I/6773/2019

150 YEARS OF CELEBRATING THE MAHATMA

सत्यमेव जयते

भारत सरकार

Government of India

विद्युत मंत्रालय

Ministry of Power

केन्द्रीय विद्युत प्राधिकरण

Central Electricity Authority

विद्युत प्रणाली योजना एवं मूल्यांकन-I प्रभाग

Power System Planning & Appraisal-I Division

To

-As per list enclosed-

Subject: 5th meeting of Northern Region Standing Committee on Transmission (NRSCT) –Agenda Note

Sir/ Madam,

The agenda note for the 5th meeting of NRSCT scheduled to be held on 13.09.2019 at 10:30 hrs is available on CEA website: www.cea.nic.in (path to access: Home Page - Wing - Power System - PSPA-I - Standing Committee on Power System Planning - Northern Region).

Venue for the meeting will be intimated separetly.

Kindly make it convenient to attend the meeting.

Yours faithfully,

मंजरी 9/9/2019

(Manjari Chaturvedi)
Director

Copy to:

(i) Chairperson, CEA, Sewa Bhawan, New Delhi
(ii) Secretary, MNRE, New Delhi
(iii) Managing Director, SECI, New Delhi

1.	Member Secretary, NRPC, 18-A ShajeedJeet Singh Sansanwal Marg, Katwaria Sarai, New Delhi - 110016 (Fax-011-26865206)	2.	Director (W &P) UPPTCL, Shakti Bhawan Extn,3rd floor, 14, Ashok Marg, Lucknow - 226 001 (Fax:0522-2287822)	3.	Director (Projects) PTCUL, Vidhyut Bhawan, Near ISBT -Crossing, Saharanpur Road, Majra, Dehradun-248002. Uttrakhand
4.	Director (Technical), Punjab State Transmission Corporation Ltd. (PSTCL) Head Office The Mall Patiala -147001	5.	Member (Power) BBMB, Sectot-19 B Madhya Marg, Chandigarh-1 60019 (Fax-01 72-2549857	6.	Director (Operation) Delhi Transco Ltd. Shakti Sadan, Kotla Marg, New Delhi-110002 (Fax-01123234640)
7.	Director (PP&D) RVPN, 3rd Floor, Room no 330, Vidhyut Bhawan, Janpath, Jaipur-302005.	8.	Director (Technical) HVPNL Shakti Bhawan, Sector-6 Panchkula-134109	9.	Director (Technical) HPSEB Ltd. VidutBhawan, Shimla -171004 Fax-0177-2813554
10.	Managing Director, HPPTCL, Barowalias, Khalini Shimla-171002 Fax-0177-2623415	11.	Chief Engineer (Operation) Ministry of Power, UT Secretariat, Sector-9 D Chandigarh -161009 Fax-0172-2637880	12.	Development Commissioner (Power), Power Department, Grid Substation Complex, Janipur, Jammu, Fax: 191-2534284
13.	Director (Projects) POWERGRID Saudamini Plot no. 2, Sector - 29. Gurgaon-122 001 (Fax-0124-2571809)	14.	CEO, POSOCO B-9, Qutab Institutional Area, Katwaria Sarai New Delhi – 110010	15	COO (CTU) POWERGRID, Saudamini, Plot no. 2, Sector -29, Gurgaon-122 001 (Fax-0124-2571809)

Nominated members for NRSCT:

1.	Er Rajesh Gupta, Chief Engineer/ Tranmission Systems, BBMB, BBMB SLDC Complex, 66kV Subsatation , Industrial area Phase –I, Chandigarh-02	2.	Chief Engineer (PP&D), RVPN, 3rdFloor, Room No. 330, Vidyut Bhawan Janpath, Jaipur, Contact No. 0141-2740794 (O) ce.ppm@rvpn.co.in	3.	Director (planning & Contract), Himfed Bhawan, Panjiri Shimla-171005 directorpc@hpptcl.in

Agenda note for 5th Meeting of Northern Region Standing Committee on Transmission

1.0 **Confirmation of the Minutes of the 4th meeting of Northern Region Standing Committee on Transmission held on 25.07.2019.**

1.1 The 4th meeting of Northern Region Standing Committee on Transmission (NRSCT) was held on 25.07.2019 and the minutes of the meeting were issued vide CEA letter no. CEA-PS-11-21(19)/2/2019-PSPA-I Division dated 9.8.2019.

1.2 Subsequently, POSOCO vide its letter NLDC/SO/NRSCT/RE/126 dated 27.8.2019 has forwarded their observations on the Agenda item no 3 of the minutes of the meeting. POSOCO stated that few suggestions provided by POSOCO in context of transmission planning studies of RE has not been incorporated in the minutes.
Accordingly, Para 3.5 (v) of the minutes is modified as follows:
v) *POSOCO stated the following:*

a) SCR of 3 nos of 220kV buses i.e Fatehgarh-II (about 4), Bhadla (aboutt 5) and Bhadla-II (about 5) is low.
b) Hydro despatches considered are low in NR and NER
c) In the planning study case, thermal generation in some of the cheaper pit head plants like Talcher, Sipat, Rihand, Vindhyachal etc. is reduced significantly in the study case while keeping generation at load centre plants like Talwandi Saboo and Dadri TPS on the higher side. Merit order dispatch and PLF may be taken in consideration while reducing the thermal generation in the study cases so as to get a better idea of the probable inter –regional flows and fault levels in 2022 scenario.
d) The LGBR taken in the study case is stated to be of 2022 monsoon daytime period but same is not matching with the typical monsoon period LGBR.
For e.g., high hydro generation is usually observed in the monsoon period but same is found to be very less in the study case. Further, HVDC APD-BNC-AGRA flow has been taken as 1,000 MW only while same is usually more than 2,000 MW in the high hydro season.
e) Network behavior under low RE and other generation scenarios needs to be studied and the results may be shared with all stakeholders.
POSOCO representative also stressed on the need to carry out studies on the all India snapshot with high RE generation in Northern, Western and Southern Region simultaneously (a likely scenario) in order to assess the need for strengthening in other parts of the network and minimize congestion and RE curtailment in future."

1.3 The minutes of 4th meeting of NRSCT along with the modifications mentioned at 1.2 above may please be confirmed.

2.0 Transmission System Strengthening for potential solar energy zones –Phase -II in Northern Region.

2.1 The transmission system strengthening for solar potential of 8.1 GW (**Ramgarh/Kuchheri (1.9 GW), Bikaner (2.95 GW), Bhadla (1.05GW) & Fatehgarh (2.2GW**) was discussed in the 4th meeting of NRSCT held on 25.7.2019, wherein two alternatives were proposed; Alternative 1: with EHVAC system, Alternative 2: with EHVAC and VSC based HVDC system. The details of Alternative 1 and Alternative 2 are as follows:

Alternative-1

i) Establishment of 400/220kV, 4x500 MVA pooling station at suitable location near Ramgarh/Kuchheri in Distt Jaisalmer (Ramgarh-II PS)

ii) Establishment of 400/220kV, 6x500MVA pooling station at suitable location near Bikaner (Bikaner-II PS)
iii) Establishment of 765/400kV, 2x1500 MVA S/s at suitable location near Sikar (Sikar-II Substation)
iv) Establishment of 765/400kV, 2x1500MVA substation at suitable location near Kadarpur (Kadarpur-II substation)
v) Augmentation with 765/400kV, 2x1500MVA transformer (5^{th} & 6^{th}) at Fatehgarh-II PS
vi) Augmentation with 400/220kV, 4x500MVA transformer at Fatehgarh-II PS
vii) Augmentation with 765/400kV, 1x1500MVA transformer (4^{th}) at Bhadla-II PS
viii) Augmentation with 400/220kV, 3x500MVA transformer at Bhadla-II PS
ix) Ramgarh-II PS –Fatehgarh-II PS 400 kV D/c Line (Twin HTLS)
x) Ramgarh-II PS – Jaisalmer-II (RVPN) 400 kV D/c Line (Twin HTLS)
xi) Fatehgarh-II PS – Bhadla-II PS 765kV D/c line (2^{nd})
xii) Bhadla-II PS – Sikar-II 765kV 2xD/c line
xiii) Sikar-II – Kadarpur-II 765kV D/c line
xiv) Sikar-II – Neemrana 400kV D/c line (Twin HTLS)
xv) LILO of 765kV Jhatikara – Agra S/c line at Kadarpur-II
xvi) Kadarpur-II – Bareilly 765kV D/c line
xvii) Kadarpur-II – Prithala 400kV D/c line (Twin HTLS)
xviii) Bikaner-II PS – Khetri 400kV 2xD/c line (Twin HTLS line on M/c tower)
xix) Khetri - Bhiwadi 400kV D/c line (Twin HTLS)
xx) Bikaner-II PS – Bikaner (PG) 400kV D/c line (Twin AL59)
xxi) Khetri - Gr. Noida (UPPCL) 765kV D/c line
xxii) Power reversal on ±500kV, 2500MW Balia – Bhiwadi HVDC line upto 2000MW from Bhiwadi to Balia for solar maximized time
xxiii) 220kV line bays for interconnection of solar projects at Bikaner-II PS (10 nos.), Ramgarh-II PS (7 nos), Fatehgarh-II PS (7 nos) & Bhadla-II PS (4 nos)
xxiv) 1x125 MVAr (420kV), 2x240 MVAr (765kV) Bus Reactor each at Sikar-II &, Kadarpur-II Substation
xxv) 2x125 MVAr (420kV) Bus Reactor each at Bikaner-II & Ramgarh-II PS
xxvi) 1x240 MVAr Switchable line reactor for each circuit at each end of Fatehgarh-II – Bhadla-II 765kV D/c line
xxvii) 1x240 MVAr Switchable line reactor for each circuit at Bhadla-II end of Bhadla-II – Sikar-II 765kV D/c line
xxviii) 1x330 MVAr Switchable line reactor for each circuit at Sikar-II end of Bhadla-II – Sikar-II 765kV D/c line
xxix) 1x240 MVAr Switchable line reactor for each circuit at each end of Sikar-II – Kadarpur-II 765kV D/c line
xxx) 1x240 MVAr Switchable line reactor for each circuit at each end of Kadarpur-II – Bareilly 765kV D/c line
xxxi) 1x80 MVAr Switchable line reactor for each circuit at each end of Bikaner-II – Khetri 400kV 2xD/c line
xxxii) 1x240 MVAr Switchable line reactor for each circuit at Gr. Noida end of Khetri – Gr. Noida (UPPCL) 765kV D/c line

