loading issue on 400 kV Kolhapur (MS) – Kolhapur (PG) D/C may be explored. Similarly, possibility of network reconfiguration which might help in addressing the constraint may also be explored in consultation with concerned states.
- e) The operation of HVDC Raigarh – Pugalur in reverse direction (towards WR) poses constraint of high loading of 400 kV Lara – Raigarh (twin moose) D/C line especially under high generation at Raigarh PS and low generation at Lara TPS. The addressal of this also needs to be discussed and requisite actions need to be initiated accordingly.
- f) Following system upgradation scheme has already been agreed in joint study meeting between CEA, CTU and POSOCO. Same was also put up for approval in 2<sup>nd</sup> SRPC (TP) meeting held on 01<sup>st</sup> Oct 2020.

- Reconductoring of 400 kV Kolhapur (PG) - Kolhapur (MS) D/C
- Construction of 765 kV Kolhapur (PG) -Pune (GIS) D/C

The scheme however could not be discussed and finalized in the meeting.

Further, the power flow on Western Maharashtra Axis is observed to be on the higher side during morning hours with the flow crossing 7000 MW on some occasions (details enclosed at **Annexure – V**).

Outlets to either Pune or Padghe from Kolhapur (PG) as mentioned above will provide additional connectivity to western Maharashtra area from southern region and will significantly enhance the reliability of the power supply in this area. Therefore, the approval and implementation of the proposed scheme can be taken up.

The availability of 400 kV Kolhapur (PG) – Kolhapur (MS) D/C line is critical for reliable power supply to Goa, southern Maharashtra (Kolhapur area) region as well as for safe evacuation of power from Kudgi TPS. With increase in renewable energy penetration in southern region, the loading of this line is expected to increase further. As the outage of this line could result in a large disturbance in Kolhapur area, it is of utmost importance that the issues are taken up at the earliest.

In view of above, it is requested to kindly take up these issues with all the concerned for implementation of above-mentioned measures.

Thanking you,

Yours Sincerely,



(Debasis De)

Executive Director, NLDC

Encl: As above

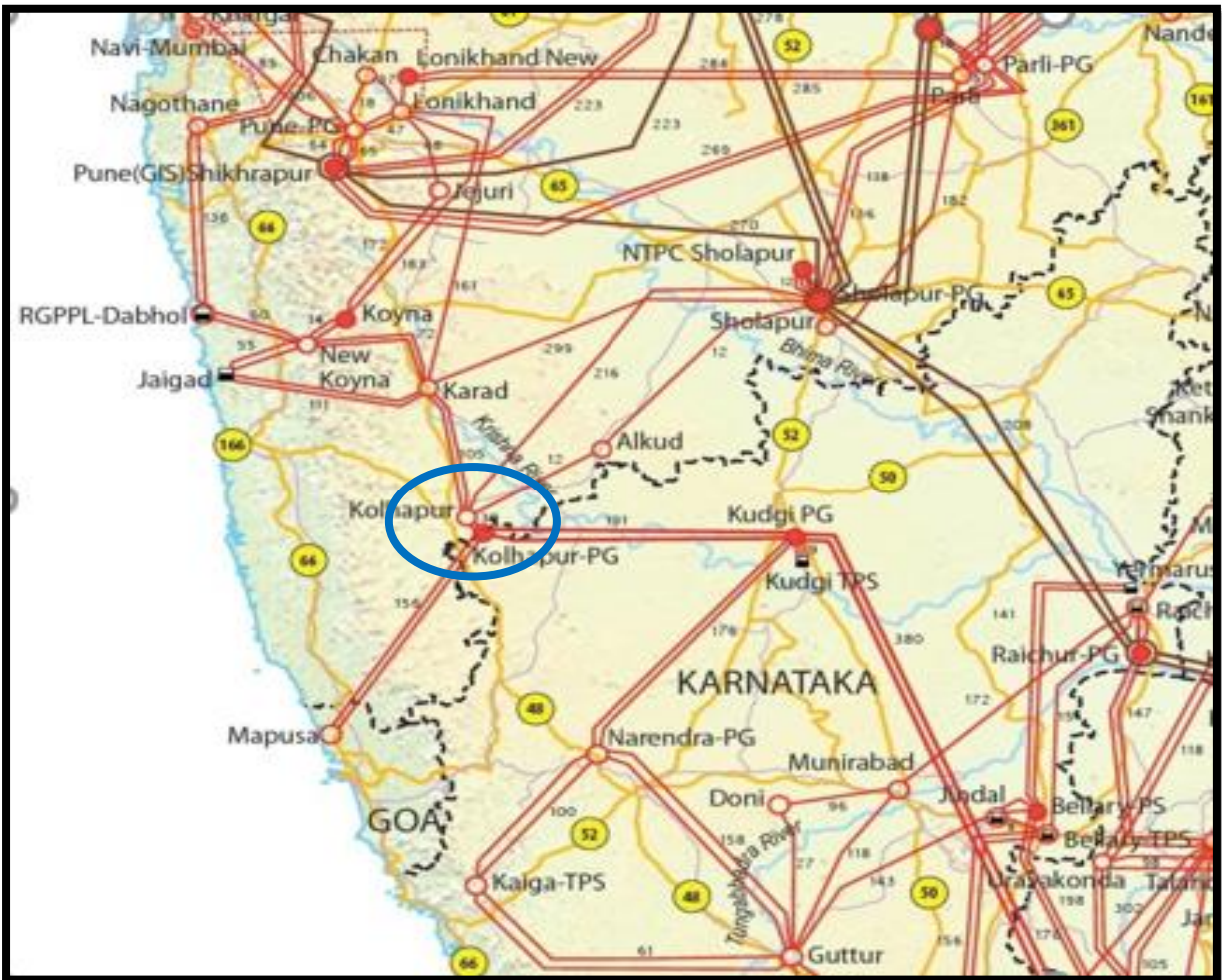
Copy to:

1. Chief Engineer (PSP&A-I) / (PSP&A-II)  
Central Electricity Authority, New Delhi } **with request to further taking up points (e) & (f)**
2. Chief Operating Office (CTU), POWERGRID, Gurgaon
3. Executive Director, WRLDC / SRLDC

