File No.CEA-PS-11-21(19)/1/2018-PSPA-I Division

I/1229/2018

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

-As per list enclosed

विषय: उत्तरी क्षेत्र की विद्युत प्रणाली योजना पर स्थायी समिति की 40 वीं बैठक- अतिरिक्त एजेंडा नोट

Sub: 40th Meeting of Standing Committee on Power System Planning of Northern Region– Additional Agenda Note

Sir/ Madam,

In continuation of our letters of even number dated 10.5.2018 and 13.6.2018 it is intimated that the additional agenda notes for 40th meeting of the Standing Committee on Power System Planning of Northern Region website: www.cea.nic.in at following link http://cea.nic.in/reports/committee/scm/nr/additional_agenda_note/40th.pdf (path to access – Home Page –Wing- Power System-PSPA-I- Standing Committee on Power System Planning- Northern region). The meeting is scheduled to be held on 22nd June, 2018 (Friday) at 1030hrs at NRPC conference Room, NRPC Katwaria Sarai, New Delhi.

Kindly make it convenient to attend the meeting.

भवदीय /Yours faithfully,

19.6.2018

;अवधेश कुमार यादवद्ध ध(Awdhesh Kr Yadav)

निदेशकध Director

Copy to: PPS to Member (PS),

1.	Member, Secretary, NRPC, 18-A Shajeed Jeet 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, Urja Bhawan Campus, Kanawali Road Dehradun-248001. Uttrakhand Fax-0135-276431
4.	Director (Technical), Punjab State Transmission Corporation Ltd. (PSTCL) Head Office The Mall Patiala -147001 Fax-0175-2304017	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 (Technical) RRVPNL, Vidut Bhawan, Jaipur-302005. Fax-:0141-2740794	8.	Director (Technical) HVPNL Shakti Bhawan, Sector-6 Panchkula-134109 Fax-0172-256060640	9.	Director (Technical) HPSEB Ltd. Vidut Bhawan, 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.	Chief Engineer (Transmission) NPCIL, 9-S-30, Vikram Sarabahai Bhawan, Anushakti Nagar, Mumbai-400094 Fax-022-25993570	14.	Director (T&RE) NHPC Office Complex, Sector-33, NHPC, Faridabad-121003 (Fax-0129-2256055)	15	Director (Projects) NTPC, NTPC Bhawan, Core 7, Scope Complex-6, Institutional Area, Lodhi Road. New Delhi (Fax-011-24361018)
16.	Director (Technical) THDC Ltd. Pragatipuram, Bypass Road, Rishikesh-249201 Fax: 0135-2431519)	17	Director (Projects) POWERGRID Saudamini Plot no. 2, Sector - 29. Gurgaon-122 001 (Fax-0124-2571809)	18.	CEO, POSOCO B-9, Qutab Institutional Area, Katwaria Sarai New Delhi – 110010 (Fax:2682747)
19.	COO (CTU) POWERGRID, Saudamini, Plot no. 2, Sector -29, Gurgaon-122 001 (Fax-0124-2571809)				

Additional Agenda Note for 40th Meeting of Standing Committee on Power System Planning of Northern Region

1.0 Transmission system for evacuation of power from Khurja STPP (2x660 MW) of THDC:

1.1 THDC vide their letter dated 14.3.2018 informed that they are implementing Khurja STPP (2x660 MW) in District Bulandshahar (UP) (with provision of one more unit of 660 MW in future) with expected date of commissioning as November 2022 (for 1st Unit) and April 2023 (for 2nd Unit). The project site is at National Highway-9 between Khurja and Aligarh. All the major clearances such as environmental clearance, water commitment etc. are in place. THDCIL also informed that PPA's have already been signed (prior to 5th January 2011) with following entities as beneficiary:

a) Delhi (BSES Rajdhani Power Limited) 125 MW
b) Uttar Pradesh (UPPCL) 792 MW
c) Uttarakhand (Uttarakhand Power Corporation Limited) 328 MW
d) Rajasthan (Jaipur Vidyut Vitran Nigam Limited, Jodhpur Vidyut Vitran Nigam Ltd.) 328 MW
e) Himachal Pradesh (Himachal Pradesh State Electricity Board Limited) 200 MW as beneficiary states.

THDC requested CEA / CTU to plan a suitable power evacuation system for 2 x 660 MW Khurja STPP.

1.2 A meeting was held on 7.5.2018 in CEA with representatives from CTU, THDC and UPPTCL. Minutes of meeting are enclosed at Annexure- A. In the meeting, it was pointed out that as per the information provided by THDC, UP has share of 60% of the total power from the plant and remaining 40% power is for the other states in Northern Region. As majority of the power is purchased by UP, the evacuation system may be planned by UP provided other beneficiaries agrees to pay intrastate transmission charges for their share of power.

After deliberations, following was agreed in the meeting:

i) THDC to share the startup power arrangement and the switchyard voltage level as mentioned in DPR of Khurja STPP.

ii) THDC to apply for connectivity to UPPTCL for Khurja STPP.

iii) THDC to furnish assurance to UPPTCL for sharing of intra state transmission charges corresponding to 40% (i.e. share of other beneficiaries) of installed capacity of Khurja STPP.

iv) UPPTCL to plan transmission system for evacuation of power from Khurja STPP (2x660 MW) keeping in view provision of one more unit of 660 MW in future.

v) The proposal would be discussed in the forthcoming Standing Committee Meeting on Power System Planning for Northern region.

1.3 Subsequently, THDC vide their email dated 25.5.2018 forwarded the power evacuation part of DPR, wherein following is mentioned :

*The power generated in the units will be evacuated through 400kV transmission lines by Uttar Pradesh Power Corporation Ltd/Power Grid Corporation Limited. THDC has requested both, UP Power Transmission Corporation Limited & Power Grid Corporation Limited, to determine power evacuation system for the project. Unit start-up power requirement shall be met by back charging of one of 400kV transmission line. The above scheme as considered presently shall be reviewed based on the finalized ATS of the project. The provision presently being kept is approximat*e.

1.4 THDC/UPPTCL may update further developments.

1.5 Members may like to deliberate.

2.0 Agenda by UPPTCL :

UPPTCL vide their letter dated 22.5.2018 has forwarded the following agenda items for inclusion in 40th meeting of SCPSPNR:

2.1 Construction of 400/220kV 2x500, 2x200 MVA Basti substation:

2.1.1 District Basti is located in the North Eastern region of U.P. Due to increasing load in and around Gorakhpur, two Nos. of 400/220kV substations viz Gorakhpur(PG) & Gorakhpur UPPTCL are insufficient to cater various 220 kV substations namely Bansi, Basti, Gorakhpur-II, Bharuwa Gorakhpur, Gola (Gorakhpur), Deoria, Hatta (Kushinagar) and upcoming new substations namely Maharajganj, Anandnagar and Khalilabad. A new 400 kV substation is therefore required to be constructed at the earliest in the area on top priority. Limited land suitable only for GIS substation is available. The details of proposal are as follows: -

i. Construction of 400/220/132 kV, 2x500, 2x200 MVA GIS substation at Basti.
ii. LILO of both ckt of Gorakhpur PG – Lucknow PG 400 kV existing PGCIL(Quad) line at Basti (400) substation – 25km.
(LILO point distance : from Lucknow PG – 200 km, from Gorakhpur PG – 60 km)
iii. LILO of Gonda (220) – Basti (220) UPPTCL 220 kV SC line at Basti(400) substation – 20 km
iv. Basti(400) – Bansi (220) 220 kV DC line – 50 km
v. LILO of Gorakhpur PG(400)- Bansi (220) 220 kV SC existing line at Khalilabad(220) - 20 km
vi. Khalilabad(220) –Pharenda, Ananadnagar(220) District Mahrajganj 220 kV DC line - 40 km
vii. Basti (400) – Haraiya, Nathnagar, Mehdawal 132kV DC lines–60km

2.2 Revision in evacuation system of 2x660 MW Tanda Extn. Thermal Power Project of NTPC :

2.2.1 The evacuation system of 2x660 MW Tanda (NTPC) TPS project was approved in 39th meeting of SCPSPNR as follows :

i. Generation of Tanda Extn. Units at 400 kV
ii. LILO of Azamgarh – Sultanpur 400 kV S/C UPPTCL existing line at Tanda TPS (At present LILO - 65 km is being constructed by UPPTCL and expected to match with 1st unit COD).

iii. 400/220 kV, 2x315 MVA ICTs at Tanda TPS(at NTPC at switchyard).

iv. 400/220/132 kV 2x315, 2x100 MVA Gonda substation (Intra-state being constructed under PPP mode)

v. Gonda (400) – Shahjahanpur PG 400 kV D/C (Q) line (This intra state line -230 km. is being constructed under PPP mode)

vi. Start-up power through 400/220 kV ICTs from existing Tanda TPS 220 kV bus.