Alternative-2

1. EHVAC Portion

i) Establishment of 400/220kV, 4x500 MVA pooling station at suitable location near Ramgarh/Kuchheri in Distt Jaisalmer (Ramgarh-II PS)
ii) Establishment of 400/220kV, 6x500MVA pooling station at suitable location near Bikaner (Bikaner-II PS)
iii) Augmentation with 765/400kV, 2x1500MVA transformer (5^{th} & 6^{th}) at Fatehgarh-II PS
iv) Augmentation with 400/220kV, 4x500MVA transformer at Fatehgarh-II PS
v) Augmentation with 400/220kV, 3x500MVA transformer at Bhadla-II PS
vi) Ramgarh-II PS –Fatehgarh-II PS 400 kV D/c Line (Twin HTLS)
vii) Ramgarh-II PS – Jaisalmer-II (RVPN) 400 kV D/c Line (Twin HTLS)
viii) Fatehgarh-II PS – Bhadla-II PS 765kV D/c line (2^{nd})
ix) Bikaner-II PS – Khetri 400kV 2xD/c line (Twin HTLS line on M/c tower)
x) Khetri - Bhiwadi 400kV D/c line (Twin HTLS)
xi) Bikaner-II PS – Bikaner (PG) 400kV D/c line (Twin AL59)
xii) Khetri - Gr. Noida (UPPCL) 765kV D/c line
xiii) Power reversal on ±500kV, 2500MW Balia – Bhiwadi HVDC line upto 2000MW from Bhiwadi to Balia for solar maximized time
xiv) 220kV line bays for interconnection of solar projects at Bikaner-II PS (10 nos.), Ramgarh-II PS (7 nos), Fatehgarh-II PS (7 nos) & Bhadla-II PS (4 nos)
xv) 2x125 MVAr (420kV) Bus Reactor each at Bikaner-II & Ramgarh-II PS
xvi) 1x240 MVAr Switchable line reactor for each circuit at each end of Fatehgarh-II – Bhadla-II 765kV D/c line
xvii) 1x80 MVAr Switchable line reactor for each circuit at each end of Bikaner-II – Khetri 400kV 2xD/c line
xviii) 1x240 MVAr Switchable line reactor for each circuit at Gr. Noida end of Khetri – Gr. Noida (UPPCL) 765kV D/c line

2. <u>HVDC Portion</u>

VSC based HVDC system between Bhadla-II PS and suitable location (near Aliganj) between Bareily and Mainpuri

i) ±400kV, 5000 MW HVDC terminal at Pooling point near Bhadla-II PS
ii) ±400kV, 5000 MW HVDC terminal at Pooling point in suitable location (near Aliganj) between Bareilly and Mainpuri
iii) ±400kV HVDC line (Quad) between Bhadla-II PS and suitable location (near Aliganj) between Bareilly and Mainpuri

EHVAC option 1 beyond Aliganj

i) 5x1500MVA transformer at suitable location (near Aliganj) between Bareilly and Mainpuri
ii) Aliganj- Bareilly (PG) 765kV D/c line
iii) Aliganj- Mainpuri (UPPCL) 765kV D/c line
iv) 1x125 MVAr (420kV), 2x240 MVAr (765kV) Bus Reactor at Aliganj Substation

EHVAC option 2 beyond Aliganj

i) Aliganj- Bareily (PG) 400kV D/c line (Twin HTLS)
ii) Aliganj- Mainpuri (UPPCL) 400kV D/c line (Twin HTLS)
iii) Aliganj- Hapur (UPPCL) 400kV D/c line (Twin HTLS)
iv) 2x125 MVAr (420kV) Bus Reactor at Aliganj Substation

2.2 Subsequently, to have detailed deliberations on the alternatives proposed above, a meeting was held on 24.7.2019 at NRPC in which most of the constituents preferred alternative 2. Based on the deliberations held in the meeting, some modifications were done in Alternative-2.

2.3 All the members of NRSCT were of the view that steady state and dynamic reactive power support was required for the connected AC transmission system due to integration of large quantum of Renewable Energy. Therefore, VSC based HVDC has been considered in the Alternative -2 instead of LCC based HVDC as the same can also provide reactive power support just like STATCOM and may take care of the dynamic reactive power support for renewable integration. Further, the uncertainty of adequate short circuit level due to intermittent & variable nature of Renewable Energy can also be addressed by VSC based HVDC in comparison to LCC based HVDC.

2.4 HVDC Experts from POWERGRID also explained that VSC based HVDC is widely used for integration of Renewable Energy across the world. The following salient features of VSC based HVDC system was highlighted by HVDC expert from POWERGRID:

Salient features of a VSC based HVDC

i) Best suitable option for integration of intermittent RE sources
ii) Active and reactive power modulations possible to improve the stability of the connected AC System
iii) Supports connected AC system due to its steady state and dynamic voltage and reactive power support
iv) Reverse power transmission is feasible up to rated capability depending on the requirements
v) Four Quadrant Operation is possible
vi) Controllability of power compared to AC transmission
vii) Grid Connection to weak/islanded AC Networks
viii) Independent Control of Active and Reactive power
ix) Supply of passive Networks and Black Start Capability
x) Can be used as STATCOM even without active power transmission
xi) Less foot print area compared to conventional HVDC system
xii) In symmetric monopole configuration, standard transformers are required instead of converter transformers
xiii) Generally, no/very little amount of harmonics thus reduces requirement of AC/DC filters

2.5 As the constituents were in agreement with the implementation of Hybrid system, the alternative -2 was agreed by the members of the NRSCT. Members also opined that even though the alternative involving VSC based HVDC system was costly, but has many advantages over AC systems for RE integration. Therefore, Govt of India may be approached for some financial support to the extent of cost difference between AC and DC option.

2.6 Based on the deliberations in the meeting, following was agreed for Transmission schemes for Solar Energy Zones (SEZs) in Rajasthan (8.1 GW) under Phase-II

A. EHVAC Portion

i) Establishment of 400/220kV, 4x500 MVA pooling station at suitable location near Ramgarh/Kuchheri in Distt Jaisalmer (Ramgarh-II PS)
ii) Establishment of 400/220kV, 6x500MVA pooling station at suitable location near Bikaner (Bikaner-II PS) with suitable bus sectionalisation at 400 and 220 kV level.