# Annexure-I

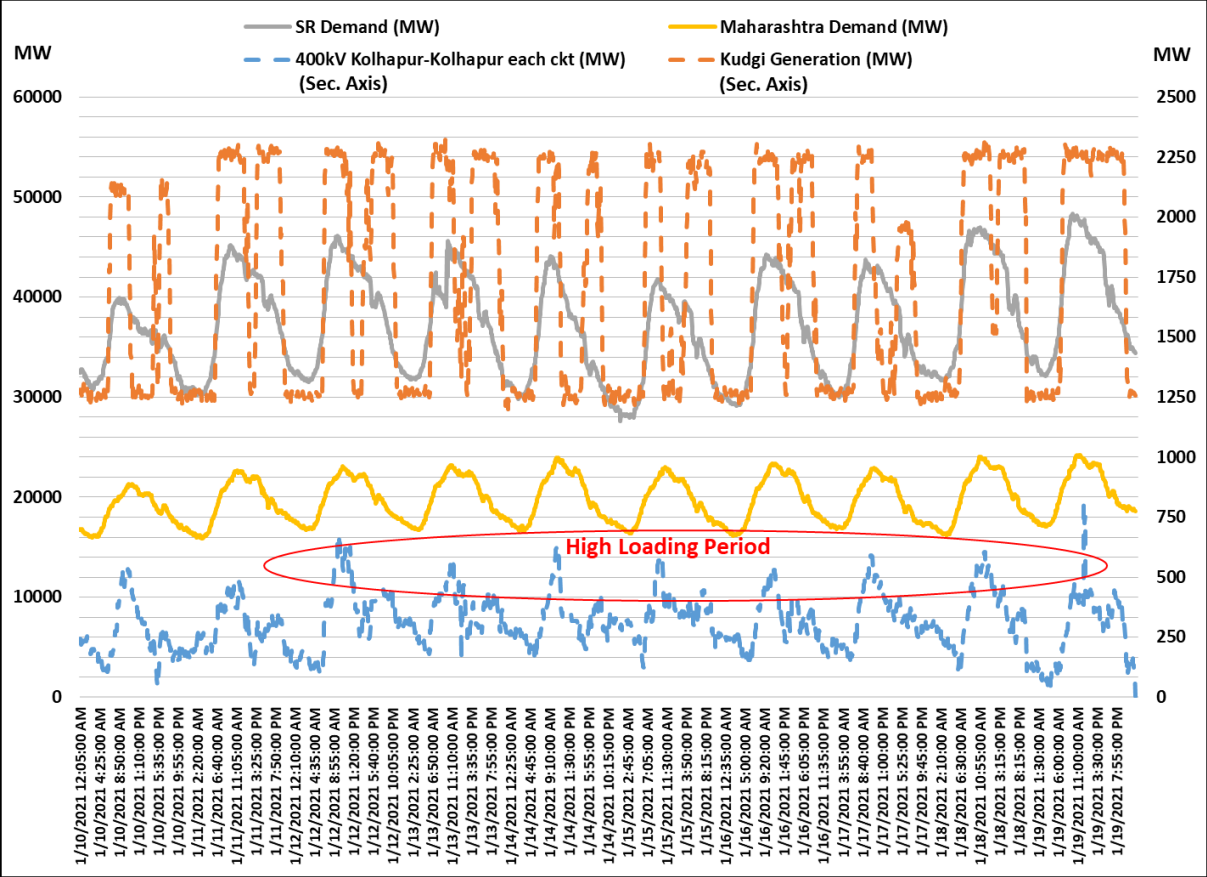
## Network Diagram

### Kolhapur (MS) – Kolhapur (PG) D/C

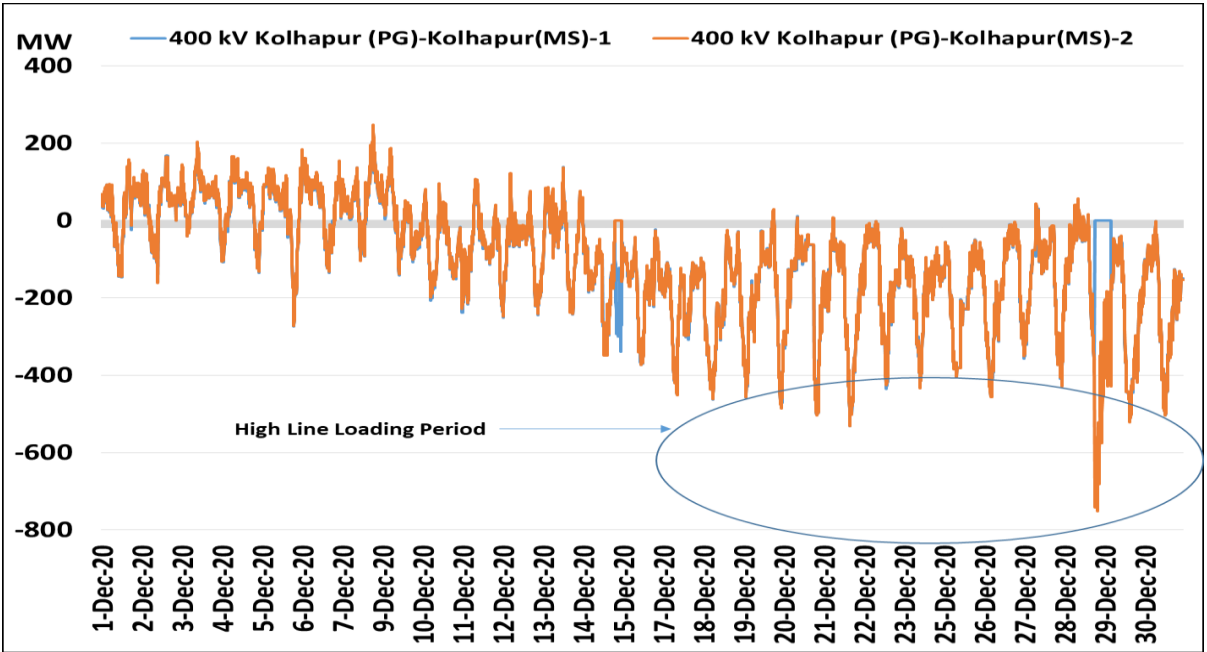


# Annexure-II

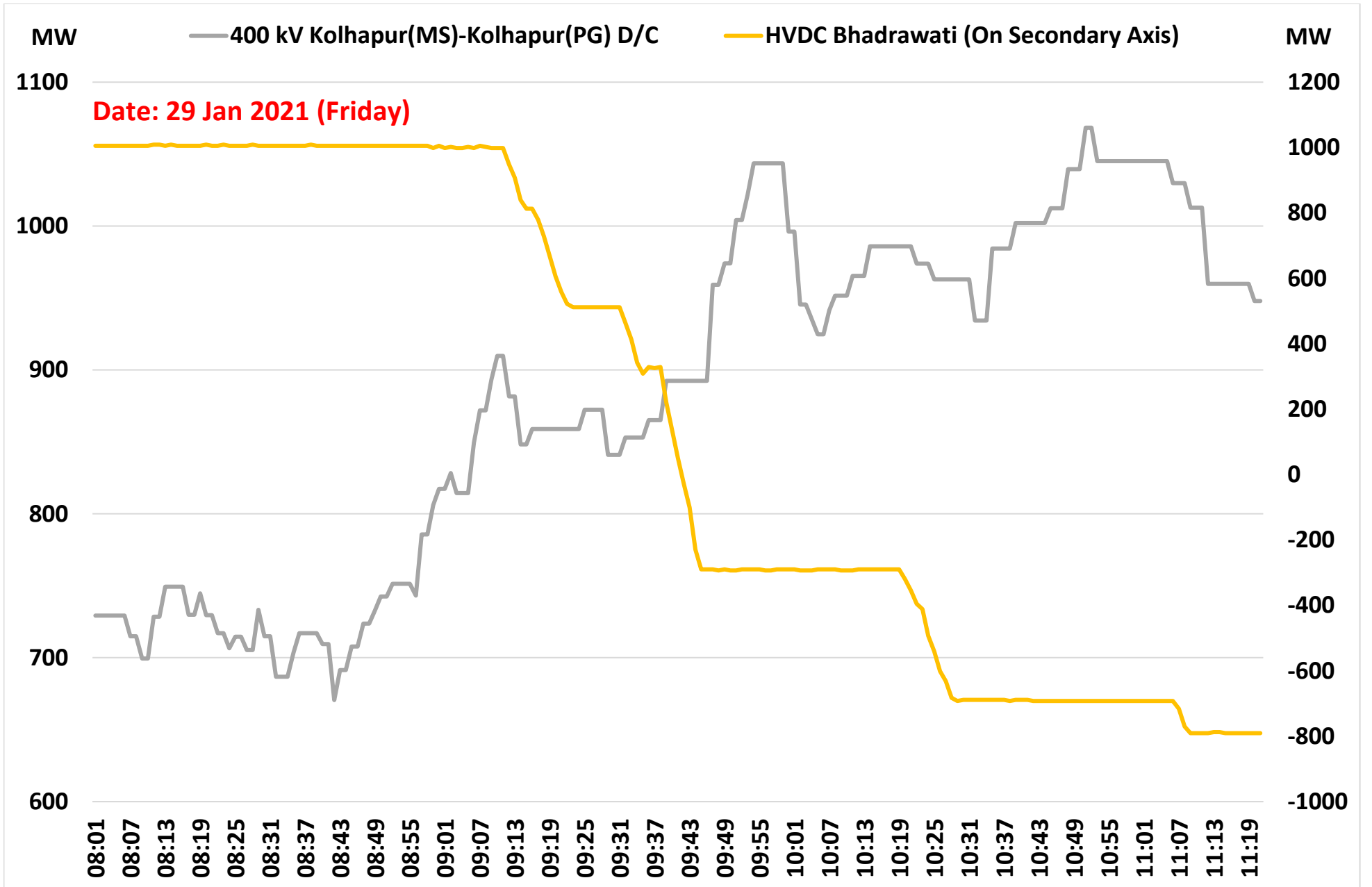
## Line Loading of 400 kV Kolhapur (PG) - Kolhapur (MS) D/C 10<sup>th</sup> Jan 2021 – 19<sup>th</sup> Jan 2021