2.2.2 UPPTCL informed that while construction work at (ii) is likely to match 1st unit COD, the items (iv) & (v) under PPP mode may get delayed due to serious financial issues with PPP licensee. It is therefore planned to evacuate the generation as follows: -

(i) <u>1st Unit :</u>

(a) LILO of Azamgarh – Sultanpur 400 kV S/C line (As earlier SCM approved).

(b) 400/220 kV 2x315 MVA ICTs at Tanda TPS (As earlier SCM approved) to be ensured by NTPC.

(ii) <u>2nd Unit :</u>

(a) Construction of 400kV S/S Basti

(b) Phase-I: Construction of Tanda Extn. – Basti 400 kV DC (Q) line – 50 km.

(c) Phase-II:

- Tanda Extn. – Gonda 400 kV DC (Q) line(Only one ckt to terminate at Tanda Extn.)
- Gonda (400) – Shahjahanpur 400 kV DC(Q) line.
- Due to limited 400 kV bays at Tanda Extn., disconnecting one ckt. of Tanda (400) – Basti 400 kV D/C line & connecting directly with Tanda –Gonda 400 kV S/C line resulting in following configuration from Tanda Extn. in addition to (i) for unit 1st as above.
  - **a.** Tanda TPS Extn. – Gonda (400) SC (Q) line.
  - **b.** Tanda TPS Extn. – Basti (400) SC (Q) line.
  - **c.** Gonda (400) – Basti 400 kV SC (Q) line.
  - **d.** Gonda (400) – Shahjahanpur 400 kV DC (Q) line.

400kV GIS S/S Basti to be constructed by UPPTCL in a highly compressed schedule.

2.3 Strengthening of 220 kV system around Tanda :-

Space for 2 Nos. 220kV bays is available at Tanda TPS Extn. (as confirmed by NTPC). To strengthen 220 kV system in the area, following is proposed :-

1. Tanda Extn. (400)- Tanda (220) 220 kV DC line (By UPPTCL)-25km
2. Construction of 220 kV bays at Tanda Extn. TPS swicthyard (By UPPTCL)- 2Nos.

2.4 Additional Downstream of Sohawal (400) PG substation and Strengthening of 220 kV system around Gonda, Behraich & Devipatan area :-

2.4.1 Space for 2Nos. of 220 kV bays are available at Sohawal(400) PG substation. Gonda, Behraich 220 kV are existing UPPTCL substations besides Gonda(400) S/S and more 220 kV substations are also proposed in the area. On review of loading of 220 kV line & their N-1 non-compliance following is proposed:-

i. Sohawal 400(PG) – Gonda(220) 220 kV D/C line - 40 km & one ckt to terminate at UPPTCL Gonda (220) & other at Behraich(220) substation.
ii. Construction of New 220/132/33 kV 2x160,2x40 MVA GIS substation by UPPTCL at Ayodhya(Faizabad)
iii. LILO of one ckt of Sohawal 400(PG) –Tanda (New) 220 kV D/C line (of UPPTCL) at Ayodhya substation.

It is to mention that the construction of 02 No. 220kV Bays at Sohawal(PG) 400kV Substation shall be done by UPPTCL.

Studies for above proposals(2.1-2.4) are enclosed at Annexure-B.

2.5 Downstream to Gorakhpur 400 (PG) substation:-

Gorakhpur 400(PG) substation is presently feeding Bansi, Bharuwa (Gorakhpur) 220kV substations. Another 220kV UPPTCL substation Gola(Gorakhpur) shall soon get connected to Gorkahpur (PG) substation and the same had already been noted by previous SCM. In the 39th SCPSPNR, one no. of 400/220 kV transformer substation alongwith 2Nos. 220kV bays at Gorakhpur(PG). The committee may kindly note the following downstream of Gorakhpur (PG) to utilize 220kV bays:-

i. Gorakhpur(PG) – Maharajganj 220 kV DC line (Twin Moose) – 40 km
ii. Maharajganj- Pharenda, Anandnagar 220 kV DC line -30 km

2.6 Utilization of 220kV Bays at 400kV Shahjahanpur(PG) & 765kV Mataur(PG) S/S:

2.6.1 220kV bays are available at Shahjahanpur(PG) S/S & shall be utilized as under:

i. Creation of 220/132/33 kV S/S Azizpur(Shahjahanpur) 2x160+2x40 MVA

ii. 220kV D/C PGCIL Shahjahanpur(400)-Azizpur(Shahjahanpur) line - 20km

iii. 220kV S/C line Shahjahanpur(220)-Azizpur(220) – 20km

2.6.2 Two number of 220kV bays are under construction at 765/400/220kV S/S Meerut(PGCIL). They will be connected and utilized as follows: -

(a) Meerut PG (765)-Charla (220) Meerut 220kV S/C line (Presently Charla (220) UPPTCL S/S is being fed from Muzzafarnagar (400)).

(b) Meerut PG (765) –Partapur (220) 220kV S/C line (Partapur (220) Meerut UPPTCL S/S will also be fed from Hapur(765) S/S).

2.7 New 220kV Substations:

2.7.1 Creation of 220/132/33 kV 2x160+2x40 MVA S/S Malwan(Fatehpur)

i) LILO of one ckt of 220kV D/C line Fatehpur(UP)-Unchahar(TPS) UPPTCL at Malwan(220) S/S -30km

2.7.2 **LILO of 220kV DC UPPTCL line Ghazipur(DTL)-Badarpur Delhi (TPS) at Noida (Sec-20).**

Noida (Sec-20) 220kV substation is an important substation of UPPTCL. Its incoming lines from Gr.Noida(400) are overloaded. Presently Noida(Sec-20) is being connected by T-off of 220kV SC Ghazipur(DTL)-Badarpur (TPS) line it is now proposed to additionally feed by constructing LILO of this line instead of T-off for proper sharing of loads.

2.7.3 Creation of 220/33 kV S/S Botanical garden GIS(Noida) (3x60 MVA)

- Noida(148)-Botanical Garden(GIS) 220kV DC line -27km
- LILO of Ghazipur-Noida 220kV S/C line at Botanical garden(GIS) – 01km

2.8 New 220kV S/S Intra State Under Construction:

2.8.1 In view of development and load growth in G.Noida area, following substations are being planned:-

2.8.2 Construction of 220/33 kV Substation IITGNL(Integrated Industrial Township Greator Noida)(GIS)

i) Creation of 220/33 kV 4x60 MVA S/S IITGNL(GIS) & 220/33 kV 2x60 MVA S/S Jevar(GB nagar)

ii) Gr.noida(765)WUPPTCL- IITGNL 220kV D/C line -45km

iii) Sikandrabad(400)WUPPTCL-IITGNL 220kV D/C line – 42km

2.8.3 Construction of 220/33 kV 2x60 MVA S/S Jewar(Gautam Budh nagar)

LILO of one ckt of Gr.Noida(765)WUPPTCL-IITGNL 220kV DC line -20km

The Committee may kindly note & approve.

2.9 Modification of Downstream 220kV Connectivity at Jawaharpur(TPS) 2x660 MW:

2.9.1 In 38th SCM the evacuation system of 2x660 MW Jawaharpur (Etah) TPS UPRVUNL (2021-22) was approved as under:

i. Evacuation at 765kV with G.T.21/765 kV
ii. LILO of Mainpuri- Greater Noida 765 kV S/C line at Jawaharpur TPS-30km
iii. 765/400 kV, 2x1500 ICT at Jawaharpur TPS
iv. 400/220kV, 2x500 ICT at Jawaharpur TPS
v. Creation of Firozabad 400/220/132kV 2x500,2x160 MVA substation
vi. Jawaharpur TPS- Firozabad 400kV DC line- 80km
vii. Firozabad – Agra South 400kV DC- 40km
viii. Etah- Jawaharpur TPS 220kV DC -20km
ix. Jawaharpur TPS- Sirsaganj 220kV DC-40km
x. 330 MVAR, 765kV Bus Reactor at Jawaharpur TPS

Due to loadings on evacuation lines and available network besides ROW issues, the earlier approved after Modification of (pt. vi & vii) the connectivity is proposed to be as under:-

i. Evacuation at 765kV with G.T.21/765 kV
ii. LILO of Mainpuri- Greater Noida 765 kV S/C line (of UPPTCL) at Jawaharpur TPS-30km
iii. 765/400/220 kV, 2x1500, 2x500 MVA ICT at Jawaharpur TPS
iv. Creation of Firozabad 400/220/132kV 2x500,2x160 MVA substation
v. Jawaharpur TPS- Firozabad 400kV DC(Quad) line- 80km
vi. LILO of one ckt of Fatehabad,Agra(765)-Agra South(400) 400kV D/C line at Firozabad(400) - 20km
vii. LILO of Mainpuri-Sikandrarao 220 kV S/C line (existing) at Jawahapur TPS-15 Km (for startup power)
viii. Creation of 220/132/33 kV UPPTCL S/S Kasganj(2x160+2x40 MVA)
ix. LILO of 220kV line SikandraRao(220)-Jawaharpur TPS(220) section at Kasganj(220)-45km
x. 330 MVAR, 765kV Bus Reactor at Jawaharpur TPS

The Committee may kindly note & approve.