iii) Establishment of 765/400kV, 3x1500MVA substation at suitable location in Narela (near delhi)
iv) Augmentation with 765/400kV, 2x1500MVA transformer (5^{th} & 6^{th}) at Fatehgarh-II PS.
v) Augmentation with 400/220kV, 4x500MVA transformer at Fatehgarh-II PS with suitable bus sectionalisation at 400 and 220 kV level
vi) Augmentation with 400/220kV, 3x500MVA transformer at Bhadla-II PS with suitable bus sectionalisation at 400 and 220 kV level.
vii) Augmentation with 765/400kV, 1x1500MVA (3^{rd}) transformer at Bikaner(PG)
viii) Ramgarh-II PS –Fatehgarh-II PS 400 kV D/c Line (Twin HTLS$^{\$}$)
ix) Ramgarh-II PS – Jaisalmer-II (RVPN) 400 kV D/c Line (Twin HTLS$^{\$}$)
x) Fatehgarh-II PS – Bhadla-II PS 765kV D/c line (2^{nd})
xi) Bikaner-II PS – Khetri 400kV 2xD/c line (*Twin HTLS$^{\$}$ line on M/c tower*)
xii) Khetri - Bhiwadi 400kV D/c line (Twin HTLS$^{\$}$)**
xiii) Removal of LILO of one circuit of Bhadla-Bikaner(RVPN) 400kV D/c(Quad) line at Bikaner(PG). Extension of above LILO section from Bikaner(PG) upto Bikaner-II PS to form Bikaner-II PS – Bikaner (PG) 400kV D/c(Quad) line
xiv) Khetri - Narela 765kV D/c line
xv) LILO of 765kV Meerut – Bhiwani S/c line at Narela S/s
xvi) Removal of LILO of Bawana – Mandola 400kV D/c(Quad) line at Maharani Bagh/Gopalpur S/s. Extension of above LILO section from Maharani Bagh/Gopalpur upto Narela S/s so as to form Maharanibagh – Narela 400kV D/c(Quad) and Maharanibagh -Gopalpur-Narela 400kV D/c(Quad) lines.
xvii) LILO of both circuits of Bawana – Mandola 400kV D/c(Quad) line at Narela S/s
xviii) Power reversal on ±500kV, 2500MW Balia – Bhiwadi HVDC line upto 2000MW from Bhiwadi to Balia
xix) 220kV line bays for interconnection of solar projects at Bikaner-II PS (10 nos.), Ramgarh-II PS (7 nos), Fatehgarh-II PS (8 nos) & Bhadla-II PS (4 nos)
xx) 1x125 MVAr (420kV), 2x240 MVAr (765kV) Bus Reactor at Narela Substation
xxi) 2x125 MVAr (420kV) Bus Reactor each at Bikaner-II & Ramgarh-II PS
xxii) 1x240 MVAr Switchable line reactor for each circuit at each end of Fatehgarh-II – Bhadla-II 765kV D/c line (2^{nd})
xxiii) 1x80 MVAr Switchable line reactor for each circuit at each end of Bikaner-II – Khetri 400kV 2xD/c line
xxiv) 1x240 MVAr Switchable line reactor for each circuit at each end of Khetri – Narela 765kV D/c line

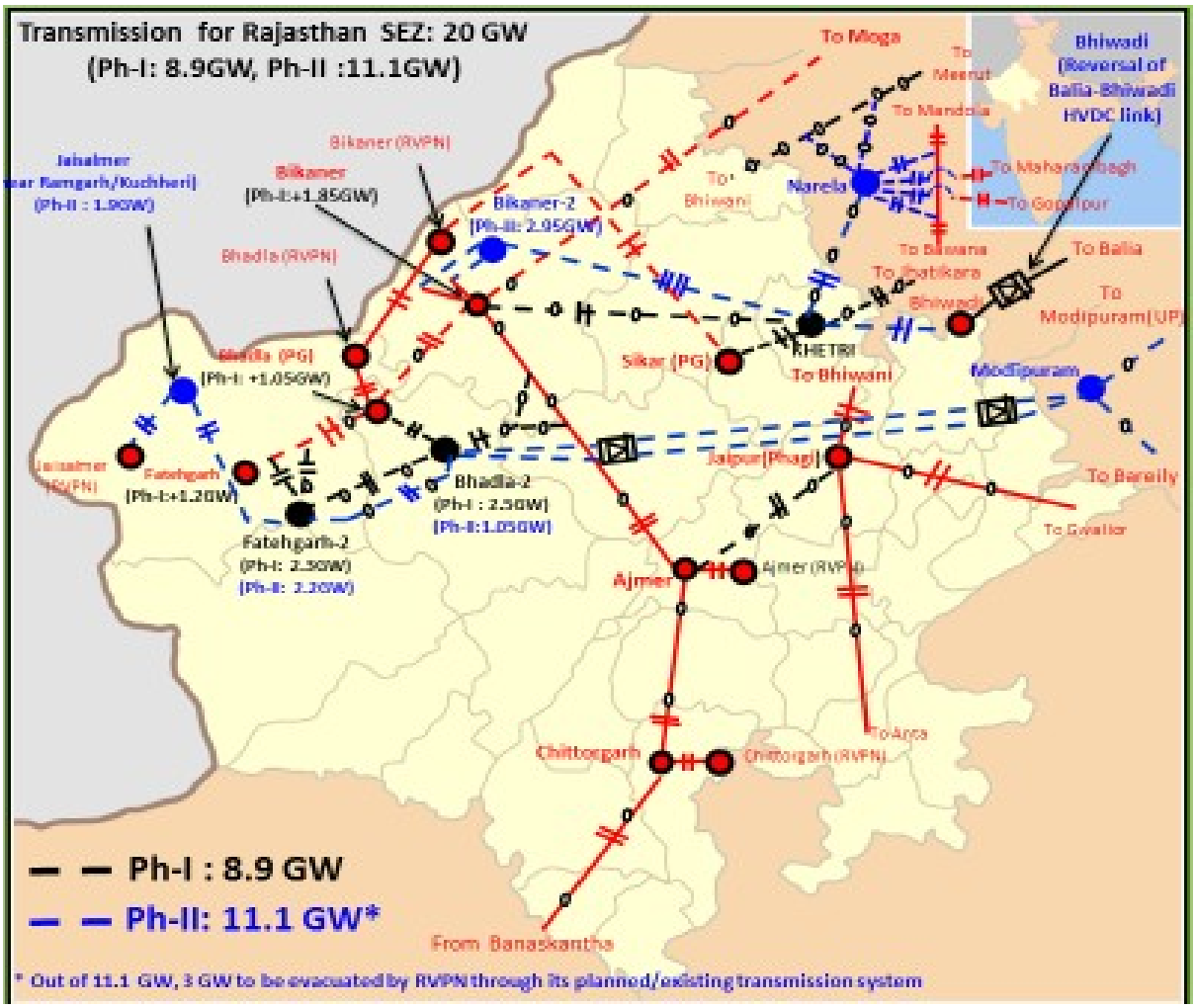
** *Due to space constraints 400kV bays at Bhiwadi S/s to be implemented as GIS*
$ *with minimum capacity of 2200 MVA on each circuit at nominal voltage*

B. HVDC Portion

1) VSC based HVDC system between Bhadla-II PS and suitable location near Modipuram
   i) ±400kV, 5000 MW HVDC terminal at Pooling point near Bhadla-II PS
   ii) ±400kV, 5000 MW HVDC terminal at Pooling point in suitable location near Modipuram
   iii) ±400kV HVDC line (Quad) between Bhadla-II PS and suitable location near Modipuram (on M/c tower)

AC interconnection at Pooling point in suitable location near Modipuram

2) 5x1500MVA transformer at suitable location (near modipuram)



2.7 Subsequently, the detailed cost worked out for Alternative -1 and 2 are of the order of 12000 Crore and 17000 Crore respectively. Considering the high cost of the HVDC system, CEA has been directed to review the system for transmission system for evacuation of power from solar potential of 8.1 GW (**Ramgarh/Kuchheri (1.9 GW), Bikaner (2.95 GW), Bhadla (1.05GW) & Fatehgarh (2.2GW**).

2.8 Load flow studies are carried out and following different options have been worked out for Alternative-I mentioned under para no 2.1 above. It has also been found that dynamic reactive power support would be required for such a huge RE additions in Northern Regions. Therefore, provision of STATCOM has also been considered in the various alternatives proposed for transmission system under Phase-II.

Alternative -1 (Modipuram)

1. Establishment of 400/220kV, 4x500 MVA pooling station at suitable location near Ramgarh/Kuchheri in Distt Jaisalmer (Ramgarh-II PS) with 2x125 MVAr bus reactor.
2. Ramgarh-II PS –Fatehgarh-II PS 400 kV D/c Line (Twin HTLS).
3. Ramgarh-II PS – Jaisalmer-II (RVPN) 400 kV D/c Line (Twin HTLS)
4. Establishment of 400/220kV, 6x500MVA pooling station at suitable location near Bikaner (Bikaner-II PS) with 2x125 MVAr bus reactor
5. Bikaner-II PS – Khetri 400kV 2xD/c line (Twin HTLS line on M/c tower)