### Dec 2020

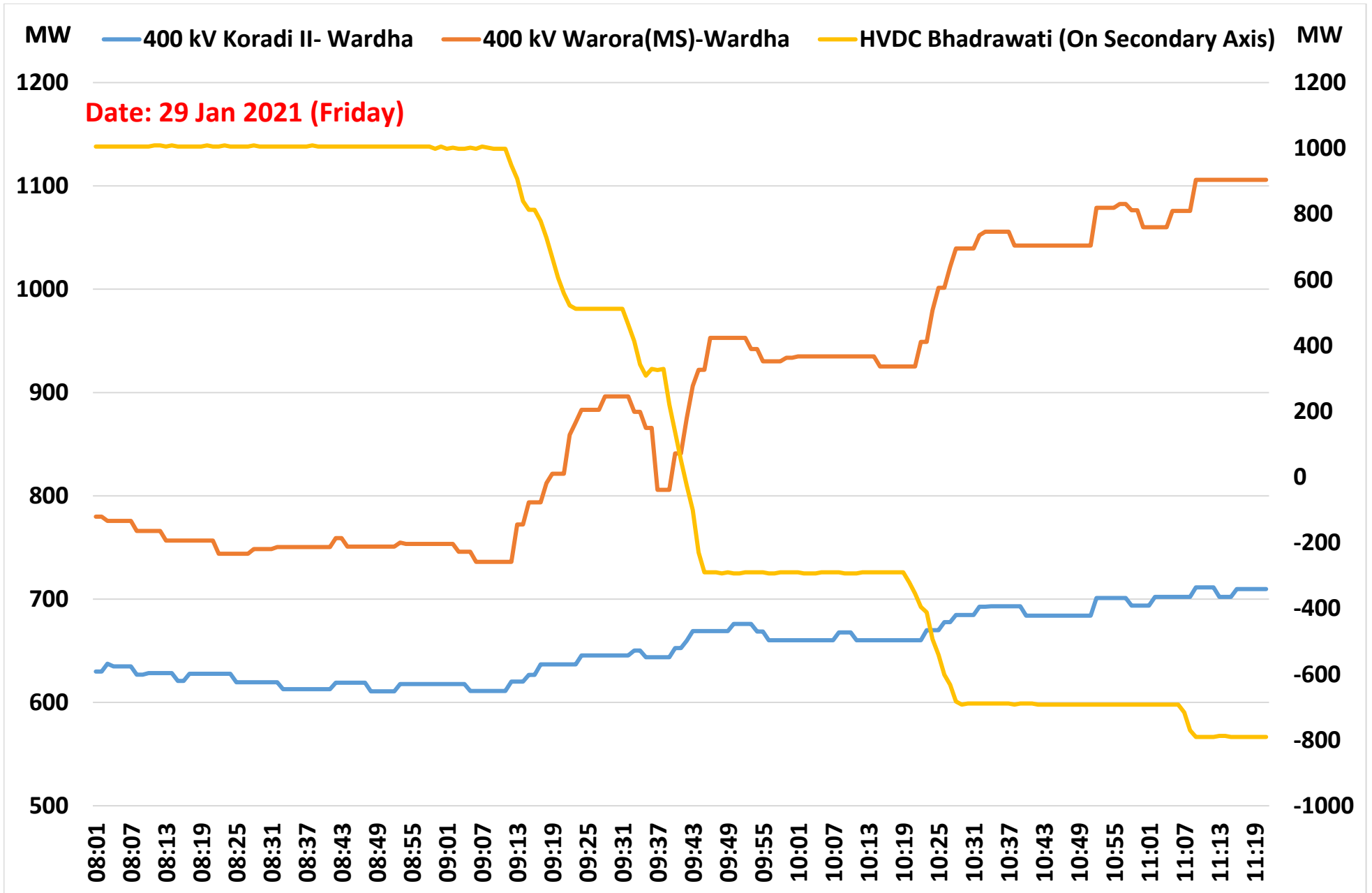


**Line Loading of 400 kV Kolhapur (PG) - Kolhapur (MS) D/C and HVDC Bhadrawati Annexure-III**  
 - 29th Jan 2021



# Line Loading of 400 kV Wardha - Waroda D/C, Koradi-II - Wardha D/C and HVDC Bhadrawati

Annexure-III





भारत सरकार / Government of India  
 विद्युत मंत्रालय / Ministry of Power  
 केन्द्रीय विद्युत प्राधिकरण / Central Electricity Authority  
 विद्युत प्रणाली योजना एवं मूल्यांकन प्रभाग - I  
**Power System Planning & Appraisal Division-I**  
 सेवा भवन आरण केण पुरम नई दिल्ली-110066  
**Sewa Bhawan, R. K. Puram, New Delhi-110066**  
 वेबसाइट / Website: [www.cea.nic.in](http://www.cea.nic.in)



[ISO: 9001:2008]

No. 26/10/2017/PSP&amp;PA-I/92- 106

Date: 16.02.2017

1. The Member (PS), Central Electricity Authority, Sewa Bhawan, R. K. Puram, New Delhi-110066
2. The Member Secretary, Western Regional Power Committee, MIDC Area, Marol, Andheri East, Mumbai Fax 022 28370193
3. The Director (Projects), GCIL, Saudamini, Plot No. 2, Sector-29, Gurgaon-122001 Fax 0124-2571760/2571932
4. Chairman and Managing Director, MPPTCL, Shakti Bhawan, Rampur, Jabalpur-482008 Fax 0761 2664141
5. The Managing Director, CSPTCL, Dangania, Raipur (CG)-492013 Fax 0771 2574246/ 4066566
6. The Managing Director, GETCO, Sardar Patel Vidyut Bhawan, Race Course, Baroda-390007 Fax 0265-2338164
7. Director (Operation), MAHATRANSCO, 'Prakashgad', Plot No.G-9, Bandra-East, Mumbai-400051 Fax 022-26390383/26595258
8. Chief Engineer (Trans), NPCIL, 9S30, VS Bhavan, Anushakti Nagar, Mumbai-400094 Fax 022-25993570
9. The Executive Director (Engg.), NTPC Ltd., Engg. Office Complex, A-8, Sector-24, NOIDA 201301 Fax 0120-2410201/2410211
10. The Chief Engineer, Electricity Department, The Government of Goa, Panaji Fax 0832 2222354
11. Executive Engineer (Projects) UT of Dadra & Nagar Haveli, Department of Electricity, Silvassa Ph. 0260-2642338/2230771
12. Executive Engineer, Administration of Daman & Diu (U.T.), Department of Electricity, Moti Daman-396220 Ph. 0260-2250889, 2254745
13. GM, WRLDC, Plot no F-3, MIDC Area, Marol, Andheri(East) Mumbai-400093 Fax no 022-28235434
14. CEO, POSOCO, B-9, Qutab Institutional Area, Katwaria Sarai, New Delhi-110016 Fax 011-26852747
15. Director (Trans), MoP, Shram Shakti Bhawan, Rafi Marg, New Delhi

**Sub:** Minutes of the 41<sup>st</sup> Standing Committee meeting on Power System Planning of Western Region

**Sir / Madam,**

The minutes of the 41<sup>st</sup> Standing Committee meeting on Power System Planning of Western Region held on 21<sup>st</sup> December 2016 at New Delhi, is available on CEA website ([www.cea.nic.in](http://www.cea.nic.in)) at the following link: <http://www.cea.nic.in/compsplanning.html> (i.e. Home page-Wings-Power Systems-PSP&PA-I - Standing Committee on Power System Planning-Western Region).

Encl: as above

Yours faithfully,

*(Handwritten signature)*

(Ravinder Gupta)

Chief Engineer, PSP&A-I

16/2/17

|    |  |   |                         |  |   |                            |
|----|--|---|-------------------------|--|---|----------------------------|
| 7  | Mapusa (PG)<br>3X315 MVA,<br>400/220         | 2 | Jun/Jul'18<br>(WRSS-16) | Mapusa - Tuem 220 kV<br>D/c  | UC  | No<br>participation        |
| 8  | Satna (PG)<br>1x500MVA,<br>400/220kV         | 2 | Jun/Jul'18<br>(WRSS-16) | LILO of one circuit of<br>Satna (MPPTCL) -<br>Chhatarpur 220 kV line<br>at Satna (PGCIL) 400 kV<br>S/s (3Km) | Targeted to<br>complete by<br>March- 2018 |                            |
| 9  | Vadodara GIS 2 x<br>500 MVA, 400/220<br>kV   | 4 | March –<br>2017         | 220 kV Venkatpura-<br>Vadodara D/C Line<br><br>220 KV Jambua –<br>Vadodara D/C Line                          | Lines<br>planned by<br>GETCO              | Dec, 2017<br><br>Dec, 2018 |
| 10 | Bijawar (TBCB) 2<br>x 500 MVA,<br>400/220 kV | 4 | RfQ stage               | LILO of Tikamgarh –<br>Chhattarpur 220kV D/c<br>line at Bijawar  | To be<br>awarded                          |                            |
| 11 | Navsari 2x315MVA<br>+ 1x500MVA,<br>400/220kV | 2 | May'18                  | Navsari – Bhestan 220kV<br>D/c line  | DGENTPL<br>under TBCB                     | May'18                     |
| 12 | Rewa PS<br>2x500MVA,<br>400/220kV            | 6 | Mar'17                  | Rewa UMSP – Rewa PS<br>220kV 3xD/c line  | UC by Rewa<br>UMSP                        | Mar'17                     |