2.10 Modification of Upgradation of existing 220/132kV Sahupuri(Chandauli) Substation to 400/220kV, 2x500 MVA(GIS)

2.10.1 In 39th meeting of SCPSPNR, upgradation of existing 220/132kV Sahupuri Substation to 400/220 kV, 2x500 MVA was approved as:

i. Upgradation of existing 220/132kV (1x160+2x200) MVA, Sahupuri Substation to 2x500 MVA, 400/220 kV level.
ii. LILO of both circuits of Biharshariff-Varanasi PG(765) 400kV DC (Quad) lines at 400kV Sahupuri(GIS) - 30kms along with 50/63 MVAR line reactor at Sahupuri end.
iii. Extension of 220kV bus of 400/220 kV Sahupuri Substation for interconnection with Sahupuri 220/132kV Substation with twin moose conductor.
iv. 1x125 MVAR, 400kV bus reactor at 400/220 kV Sahupuri.

2.10.2 Now Considering availabilities of route and load orientation, the above transmission system is modified as follows**:**

i. Upgradation of existing 220/132kV (1x160+2x200) MVA, Sahupuri(Chandauli) Substation to 2x500 MVA, 400/220 kV level(GIS).
ii. LILO of both circuits of Biharshariff-Varanasi PG(765) 400kV DC (Quad) lines at 400kV Sahupuri(GIS) - 30kms along with 63 MVAR line reactor at Sahupuri end on each line.
iii. Extension of 220kV bus of 400/220 kV Sahupuri(GIS) Substation for interconnection with Sahupuri 220/132kV Substation with U/G Cable - 2x0.7 km.
iv. Shifting of 220kV Sahupuri(220)-Bhelupur(220) DC line to 400/220 kV Chandauli with U/G cable- 2x0.7 km
v. 1x125 MVAR, 400kV bus reactor at 400/220 kV Sahupuri(Chandauli).

The Committee may kindly note & approve.

2.11 Augmentation of 400kV PGCIL substations.

It is noted that 400/220kV S/S Sohawal(PG) and Saharanpur(PG) will soon be N-1 non-compliant. Therefore, augmentation of the transformation capacity is required at 400/220kV S/S Sohawal(PG) and Saharanpur(PG).

The Committee may kindly approve.

2.12 Intimation on Increasing Capacity of 400/220kV UPPTCL Substations (As per availability of Transformers)

A) I/C of 400/220kV S/S Azamgarh from 315+500 MVA to 2x500 MVA U/C
B) I/C of 400/220kV S/S Obra TPS from 2x240 MVA to 2x315+240 MVA U/C (315MVA already added and another 315MVA in a week & 240MVA in 6 month)
C) I/C of 400/220kV S/S Motiram Adda Gorakhpur(UPPTCL) from 315+500 MVA to 315+500+240 MVA(240 MVA in 6 months)
D) I/C of 400/220kV S/S Muradnagar-II (UP) 315+240 MVA to 315+2x240 MVA U/C
E) I/C of 400/220kV S/S Unnao from 2x315 MVA to 3x315 MVA U/C in 6 months
F) I/C of 400/220kV S/S Sarnath 2x315+500 MVA to 315+2x500 MVA
G) I/C of 400/220kV S/S Moradabad 2x315 MVA to 2x500 MVA(Already completed)
H) I/C of 400/220kV S/S Math, Mathura 2x315 MVA to 1x315+1x500 MVA or 3x315 MVA

The Committee may kindly note.

3.0 Evacuation of 4000 MW Solar Power in Phased manner in four years (2020-23) under Green Corridor-II:
(in continuation to the item no 18 of the main agenda)

3.1 UPPTCL vide their letter no 3265/SE(TP&PSS)CEA dated 22.5.2018 has amended the proposal for evacuation of power from 4000 MW in Bundelkhand region included in the agenda item no 18 of the main agenda. The amended proposal is as follows:

Substations planned:

Voltage level	First Year (Apr.2020)	Second Year (Apr.2021)	Third Year (Apr.2022)	Fourth Year (Apr.2023)	Total
765kV	0	0	1	0	**1**
400kV	0	2	3	1	**6**
220kV	4	2	3	2	**11**
132kV	6	1	0	2	**9**
TOTAL	**10**	**5**	**7**	**5**	**27**

3.2 Evacuation Plan of 1st Year Solar Power for 1000 MW

<u>220kV Substations</u>

i) Creation of 220/132/33 kV, 2x160+2x40 MVA Rampura(Jalaun)

a) 220kV SC line Rampura-Sikandra(220)-30km

ii) Creation of 220/132/33 kV, 2x160+2x40 MVA Talbahat (Lalitpur)

a) 220kV DC line Talbahat(Lalitpur)-Babina(Jhansi) U/C- 40 km

iii) Creation of 220/132/33 kV, 2x160+2x40 MVA Birdha (Lalitpur)

a) 220kV SC line Birdha(Lalitpur)-Lalitpur(220) -35km

iv) Creation of 220/132/33 kV, 2x160+2x40 MVA Mandawra (Lalitpur)

a) 220kV SC line Mandawra(Lalitpur)- Lalitpur(220) -50km

<u>132kV Substations</u>

v) Creation of 132/33 kV, 2x40 MVA Kadaura(Jalaun)

a) 132kV SC line Kadaura-Hamirpur(Patara)-35km

vi) Creation of 132/33 kV, 2x40 MVA Kuthond (Jalaun)

a) 132kV SC line Kuthond(Jalaun)-Madhogarh -25km

vii) Creation of 132/33 kV, 2x40 MVA Kurara(Hamirpur)

a) 132kV SC line Kurara(Hamirpur)-Bharua(Sumerpur) -32km

viii) Creation of 132/33 kV, 2x40 MVA Gohand(Hamirpur)

a) 132kV SC line Gohand(Hamirpur)-Bharua(Sumerpur) -50km

ix) Creation of 132/33 kV, 2x40 MVA Moth(Jhansi)

a)132kV SC line Moth(New) Jhansi-Moth(existing jhansi) -10km

x) Creation of 132/33 kV, 2x40 MVA Barokh Khurd(Banda)

a)132kV SC line Barokh khurd(Banda)- Banda(400) -25km

b)Creation of 132kV Voltage level at Banda 400/220/132 kV

3.3 <u>Evacuation Plan of 2nd Year Solar Power for 1000 MW</u>

<u>400kV Substations</u>

i) Creation of 400/220/132 kV, 2x500+2x160 MVA Maheba(Jalaun)

a) LILO of 400kV DC line one ckt banda(400)-Orai(400) at Maheba(Jalaun)-25km

ii) Creation of 400/220/132 kV, 2x500+2x160 MVA Sarila(Hamirpur)

a) 400kV SC line Sarila(Hamirpur)-Maheba(Jalaun) -104km

b) 400kV SC line Sarila(Hamirpur)-Banda -74km

<u>220kV Substations</u>

i) Creation of 220/132/33 kV, 2x160+2x40 MVA Dakaur (Jalaun)

a) 220kV DC line Dakaur-Maheba(400) -35km

ii) Creation of 220/132 kV, 2x160+2x40 MVA Panwari(Mahoba)

a) 220kV SC line Panwari(Mahoba)-Sarila(Hamirpur) -40km

<u>132kV Substation</u>

i) Creation of 132/33 kV, 2x40 MVA Muskara (Hamirpur)

a) 132kV DC line Muskara(Hamirpur)-Sarila(Hamirpur) -15km

3.4 Evacuation Plan of 3rd Year Solar Power for 1000 MW

765kV Substation

i) Creation of 765/400/220 kV, 2x1500+2x500 MVA Gurusarai(Jhansi)

a) 765kV SC line Gurusarai(Jhansi)-Mainpuri -185km
b) Construction of 765kV Bays at Mainpuri S/S.