6. Removal of LILO of one circuit of Bhadla-Bikaner(RVPN) 400kV D/c(Quad) line at Bikaner(PG). Extension of above LILO section from Bikaner(PG) upto Bikaner-II PS to form Bikaner-II PS – Bikaner (PG) 400kV D/c(Quad) line)
7. 1x80 MVAr Switchable line reactor for each circuit at each end of Bikaner-II – Khetri 400kV 2xD/c line
8. Establishment of 765/400kV, 2x1500 MVA S/s at suitable location near Sikar (Sikar-II Substation) with 1x125 MVAr & 2x330 MVAr bus reactor at Sikar (II)
9. Sikar-II – Modipuram 765kV D/c line
10. Bhadla-II PS – Sikar-II 765kV 2xD/c line
11. Sikar-II – Neemrana 400kV D/c line (Twin HTLS)*
12. 1x330 MVAr Switchable line reactor for each circuit at Sikar end of Bhadla-II – Sikar-II 765kV 2xD/c line
13. 1x240 MVAr Switchable line reactor for each circuit at Bhadla-II end of Bhadla-II – Sikar-II 765kV 2xD/c line
14. 1x330MVAr Switchable line reactor for each circuit at each end of Sikar-II – Modipuram 765kV D/c line
15. Augmentation with 765/400kV, 2x1500MVA transformer (5th & 6th) at Fatehgarh-II PS
16. Fatehgarh-II PS – Bhadla-II PS 765kV D/c line (2nd)
17. 1x240 MVAr Switchable line reactor for each circuit at each end of Fatehgarh-II – Bhadla-II 765kV D/c line
18. Augmentation with 400/220kV, 4x500MVA transformer at Fatehgarh-II PS
19. Augmentation with 765/400kV, 1x1500MVA transformer (4th) at Bhadla-II PS
20. 1x240 MVAr Switchable line reactor for each circuit at Bhadla-II end of Bhadla-II – Sikar-II 765kV D/c line
21. Augmentation with 400/220kV, 3x500MVA transformer at Bhadla-II PS
22. Khetri - Bhiwadi 400kV D/c line (Twin HTLS)*
23. 220kV line bays for interconnection of solar projects at Bikaner-II PS (10 nos.), Ramgarh-II PS (7 nos), Fatehgarh-II PS (7 nos) & Bhadla-II PS (4 nos)
24. Establishment of 765/400 kV, 3X1500 MVA substation at Narela with 765 kV (2x330 MVAr) bus reactor and 400kV (1x125 MVAR) bus reactor.
25. Khetri – Narela 765 kV D/c line
26. 2 nos. of 765 kV line bays at Khetri for Khetri – Narela 765 kV D/c line.
27. 1x330 MVAr Switchable line reactor for each circuit at Narela end of Khetri – Narela 765kV D/c line
28. LILO of 765 kV Meerut- Bhiwani S/c line at Narela
29. Removal of LILO of Bawana – Mandola 400kV D/c(Quad) line at Maharani Bagh/ Gopalpur S/s. Extension of above LILO section from Maharani Bagh/Gopalpur upto Narela S/s so as to form Maharanibagh – Narela 400kV D/c(Quad) and Maharanibagh -Gopalpur-Narela 400kV D/c(Quad) lines.
30. STATCOM:

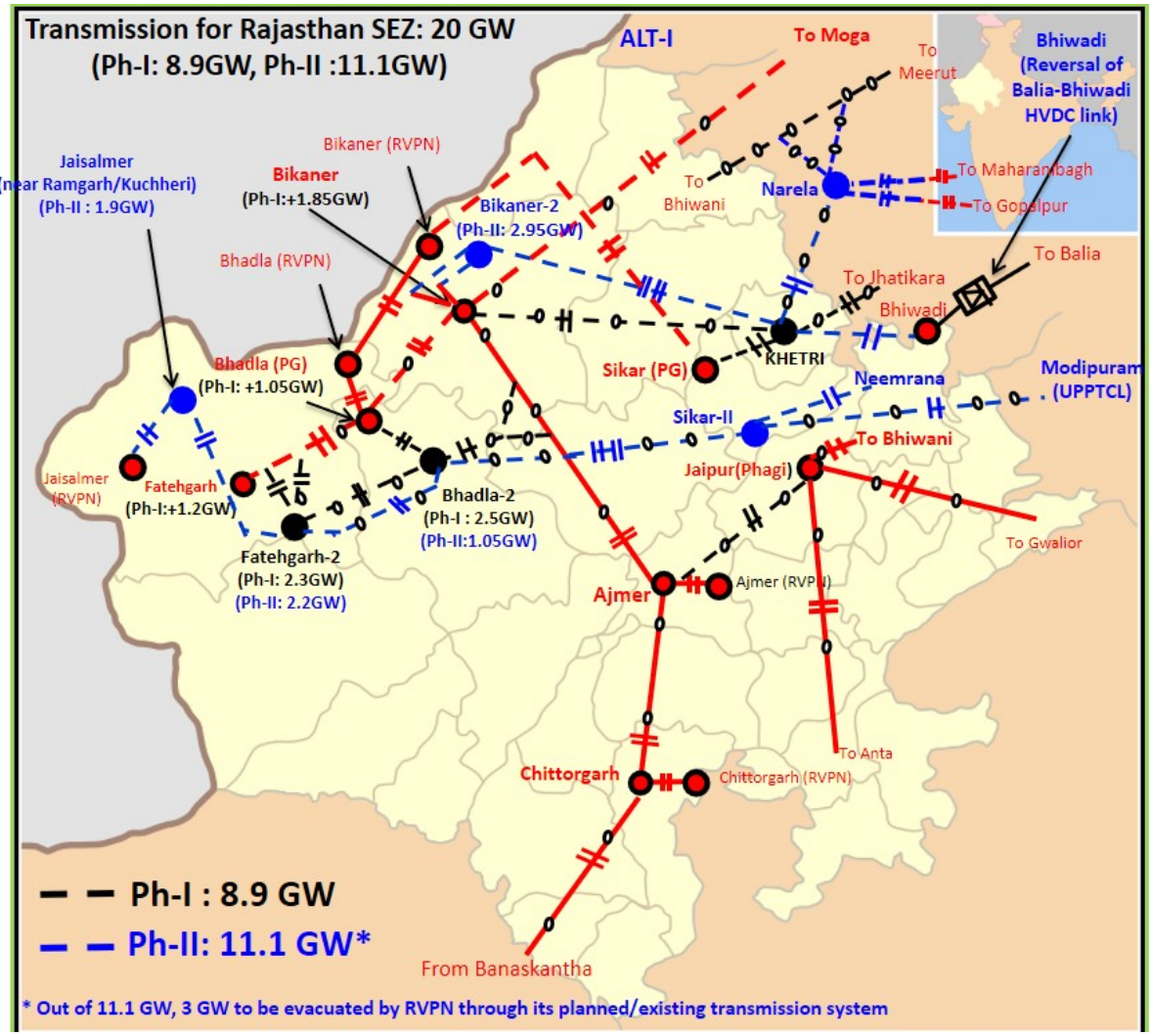
    Fatehgarh – II S/s : STATCOM : ± 600 MVAr, 4x125 MVAR MSC , 2x125 MVAr MSR

    Bhadla – II S/s : STATCOM : ± 600 MVAr, 4x125 MVAR MSC , 2x125 MVAr MSR

    Bikaner – II S/s : STATCOM : ± 300 MVAr, 2x125 MVAR MSC , 1x125 MVAr MSR

* Suitable to carry 2200 MVA at Nominal voltage

Estimated Cost: 12770 Cr.



Simulation studies with above transmission system are enclosed as Exhibit 1A (Off Peak case) and Exhibit 1B (Peak case).