## 7. Measures to control fault level at Wardha Substation

- 7.1. Director (PSPA-I), CEA stated that the issue of measures to control the fault level at Wardha sub station was discussed in the 40<sup>th</sup> meeting of SCPSPWR held on 01.06.2016, wherein, 400 kV bus splitting scheme through a series reactor to control fault level at Wardha substation was agreed in principle. However, in the studies it was observed that, the short circuit level of 74 kA at Koradi gets reduced to 56 kA with implementation of the bus splitting scheme at Wardha, which was still higher than its design limit of 40 kA. Therefore, it was decided in the 40<sup>th</sup> meeting of SCPSPWR to carry out joint studies by CEA, CTU, POSOCO and MSETCL for limiting the high fault level in Koradi complex.
- 7.2. He added that a joint studies meeting was held on 10.08.2016 among CEA, CTU, POSOCO and MSETCL to discuss issues regarding utilization of Navi Mumbai substation and High fault currents in Koradi complex. In the meeting, it was agreed that MSETCL shall examine the case of high fault current at Koradi (MSETCL) S/s and would evolve feasible alternatives in consultation with CEA, CTU and POSOCO. However, no further communication has been received in this regard from MSETCL.
- 7.3. MSETCL representative informed that presently, 2 no. of 660 MW units of Koradi II have been commissioned. There is a 400/220 ICT at Koradi II S/s, which is connected with Kaulewada S/s through 220 kV D/C line. Koradi II is also connected to Wardha and Warora (through termination of Koradi II - Wardha 400 kV D/C into one ckt of Warora – Wardha 400 kV D/C line - an interim arrangement). Further, Koradi - II would be connected with Koradi III through Koradi II – Koradi III (765/400/ 220 kV) 400 kV

D/C quad line, which is expected to be commissioned by March, 2017. As per the studies carried out by them, with the proposed bus splitting at Wardha, the short circuit level is within the design limit in both cases - with and without the existing interim arrangement. However, with bypassing of Koradi II-Wardha 400 kV D/C line and Wardha (PG) – Warora 400 kV line at Wardha, the 400 kV Koradi II – Warora lines and 220 kV Koradi II – Kaulewada D/C line may be over loaded. Therefore, MSETCL requested to keep the interim arrangement in place till the commissioning of 400 kV Koradi II – Koradi III D/C quad line.

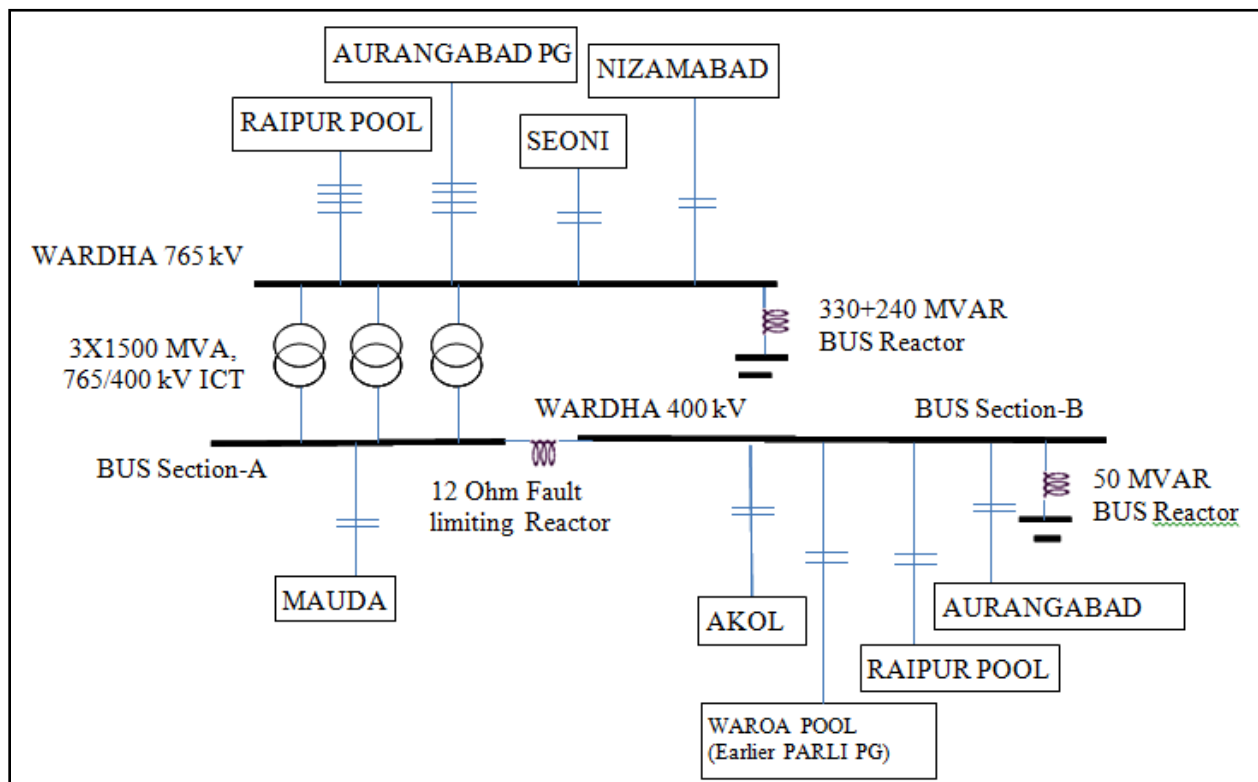
- 7.4. CEA / MSETCL observed that in the bus splitting proposal at Wardha, all the three 765/400 kV ICTs at Wardha and feeder from Mouda are connected to Bus section – A only and bus section B has more no. of outgoing feeders than the incoming feeders. Therefore, one 400 kV outgoing feeder (say, Wardha – Akola 400 kV D/C line) may be kept on section A.
- 7.5. CTU stated the bus splitting proposal at Wardha has been arrived at looking into the physical reconfiguration possibilities at Wardha 765/400 kV substation. However, the suggestion would be looked into.
- 7.6. After further deliberation, it was decided to have a joint meeting of CEA, CTU, POSOCO & MSETCL to discuss the short circuit level at Koradi II and Wardha.
- 7.7. In line with the decision of 41<sup>st</sup> meeting of SCPSPWR held on 21.12.2016, a meeting was held on 13.01.2017 amongst CEA, CTU, POSOCO & MSETCL (minutes enclosed as Annexure-3) at CEA, New Delhi.
- 7.8. Based on the deliberation in the 41<sup>st</sup> meeting of SCPSPWR held on 21.12.2016 and subsequent meeting held on 13.01.2017, the following was agreed:

**A. Scheme to control the fault level at Wardha substation**

- (i) Split of 400 kV Wardha substation into two sections, Section –A and Section-B as per following figure, with necessary switching arrangement.
- (ii) Warora – Koradi II 400 kV (Quad) line [ formed after disconnection of Koradi-II – Wardha 400 kV (Quad) line and connecting it with Warora – Wardha 400 kV (Quad) line at outskirts of Wardha substation]
- (iii) All necessary arrangement for Change in termination of Warora Pool -Wardha 400 kV D/C (Quad) line by disconnecting it from Wardha 400kV BUS Section A and terminating in vacant 400 kV bays of Warora and Koradi II 400 kV (Quad) lines at Wardha 400kV BUS Section B.
- (iv) 12 Ohm fault limiting reactor to connect 400kV BUS Section A and BUS Section B of Wardha 400 kV BUS.

- (v) 2 X 63MVA line reactors at Wardha end of Wardha – Warora Pool 400kV D/c (quad) line to be used as bus reactors at Wardha S/s - section A (by using the two nos. of 400 kV bays which shall be vacant in Wardha Bus Section-A after shifting of Warora pool - Wardha 400 kV D/C line from Section-A to Section-B)
- (vi) Necessary modification at Wardha substation like change of some elements including CTs if those are not designed for 50kA fault level.