400kV Substations

i) Creation of 400/220/132 kV, 2x500+2x160 MVA Charkhari(Mahoba)

a) 400kV SC line Charkari(Maheba)-Sarila(Hamirpur) -40km
b) 400kV SC line Charkari(Mahoba)-Gurusarai(Jhansi) -80km

c) 220kV DC line Fatehpur(400)-Malwa(Fatehpur) -35km

ii) Creation of 400/220/132 kV, 2x500+2x160 MVA Farrukhabad

a) 400kV DC line Maheba(Jalaun)-Farrukhabad -140km
b) 400kV SC line Farrukhabad-Badaun -95km
c) 220kV DC line Farrukhabad(400)-Neebkarori -50km
d) 220kV DC line Farrukhabad(400)-Etah(220) -90km

iii) Creation of 400/220/132 kV, 2x500+2x160 MVA Fatehpur

a) 400kV SC line Fatehpur(400)-Sarila(Hamirpur) -115km
b) 400kV SC line Fatehpur(400)-Charkhari(Mahoba) -120km
c) 400kV DC line Fatehpur(400)-Fatehpur(PG) -50km
d) 220kV DC line Fatehpur(400)-Malwan(Fatehpur)-35km

220kV Substations

i) Creation of 220/132/33 kV, 2x160+2x40 MVA Bamaur(Jhansi)

a) 220kV DC line Bamaur(Jhansi)-Gurusarai(Jhansi) -12 km

ii) Creation of 220/132/33 kV, 2x160+2x40 MVA Bangra(Jhansi)

a) 132kV SC line Bangra(Jhansi)-Gurusarai(Jhansi) -15km

iii) Creation of 220/132/33 kV, 2x160+2x40 MVA Kabrai(Mahoba)

a) 220kV DC line Kabrai(Mahoba)-Charkhari(Mahoba) -26km

3.5 Evacuation Plan of 4th Year Solar Power for 1000 MW

400kV Substation

i) Creation of 400/220/132 kV, 2x500+2x160 MVA Jakhora(Lalitpur) & with a provision of extension of s/s to 765kV

a) 765kV SC line Jakhora(Lalitpur)-Gurusarai(Jhansi) -115km(line to initially operate at 400kV)
b) 400kV SC line Jakhora(Lalitpur)-Lalitpur TPS -30km(After Development of 400kV Voltage level of Lalitpur TPS)
c) 400kV DC line Jakhora-Orai(PG)765 -167km

<u>220kV Substations</u>

i) Creation of 220/132/33 kV, 2x160+2x40 MVA Baragaon(Jhansi)

b) 220kV DC line Baragaon(Jhansi)-Gurusarai(Jhansi) -50km

ii) Creation of 220/132/33 kV, 2x160+2x40 MVA Jaitpur(Mahoba)

a) 220kV DC line Jaitpur(Mahoba)-Charkhari(Mahoba) -22km
b) 220kV DC line Talbahat(Lalitpur)-Jakhora(Lalitpur) -16km
c) 220kV SC line Rampura(Jalaun)-Maheba(Jalaun)- 36km

<u>132kV Substations</u>

i) Creation of 132/33 kV, 2x40 MVA Mehrauni(Lalitpur)

(a) 132kV DC line Mehrauni(Lalitpur)-Jakhora(Lalitpur) -45km

ii) Creation of 132/33 kV, 2x40 MVA Barh(Lalitpur)

(a) 132kV DC line Barh(Lalitpur)-Jakhora(Lalitpur) -26km

3.6 In the above system, the following changes has been proposed by CEA:

Evacuation Plan of 1st Year Solar Power for 1000 MW			**Remarks**
	Proposed by UPPTCL	**Proposed by CEA**	
1.	**Creation of 220/132/33 kV, 2x160+2x40 MVA Rampura(Jalaun)** a) 220kV SC line Rampura-Sikandra(220)-30km	**Creation of 220/132/33 kV, 1x160+1x40 MVA Rampura(Jalaun)** a) 220kV S/C line Rampura-Sikandra(220)-30km	1x160 + 1x40 MVA ICTs deleted
2.	**Creation of 220/132/33 kV, 2x160 + 2x40 MVA Talbahat (Lalitpur)** a) 220kV DC line Talbahat (Lalitpur)-Babina(Jhansi) - 40 km	**Creation of 220/132/33 kV, 2x160 + 2x40 MVA Talbahat (Lalitpur)** a) 220kV D/C line Talbahat (Lalitpur)-Babina(Jhansi) - 40 km	No changes
3.	**Creation of 220/132/33 kV, 2x160 + 2x40 MVA Birdha (Lalitpur)** a) 220kV SC line Birdha(Lalitpur)-Lalitpur(220) -35km	**Creation of 220/132/33 kV, 1x160 + 1x40 MVA Birdha (Lalitpur)** a) 220kV S/C line Birdha(Lalitpur)-Lalitpur(220) -35km	1x160 + 1x40 MVA ICTs deleted

4.	**Creation of 220/132/33 kV, 2x160+2x40 MVA Mandawra (Lalitpur)** a) 220kV SC line Mandawra (Lalitpur) - Lalitpur(220) -50km	**Creation of 220/132/33 kV, 1x160+1x40 MVA Mandawra (Lalitpur)** a) 220kV S/C line Mandawra (Lalitpur)- Lalitpur(220) -50km	1x160 + 1x40 MVA ICTs deleted
5.	**Creation of 132/33 kV, 2x40 MVA Kadaura(Jalaun)** a) 132kV SC line Kadaura-Hamirpur(Patara) - 35km	**Creation of 132/33 kV, 1x40 MVA Kadaura(Jalaun)** a) 132kV S/C line Kadaura-Hamirpur(Patara) - 35km	1x40 MVA ICT deleted
6.	**Creation of 132/33 kV, 2x40 MVA Kuthond (Jalaun)** a) 132kV SC line Kuthond(Jalaun)-Madhogarh -25km	**Creation of 132/33 kV, 1x40 MVA Kuthond (Jalaun)** a) 132kV SC line Kuthond(Jalaun)-Madhogarh -25km	1x40 MVA ICT deleted
7.	**Creation of 132/33 kV, 2x40 MVA Kurara(Hamirpur)** a) 132kV SC line Kurara(Hamirpur)-Bharua(Sumerpur) -32km	**Creation of 132/33 kV, 1x40 MVA Kurara(Hamirpur)** a) 132kV SC line Kurara(Hamirpur)-Bharua(Sumerpur) -32km	1x40 MVA ICT deleted
8.	**Creation of 132/33 kV, 2x40 MVA Gohand(Hamirpur)** a) 132kV SC line Gohand(Hamirpur)-Bharua(Sumerpur) -50km	**Creation of 132/33 kV, 1x40 MVA Gohand(Hamirpur)** a) 132kV SC line Gohand(Hamirpur)-Bharua(Sumerpur) -50km	1x40 MVA ICT deleted
9.	**Creation of 132/33 kV, 2x40 MVA Moth(Jhansi)** a)132kV SC line Moth(New) Jhansi-Moth(existing Jhansi) -10km	**Creation of 132/33 kV, 2x40 MVA Moth(Jhansi)** a)132kV SC line Moth(New) Jhansi-Moth(existing Jhansi) -10km	No changes
10.	**Creation of 132/33 kV, 2x40 MVA Barokh Khurd(Banda)** a)132kV SC line Barokh khurd(Banda)- Banda(400) -25km	**Creation of 132/33 kV, 2x40 MVA Barokh Khurd(Banda)** a)132kV SC line Barokh khurd(Banda)- Banda(400) -25km	No changes
11.	Creation of 132kV Voltage level at Banda 400/220/132 kV	Creation of 132kV Voltage level at Banda 400/220/132 kV	No changes
	Evacuation Plan of 2nd Year Solar Power for 1000 MW		
1.	**Creation of 400/220/132 kV, 2x500+2x160 MVA Maheba(Jalaun)** c) LILO of 400kV DC line one ckt Banda(400)-Orai(400) at Maheba(Jalaun)-25km	**Creation of 400/220/132 kV, 2x500+2x160 MVA Maheba(Jalaun)** (a) 400 kV Maheba – Orai 400 kV D/C line (if line bays are available) **OR**	Additional option provided