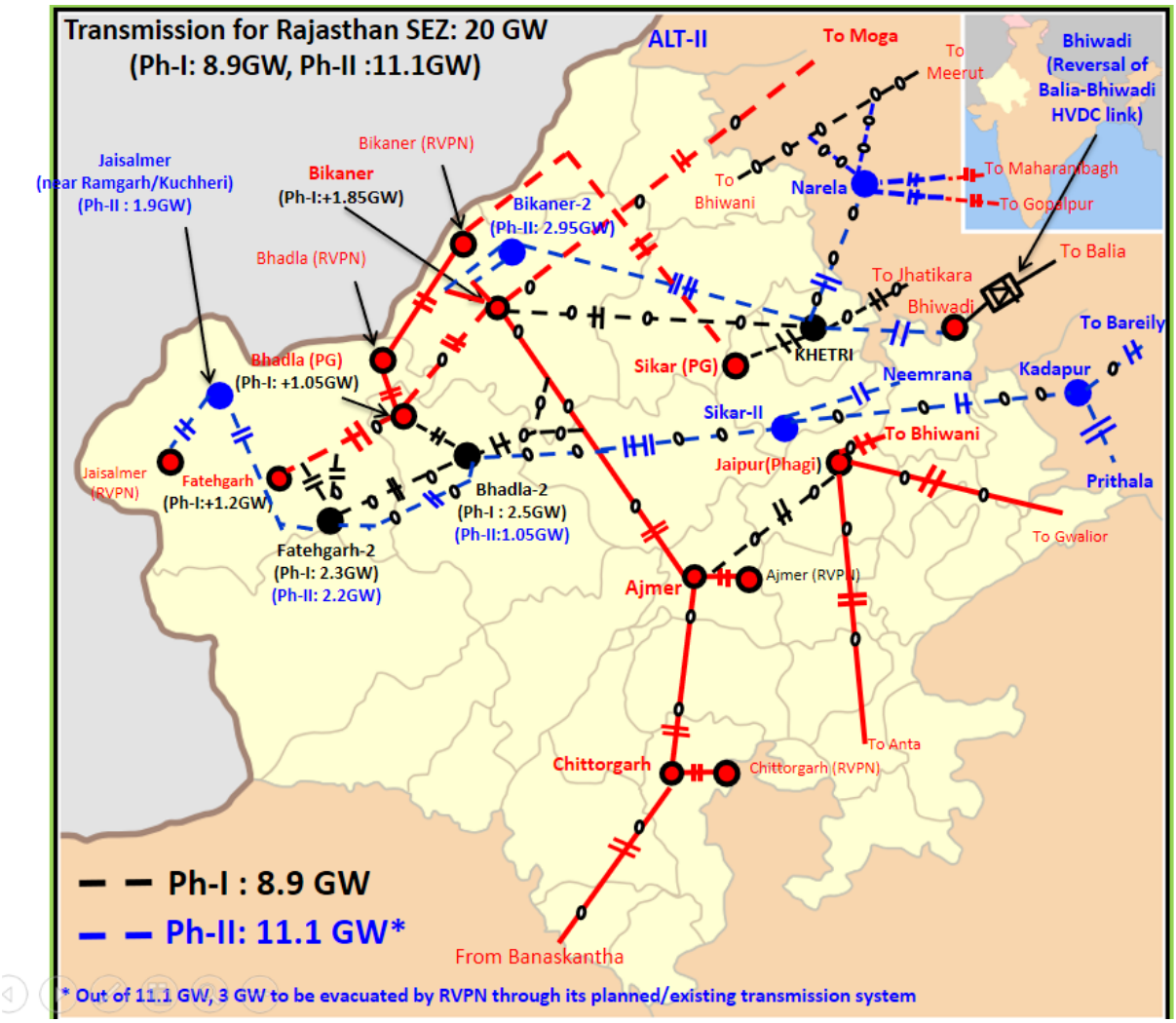
<u>Alternative -2 (Kadarpur)</u>

1. Establishment of 400/220kV, 4x500 MVA pooling station at suitable location near Ramgarh/Kuchheriin Distt Jaisalmer (Ramgarh-II PS) with 2x125 MVAr bus reactor.
2. Ramgarh-II PS –Fatehgarh-II PS 400 kV D/c Line (Twin HTLS)
3. Ramgarh-II PS – Jaisalmer-II (RVPN) 400 kV D/c Line (Twin HTLS)
4. Establishment of 400/220kV, 6x500MVA pooling station at suitable location near Bikaner (Bikaner-II PS) with 2x125 MVAr bus reactor
5. Bikaner-II PS – Khetri 400kV 2xD/c line (Twin HTLS line on M/c tower)
6. Removal of LILO of one circuit of Bhadla-Bikaner(RVPN) 400kV D/c(Quad) line at Bikaner(PG). Extension of above LILO section from Bikaner(PG) upto Bikaner-II PS to form Bikaner-II PS – Bikaner (PG) 400kV D/c(Quad) line.
7. 1x80 MVAr Switchable line reactor for each circuit at each end of Bikaner-II – Khetri 400kV 2xD/c line.
8. Establishment of 765/400kV, 2x1500 MVA S/s at suitable location near Sikar (Sikar-II Substation) with 1x125, MVAr& 2x240 MVAr bus reactor at Sikar (II)

9. Sikar-II – Kadarpur-II 765kV D/c line
10. Bhadla-II PS – Sikar-II 765kV 2xD/c line
11. Sikar-II – Neemrana 400kV D/c line (Twin HTLS).
12. 1x330 MVAr Switchable line reactor for each circuit at Sikar end of Bhadla-II – Sikar-II 765kV 2xD/c line
13. 1x240 MVAr Switchable line reactor for each circuit at Bhadla-II end of Bhadla-II – Sikar-II 765kV 2xD/c line.
14. 1x330MVAr Switchable line reactor for each circuit at each end of Sikar-II – Kadarpur-II 765kV D/c line.
15. Establishment of 765/400kV, 2x1500MVA substation at suitable location near Kadarpur (Kadarpur-II substation) with 1x125 MVAr & 2x330 MVAr bus reactor at Kadarpur-(II)
16. LILO of 765kV Jhatikara – Agra S/c line at Kadarpur-II
17. Kadarpur-II – Bareilly 765kV D/c line.
18. Kadarpur-II – Prithala 400kV D/c line (Twin HTLS)*
19. 1x330MVAr Switchable line reactor for each circuit at Kadarpur-II end of Kadarpur-II – Bareilly 765kV D/c line
20. 1x240 MVAr Switchable line reactor for each circuit at Bareilly end of Kadarpur-II – Bareilly 765kV D/c line
21. Augmentation with 765/400kV, 2x1500MVA transformer (5^{th} & 6^{th}) at Fatehgarh-II PS
22. Fatehgarh-II PS – Bhadla-II PS 765kV D/c line(2^{nd})
23. 1x240 MVAr Switchable line reactor for each circuit at each end of Fatehgarh-II – Bhadla-II 765kV D/c line
24. Augmentation with 400/220kV, 4x500MVA transformer at Fatehgarh-II PS
25. Augmentation with 765/400kV, 1x1500MVA transformer (4^{th}) at Bhadla-II PS
26. 1x240 MVAr Switchable line reactor for each circuit at Bhadla-II end of Bhadla-II – Sikar-II 765kV D/c line
27. Augmentation with 400/220kV, 3x500MVA transformer at Bhadla-II PS
28. Khetri - Bhiwadi 400kV D/c line (Twin HTLS)
29. Establishment of 765/400 kV, 3X1500 MVA substation at Narela with 765 kV (2x330 MVAr) bus reactor and 400 kV (1x125 MVAR) bus reactor
30. Khetri – Narela 765 kV D/c line
31. 2 nos. of 765 kV line bays at Khetri for Khetri – Narela 765 kV D/c line.
32. 1x330 MVAr Switchable line reactor for each circuit at Narela end of Khetri – Narela 765kV D/c line
33. LILO of 765 kV Meerut- Bhiwani S/c line at Narela
34. Removal of LILO of Bawana – Mandola 400kV D/c(Quad) line at Maharani Bagh/ Gopalpur S/s. Extension of above LILO section from Maharani Bagh/Gopalpur uptoNarela S/s so as to form Maharanibagh – Narela 400kV D/c(Quad) and Maharanibagh -Gopalpur-Narela 400kV D/c(Quad) lines.
35. 220kV line bays for interconnection of solar projects at Bikaner-II PS (10 nos.), Ramgarh-II PS (7 nos), Fatehgarh-II PS (7 nos) & Bhadla-II PS (4 nos)
36. STATCOM:
    Fatehgarh – II S/s : STATCOM : ± 600 MVAr, 4x125 MVAR MSC , 2x125 MVAr MSR
    Bhadla – II S/s : STATCOM : ± 600 MVAr, 4x125 MVAR MSC , 2x125 MVAr MSR
    Bikaner – II S/s : STATCOM : ± 300 MVAr, 2x125 MVAR MSC , 1x125 MVAr MSR

    * Suitable to carry 2200 MVA at Nominal voltage

Estimated Cost: 13660 Cr.



Simulation studies with above transmission system are enclosed as Exhibit 2A (Off Peak case) and Exhibit 2B (Peak case).

Alternative -3 (Aligarh)

1. Establishment of 400/220kV, 4x500 MVA pooling station at suitable location near Ramgarh/Kuchheri in Distt Jaisalmer (Ramgarh-II PS) with 2x125 MVAr bus reactor.
2. Ramgarh-II PS –Fatehgarh-II PS 400 kV D/c Line (Twin HTLS).
3. Ramgarh-II PS – Jaisalmer-II (RVPN) 400 kV D/c Line (Twin HTLS)
4. Establishment of 400/220kV, 6x500MVA pooling station at suitable location near Bikaner (Bikaner-II PS)) with 2x125 MVAr bus reactor
5. Bikaner-II PS – Khetri 400kV 2xD/c line (Twin HTLS line on M/c tower)
6. Removal of LILO of one circuit of Bhadla-Bikaner(RVPN) 400kV D/c(Quad) line at Bikaner(PG). Extension of above LILO section from Bikaner(PG) upto Bikaner-II PS to form Bikaner-II PS – Bikaner (PG) 400kV D/c(Quad) line)
7. 1x80 MVAr Switchable line reactor for each circuit at each end of Bikaner-II – Khetri 400kV 2xD/c line
8. Establishment of 765/400kV, 2x1500 MVA S/s at suitable location near Sikar (Sikar-II Substation) with 1x125 MVAr & 2x330 MVAr bus reactor at Sikar (II)
9. Sikar-II – Aligarh 765kV D/c line
10. Bhadla-II PS – Sikar-II 765kV 2xD/c line