*Layout of Wardha 765/400 kV S/s is I type with two main BUS. BUS section A and B of one main BUS will be connected through 12 Ohm fault limiting reactor and BUS Section A and B in second main BUS will remain disconnected.*



**Splitting arrangement at Wardha (PG)**

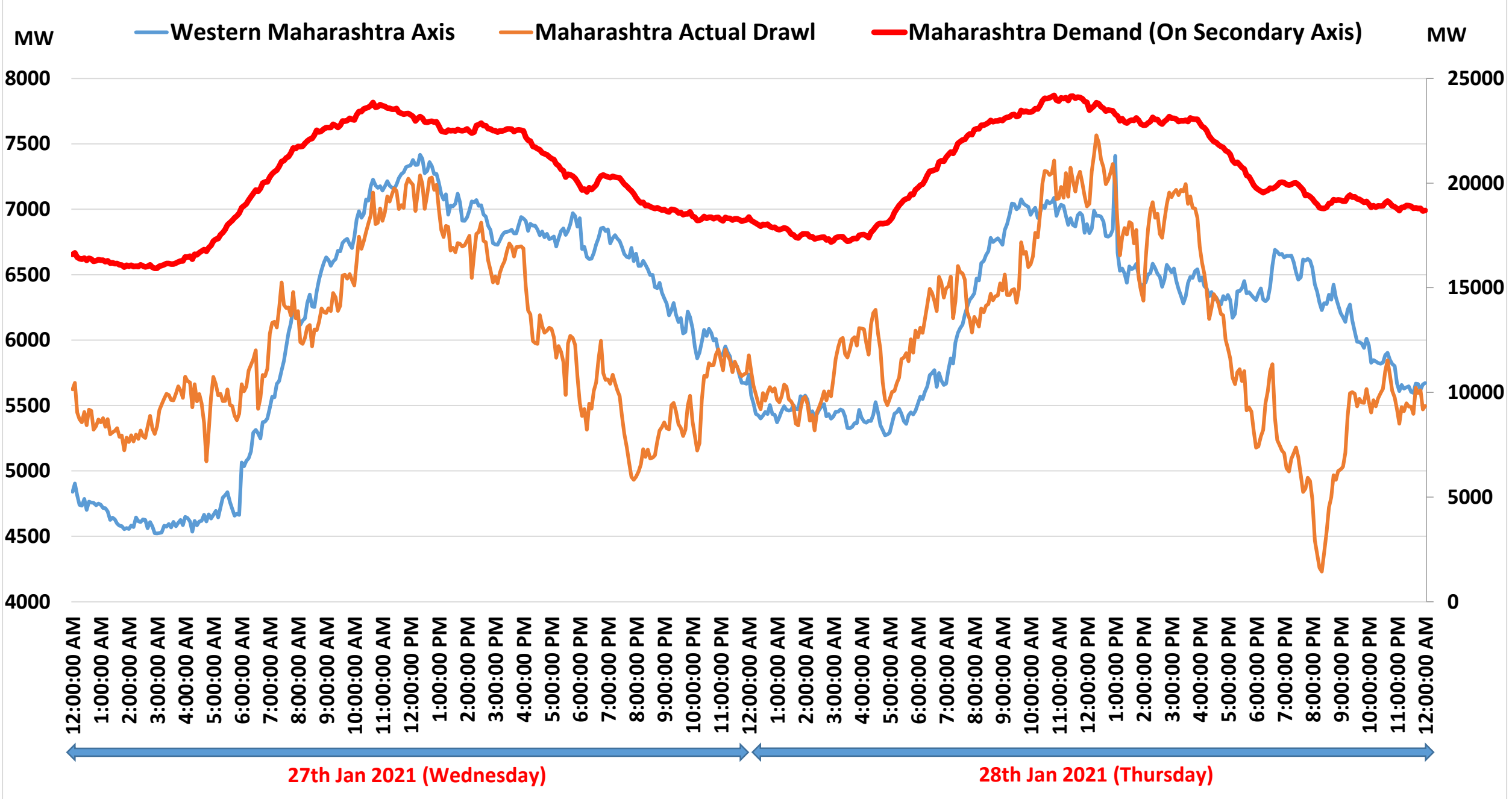
- B.** At present Koradi II - Wardha 400 kV D/C is terminated into one ckt of Warora – Wardha 400 kV D/C line as an interim arrangement (forming Koradi-II – Wardha 400 kV S/C line, Koradi-II – Warora 400 kV S/C line and Warora – Wardha 400 kV S/C line). Removal of the interim arrangement by bypassing of Koradi II- Wardha 400 kV D/C line and Wardha (PG) – Warora 400 kV line at Wardha (forming Koradi II – Warora 400 kV D/C line) would be done after commissioning of Koradi II – Koradi III 400 kV D/C quad line. At present, one ckt of Koradi II – Koradi III 400 kV D/C quad line has already been commissioned & another circuit is expected to be commissioned by March, 2017.

- C. For evacuation of power from Koradi-II generation/ Tiroda generation project, system strengthening was required beyond Warora 400 (MSETCL) substation. MSETCL would finalise the transmission system strengthening beyond Warora and the same would be intimated in the next SCM of WR.

**8. Progress of dedicated transmission lines of IPPs which are connected through interim arrangement**

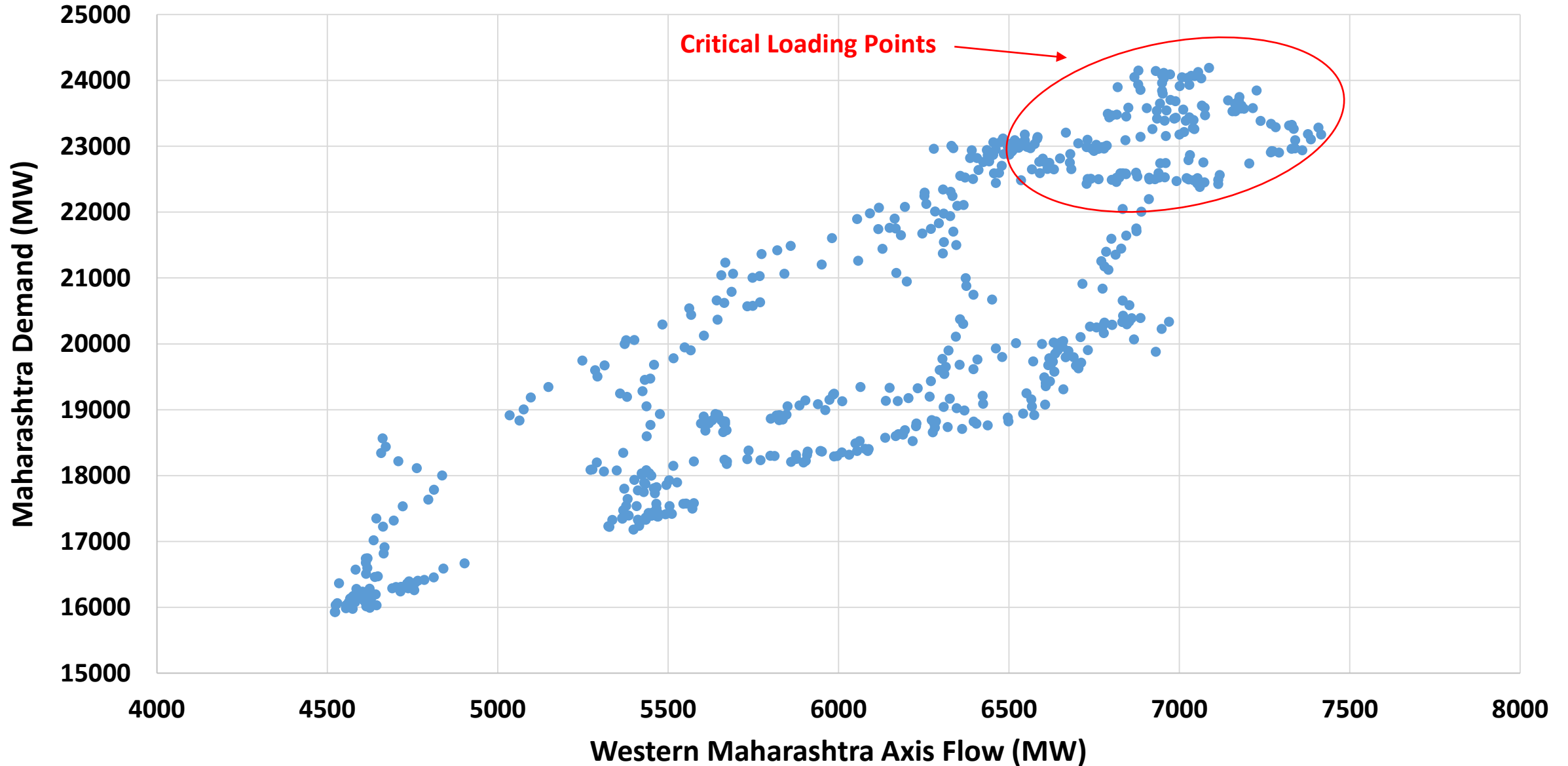
- 8.1. Director (PSPA-I), CEA stated that the progress of dedicated transmission lines of IPPs in Western Region, which were connected through interim arrangement was reviewed in 40<sup>th</sup> meeting of SCMPSPWR held on 01.06. 2016. Subsequently, a meeting was held in CEA on 16.09.2016 to review the status of implementation of the dedicated transmission lines of the IPPs connected through interim arrangement. Out of the six IPPs, four IPPs have already removed their interim arrangement and are connected to the grid through their dedicated transmission system. Only two IPPs namely, Vandana Vidyut Ltd (VVL) and Essar Power M.P. Ltd (EPMPL) are still connected to the grid through their interim arrangement.
- 8.2. Representative of M/s Essar informed that EPMPL is a generating company having generation project of 1200 MW at Mahan, out of which one unit of 600 MW has achieved COD on 29<sup>th</sup> April 2013. The evacuation system of EPMPL, interalia, includes the EPMPL generation switchyard - Bilaspur pooling station 400 kV D/C line, being implemented by Essar Power Transmission Company Limited (EPTCL) as Transmission Licensee. There has been delay in implementation of the EPMPL generation switchyard - Bilaspur pooling station 400 kV D/C line. The transmission line is 337 km in length and has 942 no. of towers. The balance works left as on date is 4 no. of foundations to be completed, 33 no. of towers to be erected, stringing to be done for 140 km. It was stated that due to financial constraints and some issues at site, the works were held up. It is expected that the work would be resumed by Feb, 2017 and expected to complete by Dec, 2017.
- 8.3. Representative of M/s VVL intimated that its 2 x 135 MW has been commissioned in 2014, but they have no PPA. Further due to non-availability of coal, the plant is under forced shutdown from last 24 months. This led to financial crunch, thus the dedicated line couldn't be taken up. It was also informed that M/s VVL is consistently pursuing with its lenders for restructuring of its loan through regular meetings with lenders and it is expected that by March, 2017 the loan would be restructured. After loan restructuring proposal, they would be in a position to give the commitment for completion of their dedicated transmission line. M/s VVL requested their plant to remain connected with the grid through the existing LILO till the completion of their dedicated line.
- 8.4. NLDC informed that even though generating units are not in operation but the generating switchyard of M/s VVL is still connected with ISTS. Also there is no operation & maintenance staff at the generating switchyard. Therefore, from grid safety and security aspects, the LILO may be bypassed from their switchyard to avoid any instance of fault. Further, M/s VVL is drawing some nominal power through this