		(b) LILO of one ckt banda(400)-Orai(400) 400kV D/C line) at Maheba(Jalaun)-25km	
2.	**Creation of 400/220/132 kV, 2x500+2x160 MVA Sarila(Hamirpur)** (a) 400kV SC line Sarila(Hamirpur)-Maheba(Jalaun) -104km (b) 400kV SC line Sarila(Hamirpur)-Banda -74km	**Creation of 220/132 kV, 2x160 MVA Sarila(Hamirpur)** (a) 220kV D/C line Sarila(Hamirpur)-Maheba(Jalaun) -104km	400 kV Sarila – Banda line deleted
3.	**Creation of 220/132/33 kV, 2x160+2x40 MVA Dakaur (Jalaun)** (a) 220kV DC line Dakaur-Maheba(400) -35km	**Creation of 220/132/33 kV, 1x160+1x40 MVA Dakaur (Jalaun)** (a) 220kV S/C line Dakaur-Maheba(400) -35km	1x160 + 1x40 MVA ICTs deleted. SC line in place of DC line
4.	**Creation of 220/132 kV, 2x160+2x40 MVA Panwari(Mahoba)** (a) 220kV SC line Panwari (Mahoba)-Sarila(Hamirpur) -40km	**Creation of 220/132 kV, 1x160+1x40 MVA Panwari(Mahoba)** (a) 220kV S/C line Panwari (Mahoba)-Sarila(Hamirpur) -40km	1x160 + 1x40 MVA ICTs deleted
5.	**Creation of 132/33 kV, 2x40 MVA Muskara (Hamirpur)** (a) 132kV DC line Muskara(Hamirpur)-Sarila(Hamirpur) -15km	**Creation of 132/33 kV, 2x40 MVA Muskara (Hamirpur)** (a) 132kV DC line Muskara(Hamirpur)-Sarila(Hamirpur) -15km	No changes
	Evacuation Plan of 3rd Year Solar Power for 1000 MW		
1.	**Creation of 765/400/220 kV, 2x1500+2x500 MVA Gurusarai(Jhansi)** c) 765kV S/C line Gurusarai (Jhansi)-Mainpuri -185km d) Construction of 765kV Bays at Mainpuri S/S	**Creation of 765/400/220 kV, 2x1500+3x500 MVA Gurusarai(Jhansi)** a) 765kV S/C line Gurusarai (Jhansi)-Mainpuri -185km b) Construction of 765kV Bays at Mainpuri S/S c) 400 kV Gurusarai – Orai (Quad) D/C line d) LILO of 400 kV Parichha – Mainpuri line at Gurusarai	400 kV Gurusarai – Orai (Quad) DC line and LILO of 400 kV Parichha – Mainpuri line at Gurusarai **are added.** **Availability**
2.	**Creation of 400/220/132 kV, 2x500+2x160 MVA Charkhari(Mahoba)**	**Creation of 220/132 kV, 1x160 MVA Charkhari(Mahoba)** a) 220kV D/C line Charkhari (Mahoba)-Gurusarai (Jhansi) -80km	220kV S/s in place of 400 kV S/s.

	b) 400kV SC line Charkhari(Maheba)-Sarila(Hamirpur) -40km c) 400kV SC line Charkhari(Mahoba)-Gurusarai(Jhansi) -80km d) 220kV DC line Fatehpur(400)-Malwa(Fatehpur) -35km		400 kV lines deleted
3.	**Creation of 400/220/132 kV, 2x500+2x160 MVA Farrukhabad** e) 400kV DC line Maheba (Jalaun) -Farrukhabad -140km f) 400kV SC line Farrukhabad-Badaun -95km g) 220kV DC line Farrukhabad(400)-Neebkarori -50km h) 220kV DC line Farrukhabad(400)-Etah(220) -90km	**Creation of 400/220/132 kV, 2x500+2x160 MVA Farrukhabad** a) 400kV S/C line Farrukhabad-Badaun -95km b) 220kV DC line Farrukhabad (400) -Neebkarori -50km c) 220kV DC line Farrukhabad(400)-Etah(220) -90km	400kV DC line Maheba (Jalaun) - Farrukhabad **deleted**
4.	**Creation of 400/220/132 kV, 2x500+2x160 MVA Fatehpur** e) 400kV SC line Fatehpur(400) - Sarila (Hamirpur) -115km f) 400kV SC line Fatehpur (400) - Charkhari (Mahoba) -120km g) 400kV DC line Fatehpur(400)-Fatehpur(PG) -50km h) 220kV DC line Fatehpur(400)-Malwan(Fatehpur)-35km		S/s deleted
5.	**Creation of 220/132/33 kV, 2x160+2x40 MVA Bamaur(Jhansi)** (a) 220kV DC line Bamaur (Jhansi)-Gurusarai(Jhansi) -12 km	**Creation of 220/132/33 kV, 2x160+2x40 MVA Bamaur(Jhansi)** (a) 220kV SC line Bamaur (Jhansi)-Gurusarai(Jhansi) -12 km	SC line in place of DC line
6.	**Creation of 220/132/33 kV, 2x160+2x40 MVA Bangra(Jhansi)** (a) 132kV SC line Bangra(Jhansi)-Gurusarai(Jhansi) -15km	**Creation of 220/132/33 kV, 2x160+2x40 MVA Bangra(Jhansi)** (a) 220kV S/C line Bangra(Jhansi)-Gurusarai(Jhansi) -15km	No changes

7.	**Creation of 220/132/33 kV, 2x160+2x40 MVA Kabrai(Mahoba)** (a) 220kV DC line Kabrai (Mahoba) - Charkhari(Mahoba) -26km	**Creation of 220/132/33 kV, 1x160+1x40 MVA Kabrai(Mahoba)** (a) 220kV SC line Kabrai (Mahoba) - Charkhari(Mahoba) -26km	SC line in place of DC line
	Evacuation Plan of 4th Year Solar Power for 1000 MW		
1.	**Creation of 400/220/132 kV, 2x500+2x160 MVA Jakhora(Lalitpur) & with a provision of extension of s/s to 765kV** d) 765kV SC line Jakhora(Lalitpur)-Gurusarai(Jhansi) -115km(line to initially operate at 400kV) e) 400kV SC line Jakhora(Lalitpur)-Lalitpur TPS -30km(After Development of 400kV Voltage level of Lalitpur TPS) f) 400kV DC line Jakhora-Orai(PG)765 -167km	**Creation of 400/220/132 kV, 2x500+2x160 MVA Jakhora(Lalitpur) & with a provision of extension of s/s to 765kV with 1x1500 MVA 765/400 kV ICT** a) 765kV S/C line Jakhora(Lalitpur)-Gurusarai(Jhansi) -115km(line to initially operate at 400kV) b) Interconnection of Lalitpur TPS through 220 kV Jakhora – Lalitpur TPS (HTLS) DC line. c) LILO of one circuit of 765 kV Lalitpur TPS – Agra DC line at Jakhora S/s (in time frame of creation of 765 kV level at Jakhora)	Interconnection with Lalitpur TPS provided. Jakhora – Orai line **deleted**
2.	**Creation of 220/132/33 kV, 2x160+2x40 MVA Baragaon(Jhansi)** (a) 220kV DC line Baragaon(Jhansi)-Gurusarai (Jhansi) -50km	**Creation of 220/132/33 kV, 2x160+2x40 MVA Baragaon(Jhansi)** (a) 220kV SC line Baragaon(Jhansi)-Gurusarai (Jhansi) -50km	SC line in place of DC line
3.	**Creation of 220/132/33 kV, 2x160+2x40 MVA Jaitpur(Mahoba)** (a) 220kV DC line Jaitpur(Mahoba)-Charkhari(Mahoba) -22km (b) 220kV DC line Talbahat(Lalitpur)-Jakhora(Lalitpur) -16km	**Creation of 220/132/33 kV, 2x160+2x40 MVA Jaitpur(Mahoba)** (a) 220kV SC line Jaitpur(Mahoba)-Charkhari(Mahoba) -22km	Talbahat-Jakhora and Rampura – Maheba lines deleted

	(c) 220kV SC line Rampura(Jalaun)-Maheba(Jalaun)- 36km		
4.	**Creation of 132/33 kV, 2x40 MVA Mehrauni(Lalitpur)** (a) 132kV DC line Mehrauni(Lalitpur)-Jakhora(Lalitpur) -45km	**Creation of 132/33 kV, 2x40 MVA Mehrauni(Lalitpur)** (a) 132kV DC line Mehrauni(Lalitpur)-Jakhora(Lalitpur) -45km	No changes
5.	**Creation of 132/33 kV, 2x40 MVA Barh(Lalitpur)** (a) 132kV DC line Barh(Lalitpur)-Jakhora(Lalitpur) -26km	**Creation of 132/33 kV, 2x40 MVA Barh(Lalitpur)** (a) 132kV DC line Barh(Lalitpur)-Jakhora(Lalitpur) -26km	No changes

3.7 The studies has been carried out at the time of completion of all the 4 phases of solar power injection. The proposed system integrates the Parichha TPS and Lalitpur TPS with the proposed RE corridor. Normal loadings on the lines is observed even in the case of outage of 2 nos. of outlets from Lalitpur TPS towards Agra. The exhibits of the studies are attached as **Annexure – C**.

3.8 Members may like to deliberate.

4.0 Transmission system for evacuation of power from Singrauli STPP -III (2x660 MW) of NTPC.

4.1 NTPC vide their letter dated 22.3.2018 informed that that they have planned to construct Singrauli STPP-III (2x660 MW) within the existing Singrauli TPS complex in UP. Tendering process for main plant, EPC package for the project is in advance stage and NIT has already been issued. Regarding sale of power from the project, NTPC also informed that they have commitment for purchase of 85% of power from UP. The investment approval is likely to be done by June-18 and the implementation time for the project is 44 months. NTPC requested to freeze the generation switchyard provisions for evacuation of power from Singrauli STPP-III (2x660 MW), so that the same could be included in their tender document.