11. Sikar-II – Neemrana 400kV D/c line (Twin HTLS)*
12. 1x330 MVAr Switchable line reactor for each circuit at Sikar end of Bhadla-II – Sikar-II 765kV 2xD/c line
13. 1x240 MVAr Switchable line reactor for each circuit at Bhadla-II end of Bhadla-II – Sikar-II 765kV 2xD/c line
14. 1x330MVAr Switchable line reactor for each circuit at each end of Sikar-II –Aligarh 765kV D/c line
15. Augmentation with 765/400kV, 2x1500MVA transformer (5^{th} & 6^{th}) at Fatehgarh-II PS
16. Fatehgarh-II PS – Bhadla-II PS 765kV D/c line (2^{nd})
17. 1x240 MVAr Switchable line reactor for each circuit at each end of Fatehgarh-II – Bhadla-II 765kV D/c line
18. Augmentation with 400/220kV, 4x500MVA transformer at Fatehgarh-II PS
19. Augmentation with 765/400kV, 1x1500MVA transformer (4^{th}) at Bhadla-II PS
20. 1x240 MVAr Switchable line reactor for each circuit at Bhadla-II end of Bhadla-II – Sikar-II 765kV D/c line
21. Augmentation with 400/220kV, 3x500MVA transformer at Bhadla-II PS
22. Khetri - Bhiwadi 400kV D/c line (Twin HTLS)
23. 220kV line bays for interconnection of solar projects at Bikaner-II PS (10 nos.), Ramgarh-II PS (7 nos), Fatehgarh-II PS (7 nos) & Bhadla-II PS (4 nos)
24. Establishment of 765/400 kV, 3X1500 MVA substation at Narela with 765 kV (2x330 MVAr) bus reactor and 400kV (1x125 MVAR) bus reactor.
25. Khetri – Narela 765 kV D/c line
26. 2 nos. of 765 kV line bays at Khetri for Khetri – Narela 765 kV D/c line.
27. 1x330 MVAr Switchable line reactor for each circuit at Narela end of Khetri – Narela 765kV D/c line
28. LILO of 765 kV Meerut- Bhiwani S/c line at Narela
29. Removal of LILO of Bawana – Mandola 400kV D/c(Quad) line at Maharani Bagh/ Gopalpur S/s. Extension of above LILO section from Maharani Bagh/Gopalpur upto Narela S/s so as to form Maharanibagh – Narela 400kV D/c(Quad) and Maharanibagh -Gopalpur-Narela 400kV D/c(Quad) lines.
30. STATCOM:

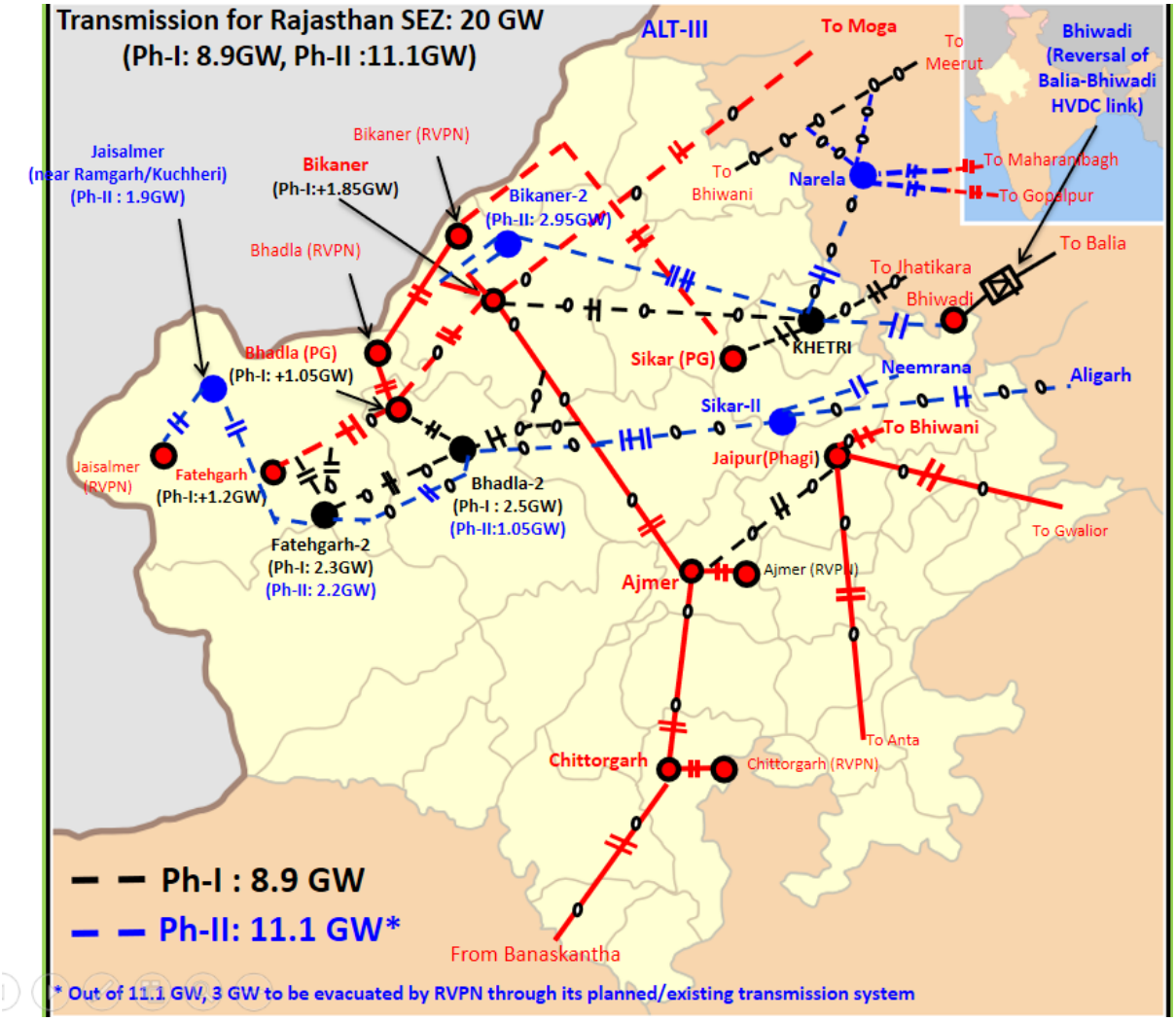
    Fatehgarh – II S/s : STATCOM : ± 600 MVAr, 4x125 MVAR MSC , 2x125 MVAr MSR

    Bhadla – II S/s : STATCOM : ± 600 MVAr, 4x125 MVAR MSC , 2x125 MVAr MSR

    Bikaner – II S/s : STATCOM : ± 300 MVAr, 2x125 MVAR MSC , 1x125 MVAr MSR

    * Suitable to carry 2200 MVA at Nominal voltage

Estimated Cost: 12442 Cr.



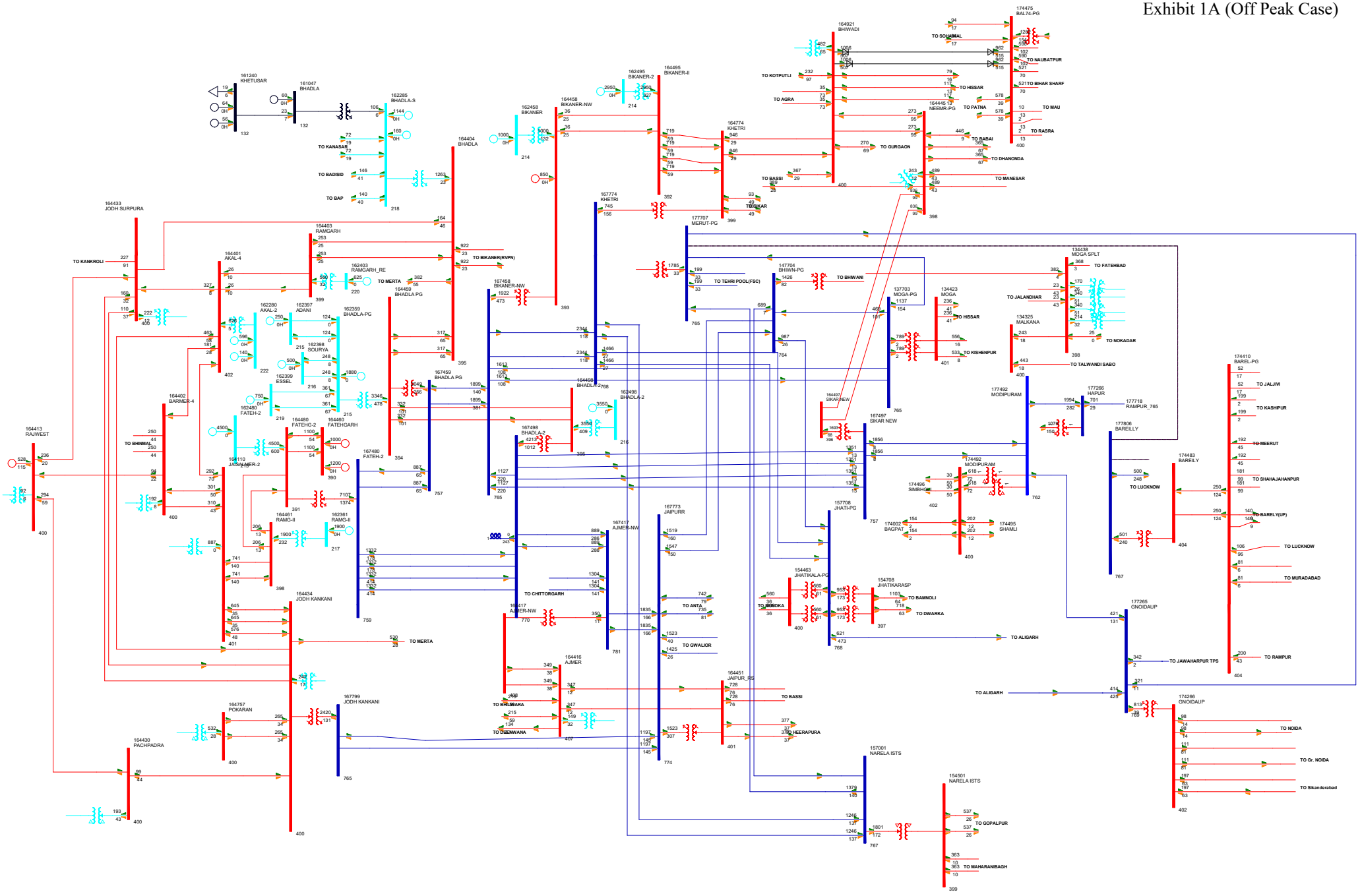
Simulation studies with above transmission system are enclosed as Exhibit 3A (Off Peak case) and Exhibit 3B (Peak case).