**Annexure-V**



# Western Maharashtra Axis Flow (MW) vs Maharashtra Demand (MW) for 27th and 28th Jan 2021

Annexure-V



**Important Considerations for the study:**

- Scenario: Solar Max (Jun'24 Afternoon Peak) with high generations in Narendra complex (Kudgi, Raichur, Bellary, Gadag SEZ & Koppal WEZ)
- Out of 18.5 GW potential REZ in SR, only 8 GW (Koppal-2.5 GW, Gadag-2.5 GW, Karur-2.5 GW & Tuticorin-0.5 GW) has been considered. Balance 10.5 GW (Bidar-2.5 GW, Kurnool & Anantapur – 8 GW) has not been considered due to non-availability of land and other issues.
- Out of 7GW REZ potential in Maharashtra, only 1 GW at Kallam has been considered. Further, additional 1 GW at Kallam is under Intra State and balance 5 GW (Wardha – 2.5 GW, Solapur – 2.5 GW) has not been considered due to non-availability of land and other issues.
- All India Demand of 224 GW has been considered and demand for WR & SR is considered as 69 GW & 54 GW respectively as per the Load Generation Balance considered for All India Studies for 2024-25 timeframe, as per the methodology finalized with CEA, CTU and POSOCO.
- For simulating the worst case:
  - 100% Despatch has been considered at Gadag and Koppal REZs (2500MW each)
  - 90% Thermal Despatch has been considered at Kudgi TPS (3x800MW)

**With this, the Net SR Surplus in Solar Max scenario works out to about 5000 MW with SR to WR inter-regional flow to the tune of about 8000 MW. LGB shown at Annexure-I.**

## Alternatives studied:

Table 1: Summary of results for different alternatives

| <u>Name of transmission element</u>                           | <u>Case-I:</u><br>Base case (Kolhapur (PG) – Kolhapur (MH) reconductoring) (MW) | <u>Case-II:</u><br>Case-I + Upgradation of Narendra New – Kolhapur (PG) to 765kV | <u>Case-III:</u><br>Case-II + Kolhapur (PG) – Pune (PG) 765kV D/c line (MW) | <u>Case-IV:</u><br>Case-I + Narendra (New)- Kolhapur 400kV D/c line + Narendra New – Solapur 765kV D/c line | <u>Case-V:</u><br>Case-I + Narendra- Kolhapur (400kV D/c line) + Narendra New – Jejuri (New) 765kV D/c line + Jejuri (New) 765kV – Pune (PG) GIS D/c line + Jejuri (New) – Jejuri (MSETCL) 400kV D/c line# | <u>Case-VI:</u><br>Case-II + Kolhapur – Jejuri (New) 765kV D/c line + Jejuri (New) 765kV – Pune (PG) GIS D/c line + Jejuri (New) – Jejuri (MSETCL) 400kV D/c line | <u>Case-VII :</u><br>Case-I + Narendra (New) – Kolhapur (400kV D/c line) + Narendra New – Pune(GIS) 765kV D/c line |
|---|---|--|---|---|--|---|--|
| Kolhapur(PG) 765/400kV ICTs                                   |   | 2*1463<br>(2540)   | 2*643   | -   |  | 2*614<br>(992)  |  |
| Kolhapur (PG) – Kolhapur(MSETCL) 400kV D/c line               | 2*1453<br>(2521)  | 2*1517<br>(2624)   | 2*762<br>(1242)   | 2*757<br>(1285)   | 2*759<br>(1293)  | 2*727<br>(1182)   | 2*828<br>(1416)  |
| Kolhapur(MSETCL) – Karad 400kV D/c line                       | 2*748<br>(1021)   | 2*838<br>(1081)  | 2*434<br>(595)  | 2*486<br>(678)  | 2*383<br>(529)   | 2*383<br>(520)  | 2*455<br>(634)   |
| Narendra New – Kolhapur(PG) 765kV D/c line (charged at 400kV) | 2*1402<br>(1892)  | -  | -   | 2*742   | 2*757  |   | 2*815  |
| Narendra New – Kolhapur(PG) 765kV D/c line                    | -   | 2*1473<br>(2582)   | 2*2287<br>(3853)@   | -   | -  | 2*2270<br>(3834)  | -  |
| Kolhapur(PG) – Pune(PG) 765kV D/c line (250 km)               | -   | -  | 2*1622<br>(2454)  | -   | -  | -   | -  |

|  |                   |                   |                  |                  |                  |                  |                  |
|--|-------------------|-------------------|------------------|------------------|------------------|------------------|------------------|
| Narendra New – Solapur 765kV D/c line (150 km)             | -                 | -                 | -                | 2*2161<br>(3616) | -                | -                | -                |
| Narendra New 765/400kV ICTs                                | -                 | 2*1473<br>(2563)  | 4*1143<br>(1474) | 4*1080<br>(1376) | 4*987<br>(1269)  | 4*1135<br>(1464) | 4*935<br>(1203)  |
| Narendra New – Madhugiri 765kV D/c line (Charged at 400kV) | 2*854             | 2*837             | 2*556            | 2*359            | 2*424            | 2*564            | 2*437            |
| Narendra New – Xeldem 400kV S/c line                       | 649               | 621               | 507              | 336              | 352              | 503              | 373              |
| Narendra New – Narendra 400kV S/c line                     | 947               | 908               | 505              | 190              | 272              | 512              | 298              |
| Solapur – Raichur 765kV 2xS/c lines                        | -2*862<br>(-1290) | -2*844<br>(-1262) | -2*543           | -2*102           | 2*412            | 2*550            | 2*426            |
| Wardha – Nizamabad 765kV D/c line                          | 2*143             | 2*149             | 2*340            | 2*322            | 2*402            | 2*330            | 2*401            |
| Warora – Warangal 765kV D/c line                           | 2*213             | 2*219             | 2*373            | 2*420            | 2*436            | 2*370            | 2*428            |
| Narendra New – Jejuri (New) 765kV D/c line (280 km)        |                   |                   |                  |                  | 2*1975<br>(3042) | 0                | -                |
| Jejuri (New) - Pune (PG) GIS 765kV D/c line (60 km)        |                   |                   |                  |                  | 2*1295<br>(2304) | 2*1020<br>(1806) | -                |
| Jejuri (New) 765/400kV ICTs                                |                   |                   |                  |                  | 2*657            | 2*599            | -                |
| Jejuri (New) – Jejuri 400kV D/c line                       |                   |                   |                  |                  | 2*657            | 2*599            | -                |
| Kolhapur (PG) - Jejuri (New) 765kV D/c line (250 km)       |                   |                   |                  |                  | -                | 2*1634<br>(2483) | -                |
| Narendra New – Pune (PG) GIS 765kV D/c line (340 km)       |                   |                   |                  |                  |                  |                  | 2*1870<br>(2899) |