4.2 To discuss the above issue a meeting was held on 7.5.2018 in CEA (minutes of meeting are enclosed at Annexure-D) wherein, CEA suggested that keeping in view the high short circuit level in Singrauli, Anpara generation complex, Singrauli St-III may be connected to Vindhyachal 765/400kV pooling station through Vindhyachal St-IV through Singrauli-III – Vindhyachal IV 400kV D/c line

NTPC opined that interconnection of Singrauli St-III with Rihand St-III may also be planned as it would provide two numbers of independent outlets for reliable evacuation of power from both Singrauli St-III and Rihand St-III. NTPC further informed that Vindhyachal St- IV and Vindhyachal St-V are interconnected through 400kV twin moose line about three kms in length. Vindhyachal St-IV and Vindhyachal pooling station are interconnected through 400kV 2xD/c quad line. Vindhyachal St-V is also interconnected with Vindhyachal St –III through

400kV twin moose line which is normally kept open. Therefore, instead of new 400kV D/c quad line between Singrauli-III and Vindhyachal IV, the following was suggested:

i) LILO of both circuit of Vindhyachal-IV - Vindhyachal–V 400kV D/c line (twin) at Singrauli-III thus forming Vindhyachal- IV –Singrauli –III 400kv D/c line and Vindhyachal–V - Singrauli–III 400kv D/c line.
ii) Upgradation of Vindhyachal- IV –Singrauli –III 400kv D/c line with HTLS conductor
iii) Singrauli-III – Rihand-III 400kV quad D/c line (20 km)

However, as per CEA opinion, with above suggestion Vindhyachal St-V would be radially connected to Singrauli St-III through a single 400 kV D/c line. Therefore, with shifting of one of the two nos. of 400kV quad lines (Vindhyachal St-IV - Vindhyachal Pool 400kV 2xD/c quad line) from Vindhyachal St-IV to Vindhyachal St-V would provide two number of 400kV outlets to Vindhyachal St-IV, Vindhyachal St-V, Singrauli St-III and Rihand St-III.

4.3 After deliberations in the meeting held on 7.5.2018 it was observed that availability of space at Vindhyachal St-V, Rihand St-III, Vindhyachal 765/400kV pooling station (for augmentation of 765/400kV ICT as overloading observed in preliminary studies during N-1 condition) and feasibility of 400kV link with Rihand St-III needs to be explored through a joint visit of CEA, CTU and NTPC. However, as far as the provisions at the generation switchyard for evacuation of power from Singrauli St-III is concerned, the following was agreed:

i) Step up voltage of 400Kv.
ii) 6 nos. of 400kV line bays.
iii) 1x125 MVAR, 400 kV bus reactor.

Members may like to deliberate.

5.0 DTL agenda regarding Reactive power Compensation in Delhi:

5.1 In the 39th meeting of SCPSPNR installation of reactors at various 400kV and 220kVS/Stn were agreed in and around Delhi to control high voltage issues particularly during winter off peak period. The installation of reactors were agreed subject to availability of space. DTL vide their letter no F.DTL/202/Opr(Plg)/DGM(Plg)/2018-19/F-20/50 dated 11.06.2018 has informed that there are some difficulty in installation of these reactors at some locations. The details are as under:

S.N.	Bus Name	Voltage Level (kV)	Reactor agreed in 39th SCPSPNR (MVAR)	Remarks
1.	Mundka	400	125	Space is available. 400kV bay is also required to be erected.
2.	Narela	220	25	No space is available
3.	R.K.Puram-I	220	25	No space is available
4.	Patparganj-II	220	2x25	No space is available
5.	Maharani Bagh	220	2x25	Could be considered after the erection of new GIS Stn.
6.	Bamnauli	220	25	Space is available. Considering the reactive power injection under high

				voltage conditions two no. reactors are proposed to be installed. Though the bays are available, some of the equipments are required to be erected.
7.	Subzi Mandi	220	2x25	At present, no space. Would be considered after the remodeling of the substation with GIS.
8.	Gopalpur	220	2x25	At present, no space. Would be considered at the time of establishment of 400kV S/Stn.
9.	Indrapastha	220	2x25	Space is available and 220kV bays are also required to be erected.
10.	Geeta Colony	220	2x25	No space.
11.	Harsh Vihar	220	2x25	Space and 220kV GIS bays are available at present. Due to space constraints at Patparganj and Preet Vihar Substations and to reduce the Reactive power injection two no. 50MVAR reactors are proposed.
12.	Wazirabad	220	2x25	No space.
13.	Electric Lane	220	2x25	Space constraint is there, so 1x50 MVAR is proposed. 220kV GIS bay is also required to be erected.
14.	Mandola	220	25	No space.
15.	AIIMS	220	2x25	No space.
16.	Sarita Vihar	220	25	No space.
17.	Bawana	220	25	No space.
18.	Preet Vihar	220	25	No space.
19.	Mundka	220	25	Space is available. 220kV bay is also required to be erected.
20.	Masjid Moth	220	25	No space.
21.	Maharani Bagh (PG)	400	125	To be installed in Powergrid through TBCB route.
22.	Mandola (PG)	400	125	
TOTAL			**1100**	

5.2 Based on the above, in the State Steering Committee meeting held on 30.10.2017 it was decided that at present, reactors would be installed in Delhi system at the following locations:

S. N.	**Bus Name**	**Voltage Level (kV)**	**Reactor (MVAR)**	**Remarks**
1.	Mundka	400	125	
2.	Bamnauli	220	2x25	

3.	Indrapastha	220	2x25	To be installed by DTL
4.	Harsh Vihar	220	2x50	
5.	Electric Lane	220	1x50	
6.	Mundka	220	25	
7.	Peeragarhi	220	1x50	One GIS 220kV bay is spare at Peeragarhi. The S/Stn. is connected with 1000sq.mm 220kV Mundka-Peeragarhi D/C (13KM) and 220kV Peeragarhi-Wazirpur D/C (8.3KM) cables. Due to these cables, during off-Peak hrs particularly during winter nights, voltage shoots up beyond the permissible limits. Therefore during winter nights one ckt. is kept in operation out of the four 220kV cable circuits to control high voltage issue to some extent. This ckt. also trips on account of high voltage affecting the areas fed from Peeragarhi S/Stn. To overcome high voltage issue one 220kV, 50 MVAR Reactor is proposed to be installed at Peeragarhi S/Stn. considering the fact that one 220kV GIS bay is also available.
8.	Maharani Bagh (PG)	400	125	To be installed in Powergrid through TBCB route.
9.	Mandola (PG)	400	125	
TOTAL			700	

5.3 DTL further informed that State Steering Committee also decided that in future wherever new 220KV Sub Station installed and in-feeds are envisaged through 220KV Cables, two nos. 25MVAR should be considered in the scheme.

5.4 M/s Siemens has conducted in coordination with DTL and recommended the following:-

a) 75MVAR (inductive) to 200MVAR (capacitive) SVC at 400kV Bamnauli S/Stn. with 125MVAR Fixed Reactor.
b) 125MVAR Fixed Reactor at 400kV Level and 25 MVAR Fixed Reactor at 220kV Level at Mundka.
c) 50MVAR Fixed Reactor at 220kV Maharani Bagh, Harsh Vihar and Electric Lane.

A copy of the report enclosed at Annexure-E.

5.5 DTL also informed that recent CERC order dt. 26.03.2018 in the matter of Following up actions on the recommendations of CAC Sub-Committee on congestion in Transmission at para 97(e) (Summary of Findings) stipulates the following:-

"CTU is directed to carry out a nationwide study to assess the requirement of SPS and dynamic control mechanism including SVCs, STAT COMs etc. including within the State Sector and its proposed funding mechanism and submit a report within six months of issue of this order to CEA and Commission."

5.6 DTL requested to the committee that the funding for reactive power management be done from PSDF.

Members may like to deliberate.

6.0 Proposal for conversion of 400kV D/c Bamnoli- Ballabhgarh O/H line into cable in Global City Project Gurugram (a JV of Centre & State Govt.) by DMICDC

6.1. Delhi-Mumbai Industrial Corridor Development Corporation (DMICDC) and Haryana State Industrial and Infrastructure Development Corporation (HSIIDC) are jointly developing Global City in Gurugram (Haryana). The Global City is a joint venture of DMICDC and HSIIDC to develop a city of international standard all along Delhi-Mumbai Industrial Corridor, which is covering States viz. Maharashtra, Gujarat, Rajasthan, Haryana and Uttar Pradesh.