2.9 Members may discuss.

3.0 Any other issue with the permission of chair.

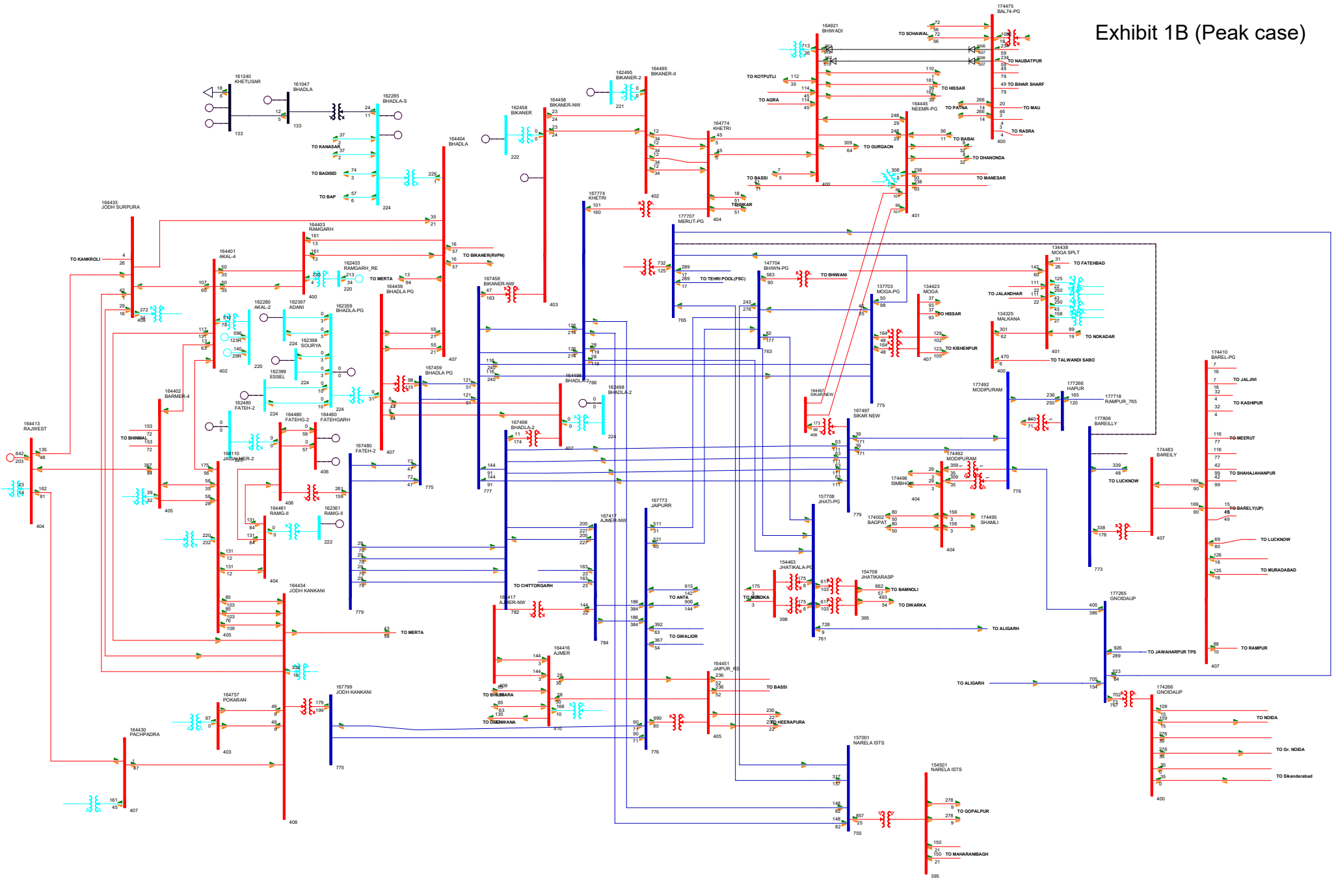
Transmission Scheme for Rajasthan SEZ PH-II(HVAC OPTION - ALT1)

Exhibit 1A (Off Peak Case)



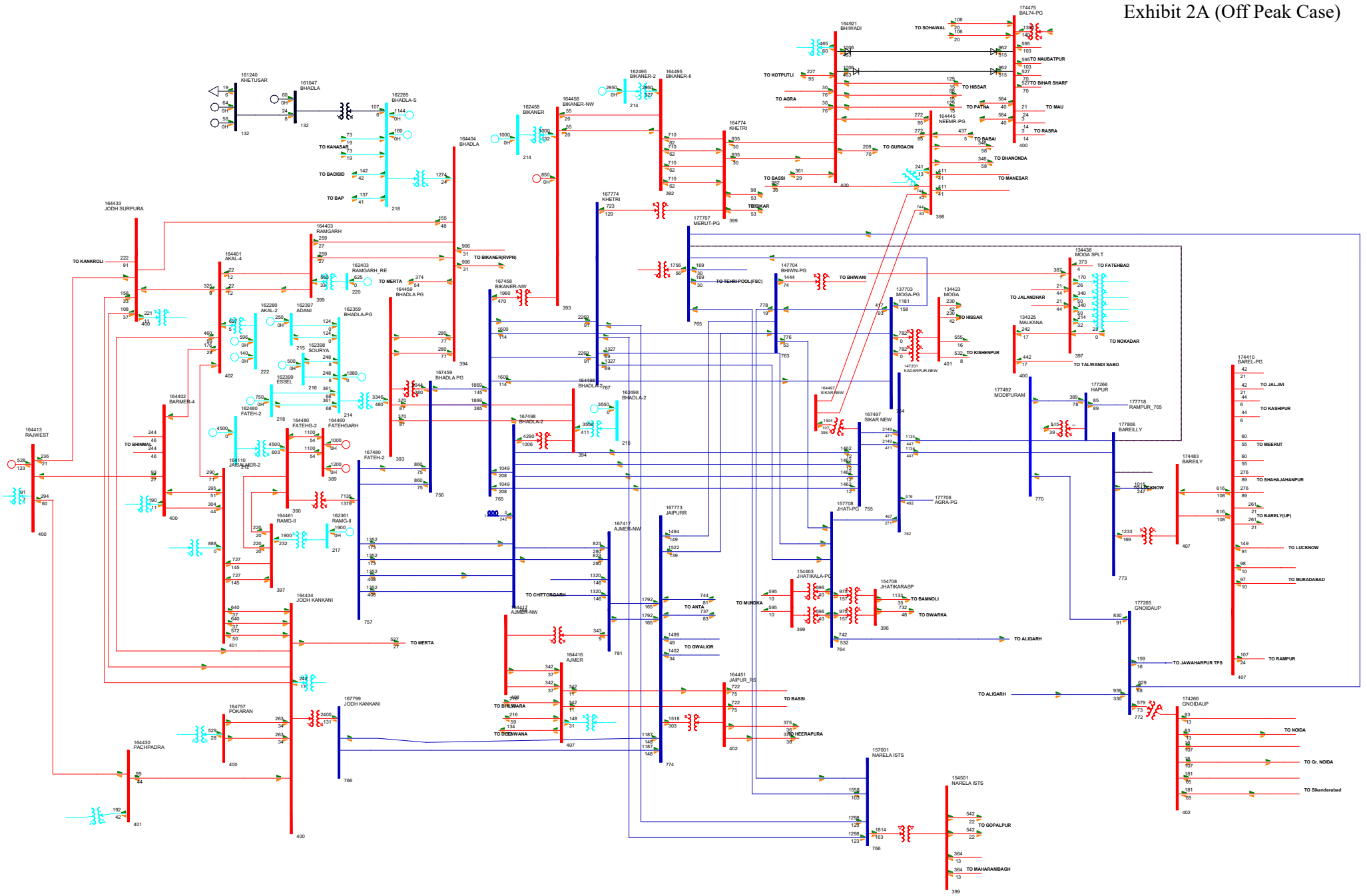
Transmission Scheme for Rajasthan SEZ PH-II(HVAC OPTION - ALT1)