\*Raigarh-Pugalur reverse flow of 3000 MW has been considered with proposed 1x1500MVA ICT at Section-A and 2x1500MVA ICTs at Section-B of 400kV Raigarh (Kotra) 765/400kV S/s.

**Table 2: 3-Phase Short Circuit levels in different alternatives**

| <b>Substation Bus</b>  | <b>Case-III :</b>  | <b>Case-IV :</b>  | <b>Case-V :</b>  | <b>Case-VI:</b>   | <b>Case-VII:</b>   |
|------------------------|--|---|--|---|--|
|                        | <b>Case-II + Kolhapur (PG) – Pune (PG) 765kV D/c line (MW)</b> | <b>Case-I + Narendra (New)- Kolhapur 400kV D/c line + Narendra New – Solapur 765kV D/c line</b> | <b>Case-I + Narendra- Kolhapur (400kV D/c line) + Narendra New – Jejuri (New) 765kV D/c line + Jejuri (New) 765kV – Pune (PG) GIS D/c line + Jejuri (New) – Jejuri (MSETCL) 400kV D/c line</b> | <b>Case-II + Kolhapur – Jejuri (New) 765kV D/c line + Jejuri (New) 765kV – Pune (PG) GIS D/c line + Jejuri (New) – Jejuri (MSETCL) 400kV D/c line</b> | <b>Case-I + Narendra (New) - Kolhapur (400kV D/c line) + Narendra New – Pune(GIS) 765kV D/c line</b> |
| Kolhapur(PG) 765kV     | 18.9   | -   | -  | 18.1  | -  |
| Kolhapur(PG) 400kV     | 27.3   | 21  | 20.8   | 26.8  | 20.8   |
| Kolhapur(MSETCL) 400kV | 27   | 24.4  | 24.5   | 27  | 24.3   |
| Pune(PG) 765kV         | 30.3   | 25.9  | 31.2   | 30.9  | 30.1   |
| Pune(PG) 400kV         | 41.4   | 40.1  | 42.1   | 41.7  | 41.6   |
| Solapur 765kV          | 31.6   | 37.4  | 31.7   | 31.6  | 31.8   |
| Solapur 400kV          | 40.2   | 41.4  | 40.2   | 40.2  | 40.2   |
| Narendra New 765kV     | 16.8   | 23.1  | 17.9   | 16.5  | 17.7   |
| Narendra New 400kV     | 37.5   | 47.3  | 42   | 37.1  | 41.7   |
| Jejuri (New) 765kV     | -  | -   | 25.6   | 25.3  | -  |
| Jejuri (New) 400kV     | -  | -   | 31.5   | 31.1  | -  |

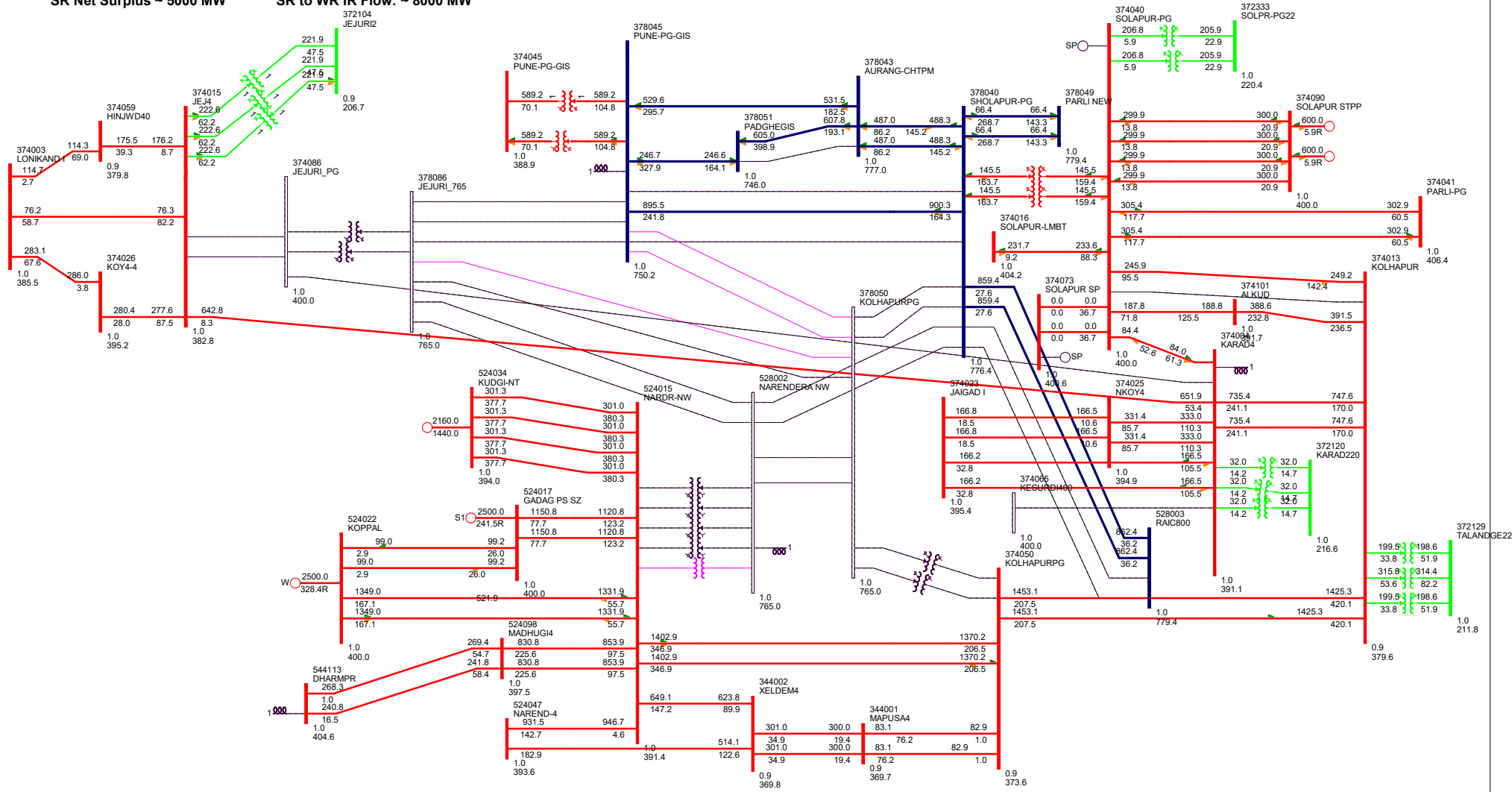
# Annexure-V (under Annexure-VI)