6.2. The Global city, Gurugram project covers approx. 1004 Acres of land between NH-8 to Pataudi Road near Northern Peripheral Road (NPR) and Central Peripheral Road (CPR). The Global City is unique Project containing facilities like Metro connectivity, High way connectivity, etc. and all the utilities are underground (U/G) as per international standards. Therefore, it is proposed to make section of various 400 kV, 220 kV and 66 kV overhead (O/H) lines passing through the proposed Global city area U/G.

6.3. A section of the 400 kV Bamnauli-Ballabgarh D/C line of DTL is also passing across the Global City. DMICDC has earlier intimated that they had examined the possibility of shifting the line through O/H arrangement, which is not found feasible. Therefore, conversion of O/H section of the line falling in the Global city area into U/G is the only option.

6.4. Further, a meeting was held with DTL on 06-12-2017 in New Delhi, wherein, DTL had requested that matter of conversion of section of O/H 400 kV Bamnauli-Ballabgarh D/C line to U/G may be technically assessed by CEA as it forms a 400 kV hybrid system i.e. O/H transmission line - U/G cable - O/H transmission line.

6.5. The matters of conversion of a section of 400 kV Bamnauli-Ballabgarh D/C O/H line into U/G was discussed preliminarily in a meeting held on 18.12.2017 in CEA and following was emerged:

a) 400 kV Bamnauli-Ballabgarh D/C is a ACSR quad Bersimis line which belongs to M/s DTL. Therefore, consent of M/s DTL would be required for the conversion.

b) Cable of eq. rating to ACSR quad Bersimis conductor would be required for the conversion along with spare cable.

c) Adequate protection system is required for the fault in the U/G cable.

d) The U/G cable would be provided with Distributive Temperature Sensing (DTS) system all along the cable to identify to hotspot.

e) Global city to provide parameters & rating of the cable to assess the reactive compensation requirement.

f) Global city to explore following techno-economies options for conversion of the O/H section to U/G:

i) Using of buried cable

ii) Use of cable through trenches

iii) Gas Insulated line (GIL)

6.6. Regarding point (a) to (f) above, following clarifications have been submitted by HSIDC:

1) The consent of M/s DTL would be given after obtaining feasibility report from CEA.
2) 2500 sq mm size XLPE cable- two cable per phase will be laid as already laid in this line at Bamnoli end for 900mtr stretch.
3) Adequate protection will be laid i.e. DTS-Distributive Temperature Sensing System all along the cable to identify the hot spot and OFC cable will also be laid for protection as well as communication etc.
4) With respect to different options explored by HSIDC for conversion of the O/H section to U/G, it was observed that cost of GIL (without civil work) would be around 210 Crore and that of XLPE cable (without civil work) would be around 182 crore. The cost of civil works would also be higher in case of GIL, therefore, for conversion of the O/H section to U/G, cable is a better option.

6.7. The issue of reactive compensation was discussed in the meeting 15.5.2018 in CEA. The length of 400kV Ballabhgarh- Bamnoli is 52km ad length of line from Global City to Bamnoli is 16km. At Bamnoli end, one 900m cabling is already done by DTL and no bus reactor is provided for reactive compensation. It was agreed that value of susceptance (B) may be calculated and HSIDC would provide reactive compensation, if required.

6.8. HSIIDC vide their letter HSIIDC(IA)MK:2018:807 dated 25.5.2018 has requested CEA to provide feasibility report of conversion of 400kV Ballabhgarh –Bamnoli line into underground XLPE cable in a stretch of 3km (approx.) in Global city project.

6.9. Members may like to deliberate.

7.0 PTCUL Agenda regarding UITP scheme:

PTCUL vide their letter no C-1506/dir (Projects)/PTCUL/camp dated 15.6.2018 has forwarded the following items for inclusion in in agenda for 40th Meeting of SCPSPNR:

7.1. **Construction of 220/ 33 kV GIS Baramwari (Rudrapur) and its associated 220 kV D/C line from proposed 220/33 kV substation Baramwari (Rudrapur) to LILO point of Singoli Bhatwari HEPP (L&T) under Intra State Strengthening Scheme**:

7.1.1. 2x50MVA, 220/33 kV Baramwari Substation & its associated 220 kV line was proposed in UITP scheme for power evacuation of proposed 99 MW Singoli Bhatwari HEPP (M/s L&T) and 76 MW Phatabyung HEPP (M/s Lanco) which was approved by CEA vide their letter No. 12A/G/2006-SP&PA/39 dated 03/01/2007. UITP scheme of PTCUL has been accorded Deemed ISTS Status by Hon'ble CERC vide its order dated 31/01/2013.

7.1.2. A meeting was held in CEA on 25.09.2017, wherein, it was deliberated that Baramwari 220KV S/s would not be required in timeframe of 99MW Singoli Bhatwari HEP of M/s L&T and the same could be taken up by PTCUL when 76 MW Phatabynung HEP of M/s Lanco comes in future. Also as the Phatabyung HEP is now uncertain, it was advised to PTCUL to take up the 220KV D/c Baramwari-Srinagar Line in two phases:-

- Phase I: Point of interconnection (of Singoli Batwari HEP with proposed Baramwari-Srinagar 220KV D/c line) to Srinagar substation (matching with the commissioning of Singoli Bhatwari HEP). Dedicated line from Singoli Bhatwari switchyard to point of interconnection would be built by M/s L&T as an interim connectivity. With implementation of Baramwari switching station, M/s L&T would be required to construct 220kV D/c line from point of interconnection to Baramwari Switching station (as a part of final connectivity)

- Phase II: Baramwari to Point of interconnection (of Singoli Batwari HEP with proposed Baramwari-Srinagar 220KV D/c line). (to be taken up for implementation matching with the commissioning schedule of Phatabyoung HEP)

7.1.3. PTCUL, to meet local demand in Baramwari (Rudrapur) area and in view of commissioning schedule of SHPs of UJVN Ltd (Kaliganga I - 4 MW, Kaliganga II - 4.5MW & Madhyamaheshwar- 15 MW), has proposed to implement 220/33 kV 10x6MVA Baramwari (Rudrapur) substation and 220 kV D/C line from proposed 220/33 kV substation Baramwari (Rudrapur) to LILO point of Singoli Bhatwari HEP (L&T) as under Intra State Transmission network. The necessary approval from the State Electricity Regulatory Commission will be sought by PTCUL.

The proposed 220/33 KV Substation will be connected to 400KV Srinagar S/s i.e ISTS network through 220KV D/c Baramwari-Srinagar Line (Phase —I & II) which is also part of ISTS Network.

7.1.4. In view of the above, PTCUL has requested SCPSPNR to deliberate on the following issues wrt above proposal:

(i) Commercial treatment of second phase of 220kV Baramwari –Srinagar line by changing its status from ISTS to Intra STS and accordingly its recovery through ARR of PTCUL.

(ii) Recovery mechanism when this Intra STS will be used in conjunction with deemed ISTS network

(iii) Status of 220kV Baramwari switching station and phase-II of 220kV D/c Baramwari to Point of interconnection (of Singoli Batwari HEP with proposed Baramwari-Srinagar 220KV D/c line) when Phata Byung will come in future.

7.2. Issue related to signing of Transmission Agreement/LTA Agreements for implementation of UITP Scheme (deemed ISTS) by PTCUL for evacuation of power from various Generators:

7.2.1 PTCUL is implementing UITP scheme as deemed ISTS as per CERC order dated 31.10.2013 for evacuation of power from Tapovan Vishnugad HEP (520MW) by M/s NTPC, Singoli Bhatwari 99MW(M/s L&T), Phata Byung (76MW) by Lanco mandakini HEPL), Pipalkoti 444 ME(by THDC ltd), Naitwar Mori(60 MW) by SJVNL.

7.2.2 CTU is the nodal agency for grant of connectivity and LTA to these generators in accordance with applicable CERC regulations. Accordingly, intimation for connectivity & LTA had been issues to following generators by CTU as quoted below:

1. **M/s L&T Uttaranchal Hydropower Ltd** (**Singoli Bhatwari HEP (99MW))**

Point of connection: -
Interim arrangement - 400/220kV Srinagar substation(PTCUL)
Final arrangement – 220kV Baramwari substation(PTCUL)

Transmission system for grant of Connectivity to Singoli Bhatwari HEP

Interim arrangement:

- LILO of one circuit of Phata Byung–Srinagar 220 kV D/c line (LILO point at proposed Baramwari sw. station site) at Singoli Bhatwari – LILO to be implemented by applicant (including 220 kV bays at generation end).

Common transmission system required for Connectivity

- Proposed site of Baramwari (PTCUL) S/s – Srinagar (PTCUL) substation 220 kV D/c line - To be implemented by PTCUL as deemed ISTS

Final arrangement:

- Singoli Bhatwari generation switchyard–Baramwari sw. station 220 kV D/c with the opening of LILO as mentioned above in Interim arrangement - To be implemented by applicant (including 220 kV bays at both ends).