Exhibit 1B (Peak case)



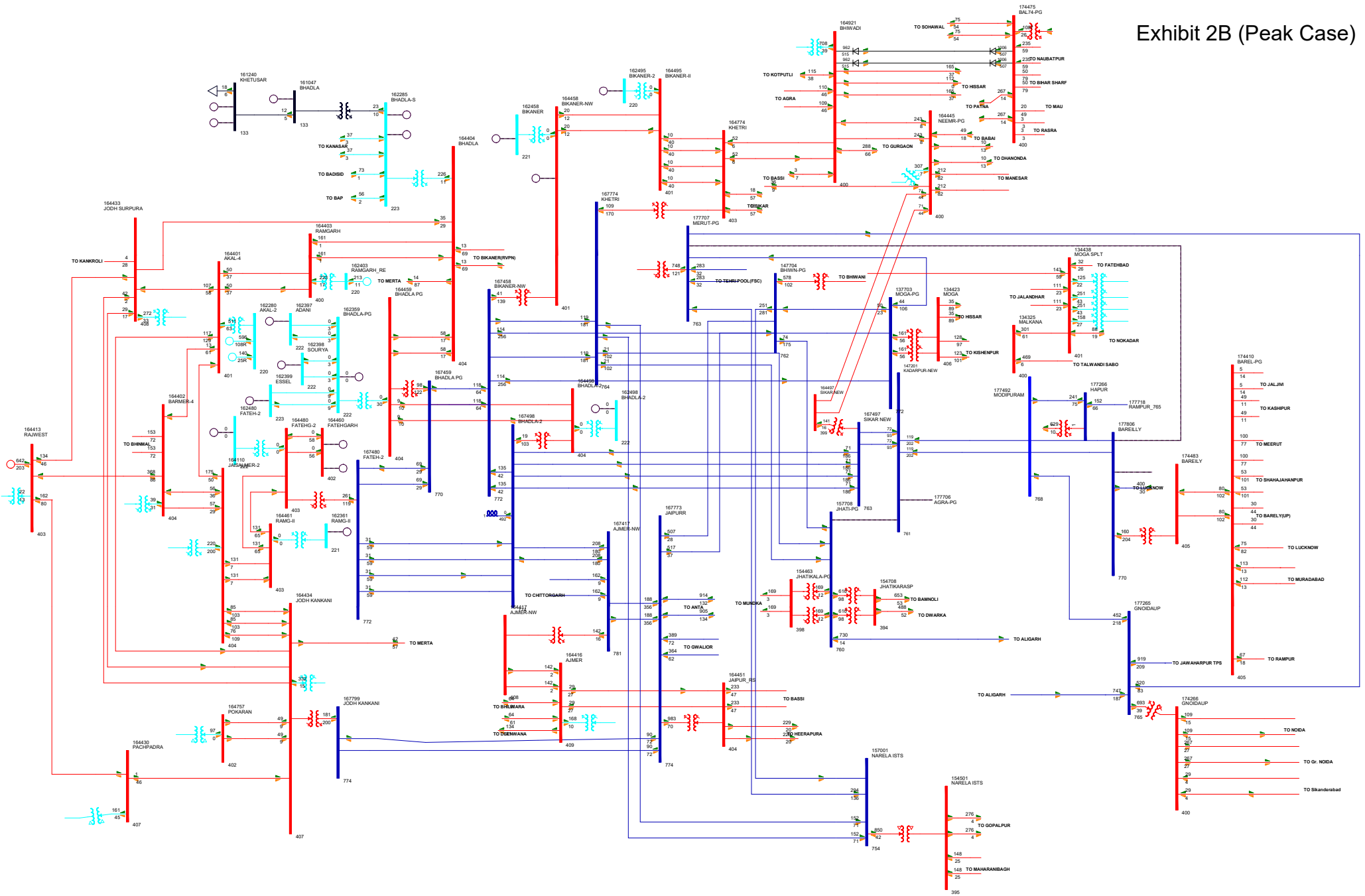
Transmission Scheme for Rajasthan SEZ PH-II(HVAC OPTION - ALT2)

Exhibit 2A (Off Peak Case)



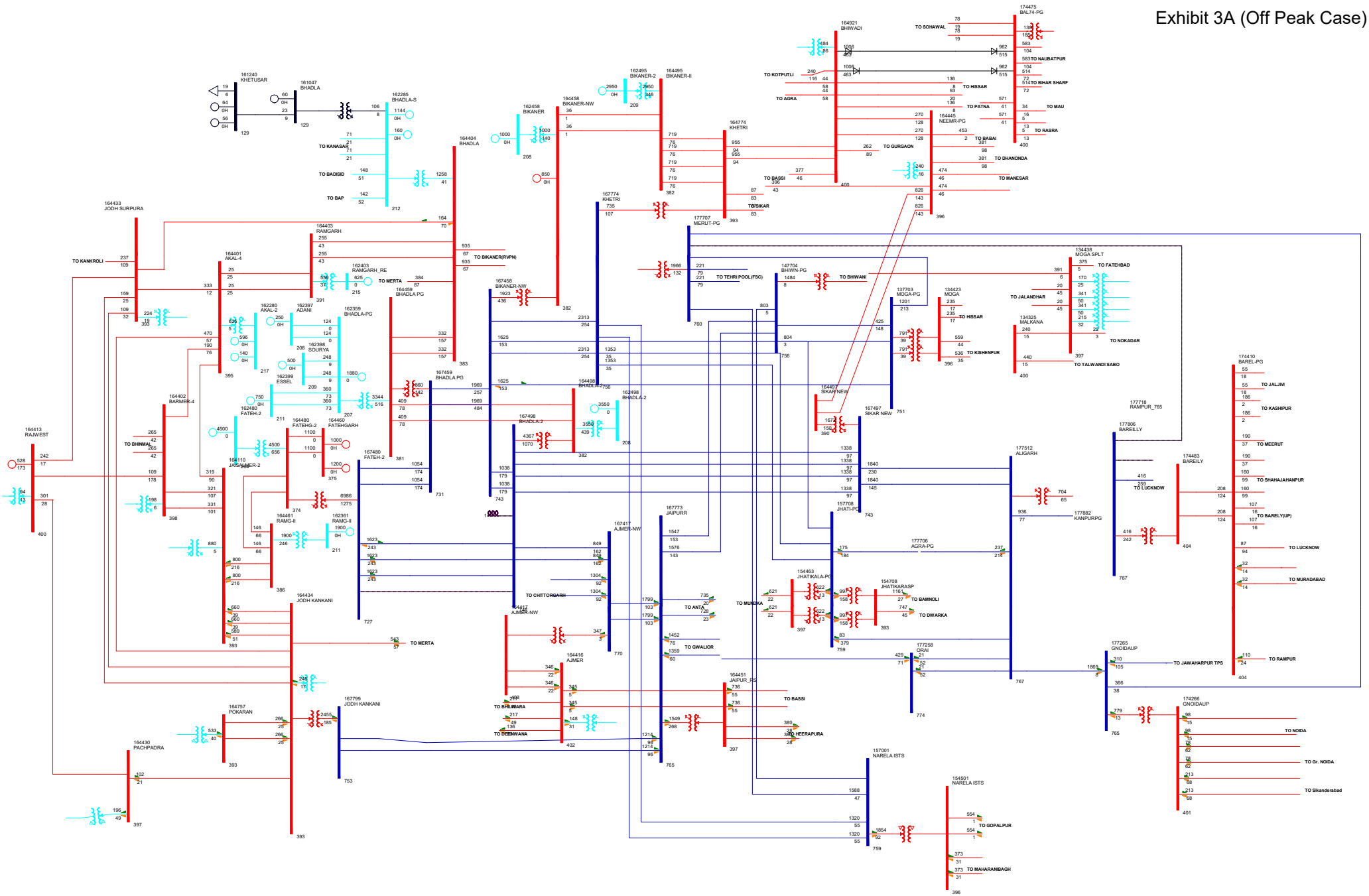
Transmission Scheme for Rajasthan SEZ PH-II(HVAC OPTION - ALT2)

Exhibit 2B (Peak Case)



Transmission Scheme for Rajasthan SEZ PH-II(HVAC OPTION-ALT III)

Exhibit 3A (Off Peak Case)



Transmission Scheme for Rajasthan SEZ PH-II(HVAC OPTION-ALT III)

Exhibit 3B (Peak Case)