## SR WR strengthening (Scenario 4 Solar Max with high generation in Narendra complex)

### Alternative-1: Base Case

SR Net Surplus ~ 5000 MW

SR to WR IR Flow: ~ 8000 MW





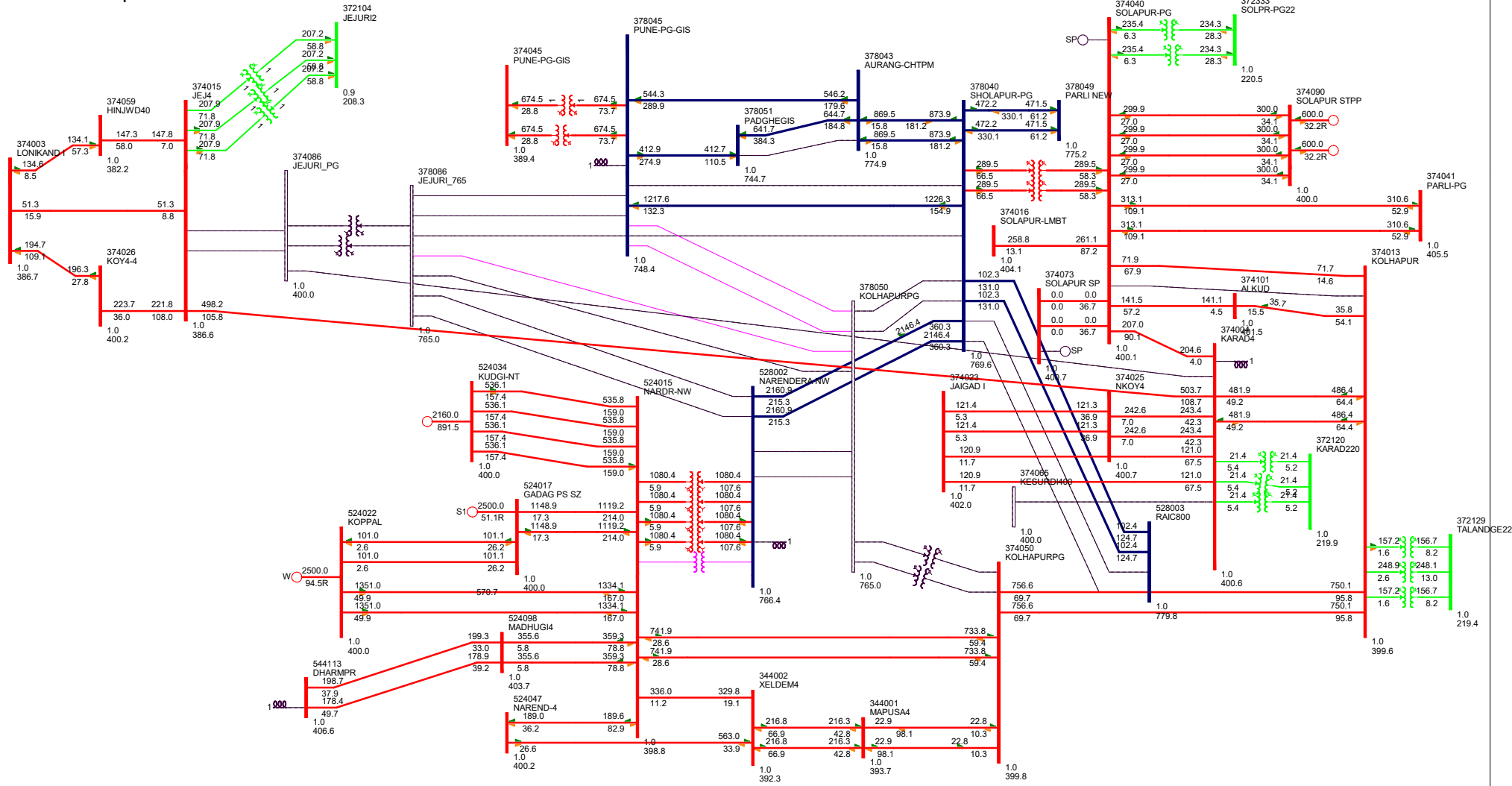


SR WR strengthening (Scenario 4 Solar Max with high generation in Narendra complex)

Alt-4: Narendra New – Solapur 765kV D/c line

SR Net Surplus ~ 5000 MW

SR to WR IR Flow: ~ 8000 MW

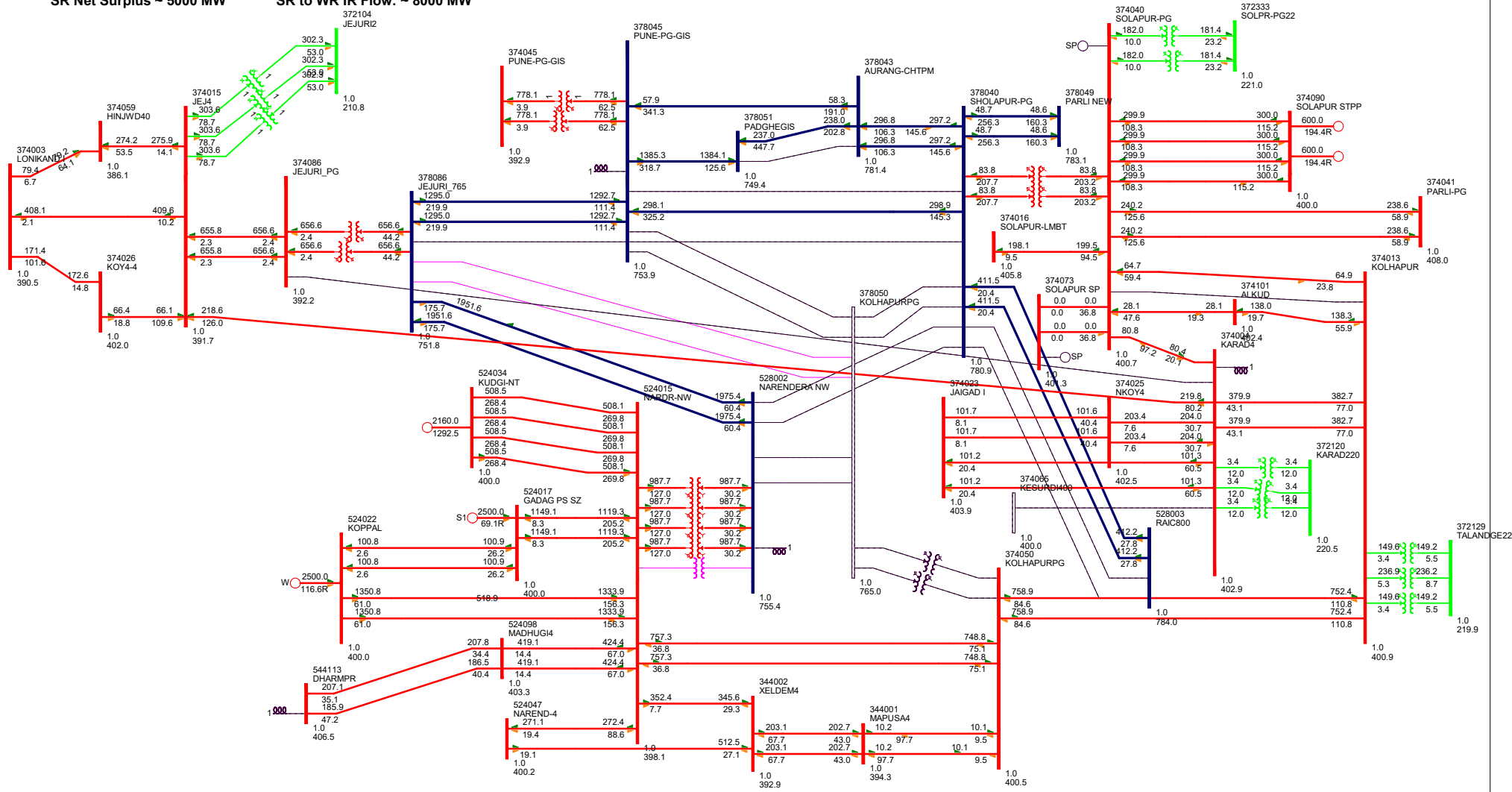


SR WR strengthening (Scenario 4 Solar Max with high generation in Narendra complex)

Alternative-5: Narendra New – Jejuri (New) 765kV D/c line

SR Net Surplus ~ 5000 MW

SR to WR IR Flow: ~ 8000 MW







**Important Considerations for the study:**

- Load-Generation considerations are similar to those considered at (A) (ii) above.
- Full Generation considered from KWPCCL Now (REGL) (600MW), SKS (4x300MW) & NTPC Lara (2x800MW) on Section A and DB Power (2x600MW) & RKM (4x360MW) on Section B.
- Athena Power (2x600 MW– Bus Section-B) and Visa Power (2X600 MW – Bus Section-A) have been abandoned and are unlikely to come up in future. Hence, NIL generation has been considered from these generators.
- For reverse flow case, Reverse flow upto 1500MW per bipole has been considered (i.e. 1500MW reverse flow is getting injected on each 400kV bus section)
- Champa – Kurukshetra HVDC is considered to be on forward mode with dispatch of 4500MW (3000MW on Bipole-1 connected to Lara and 1500MW on Bipole-2 connected to KSK).

Load Flow Results