  Common transmission system required for Connectivity

- Proposed site of Baramwari (PTCUL) S/s – Srinagar (PTCUL) substation 220 kV D/c line - To be implemented by PTCUL as deemed ISTS.

Transmission system for Long Term Access:

Srinagar-Kashipur 400kV D/c line

2. M/s NTPC (520 MW Tapovan Vishnugarh HEP):

As per intimation of connectivity, the point of connection is Generation switchyard of Tapovan Vishnugarh HEP & the transmission system, required for connectivity is as follows:

- Tapovan Vishnugad HEP–Proposed site of Pipalkoti 400 kV substation 400kV D/c (Twin Moose) line – To be implemented by PTCUL
- Proposed site of Pipalkoti 400 kV S/s-Srinagar 400kV D/c (Quad Moose) line - To be implemented by PTCUL

Transmission system for Long Term Access:

- Srinagar-Kashipur 400kV D/c line

3. M/s THDC (444 MW Pipalkoti HEP):

The point of connection is Generation switchyard of Pipalkoti HEP & the transmission system, required for connectivity is as follows:

(i) Pipalkoti HEP-Pipalkoti switching station 400kV D/c line (twin moose) – to be implemented by PTCUL

(ii) Establishment of the 400kV Pipalkoti Switching station - to be implemented by PTCUL

(iii) Diversion of Tapovan Vishnugad HEP-Proposed site of Pipalkoti 400kV Substation D/c line at Pipalkoti switching station - to be implemented by PTCUL

(iv) Diversion of Proposed site of Pipalkoti 400kV Substation-Srinagar 400kV D/c line at Pipalkoti switching station - to be implemented by PTCUL

4. M/s SJVN (60 MW Naitwar Mori HEP):

As per intimation of connectivity, the point of connection is 400/220kV Dehradun S/s & the transmission system required for connectivity is as follows:

(i) Naitwar Mori HEP - location of Mori 220/132kV (PTCUL) S/s 220 kV D/c line (to be implemented by applicant incl. 2 no. 220 kV line bays at Mori)
(ii) Location of Mori 220/132 kV(PTCUL) S/s–Dehradun (POWERGRID)220 kV D/c line along with 2 nos. of 220 kV line bays at Dehradun (to be implemented by PTCUL)

- Mori 220/132 kV substation is not required in the time frame of of Naitwar Mori HEP

5. M/s Lanco Mandakini Hydro Energy Pvt. Ltd (Phata Byung Hydro project (76 MW)):

Point at which connectivity is granted-
Interim arrangement - 400/220kV Srinagar substation(PTCUL) (till the commissioning of Baramwari 220kV switching station of PTCUL)

Final arrangement – 220kV Baramwari substation(PTCUL)
Transmission system for grant of Connectivity
Interim arrangement:

- Phata Byung generation switchyard–Proposed site of Baramwari sw. station 220 kV D/c line - To be implemented by applicant (including 220 kV bays at generation end).

Common transmission system required for Connectivity (deemed ISTS):

- Proposed site of Baramwari (PTCUL) sw. station–Srinagar (PTCUL) substation 220 kV D/c line - To be implemented by PTCUL

Final arrangement:

- Phata Byung generation switchyard–Baramwari S/s 220 kV D/c - To be implemented by applicant (including 220 kV bays at both ends).

Transmission system for Long Term Access:

- Srinagar-Kashipur 400kV D/c line

Note: as per minutes of meeting held on 25.9.2017 in CEA between CTU, CEA, PTCUL and generators, Phata Byung has become uncertain and 220kV D/c Baramwari –Srinagar line is to be implemented in two phases.

7.2.3 PTCUL's view on connectivity/LTA intimations are:

i) On the above Intimations of Connectivity/LTA, PTCUL has raised its objection at various platforms/meetings and with CTU on the alleged treatment of Transmission System being implemented by PTCUL as connectivity lines & transmission system required for LTA. It is understood that Connectivity & LTA are two different provisions and are to be dealt accordingly as per CERC (Grant of Connectivity, Long term Access and Medium term Open Access in inter-State Transmission and related matters) Regulations, 2009. But at the same time it is implicit that the whole Transmission System is being developed and implemented by PTCUL under coordinated system planning of CEA/CTU and accordingly all the elements of Associated Transmission System being implemented by PTCUL is to be made part of LTA intimations/LTA Agreements so as to ensure its recovery through beneficiaries rather than executing a separate Transmission Agreement for Connectivity lines as per CTU. As per CERC Regulations, a Transmission Agreement is signed for dedicated lines only.

Further, CTU is not including 400KV S/s Srinagar & 400KV D/c Srinagar-Srinagar PH Line, already implemented by PTCUL as ISTS Network, in LTA intimations.

ii) As per intimations of Connectivity issued by CTU, 400KV S/s Pipalkoti is not required in time frame of Tapovan Vishnugad HEP, 220/132 KV S/s Mori is not required in time frame of Naitwar Mori HEP and 220KV S/s Baramwari is not required in time frame of Singoli Bhatwari HEP. With this approach, the Transmission System required for Connectivity for these Generators up to the point of Connectivity becomes a single link/line i.e the Transmission lines to be constructed by the Generator i.e. by M/s L&T & M/s SJVN and afterwards those to be constructed by PTCUL are basically a single link up to the point of Connectivity. Similarly, The Transmission lines to be constructed by PTCUL for Tapovan Vishnugad HEP i.e. 400KV D/C Tapovan Vishnugad –Pipalkoti S/s line & 400KV D/c Pipalkoti – Srinagar S/s is a single link. Thus, the Transmission System seems to be treated as dedicated lines by CTU for which CTU is insisting for signing a Transmission Agreement for recovery of Transmission Charges against these lines between PTCUL & Generators. Only 400KV (Quad Bersimis) D/c Srinagar- kashipur Line is included in LTA intimations issued by CTU to M/s NTPC, M/s L&T & M/s Lanco.

<u>In view of the above, Committee may deliberate on the following issues: -</u>

1. To include complete Associated Transmission System to be implemented by PTCUL, as agreed between Generators & PTCUL in the implementation Agreements, in the LTA intimations/LTA Agreements so as to ensure its recovery through beneficiaries. Otherwise, in the absence of any security against the investment made by PTCUL, PTCUL will be unable to fulfill the commitments of timelines for completion of Associated Transmission System of various Generators in the absence of LTA Agreements.
2. As Transmission Agreement is to be signed for dedicated lines (if implemented by ISTS licensee). So, is there any need for signing the Transmission Agreement for connectivity lines with Generators and what would be the sanctity of these Transmission Agreements after implementation of above mentioned substations i.e. 400KV S/s Pipalkoti, 220KV S/s Baramwari & 220KV S/s Mori at later stage when these connectivity lines/Transmission system including these substations will be shared by upcoming Generators.
3. To include 400KV S/s Srinagar & 400KV D/c Srinagar- Srinagar PH line in the LTA intimations/Agreements (Which are also agreed between PTCUL & Generators in the Implementation Agreements).
4. In the Meeting held at CEA on 04.04.2018, regarding LTA issues of Singoli Bhatwari HEP, it was stated by CEA quoted as below –
   "CEA stated that with change in commissioning schedule of Tapovan Vishnugarh (September 2020) its connectivity system can be implemented in matching time frame of Srinagar-Kashipur 400 kV D/C line. However, in case of SBHEP operationalization of LTA would be delayed by about 18 months. Hence, it is advisable to explore the possibility of operationalization of LTA of SBHEP, before commissioning of the Srinagar-Ksahipur 400 kV D/C line in the existing margins and/or with alternate arrangement."
   Accordingly, the matter of grant of LTA of Singoli Bhatwari HEP may be finalized at the earliest.

Members may like to deliberate.

8.0 Construction of 2 No. 400 kV bays at 400/220 kV Chamera Pooling Station of PGCIL under Northern Region System Strengthening scheme:

8.1 HPPTCL vide their letter no No HPPTC L/PI ann ing/CEA_Vol-VI/20 18-3215 dated 18.5.2018 has informed that in the 27th meeting of Standing Committee on Power System Planning of Northern Region held on 30.05.2009, it was decided that HPPTCL would establish a 400/220 kV substation at Lahal in the time frame of Kutehar HEP which would be connected to Chamera Pooling Station by a 400 kV D/C line. HPPTCL has awarded the package of construction of 400 kV D/C line from Lahal to Chamera on 02.04.2018 and the line is scheduled to be completed by June, 2020. As the system comes under Northern Region System Strengthening and approved master plan of Ravi Basin, therefore, HPPTCL requested the committee to approve the proposal of provision of 2 No. 400 kV Bays by PGCIL at 400/220 kV Chamera Pooling Station of PGCIL under Northern Region System Strengthening scheme.

Members may like to deliberate.

9.0 Issues related to evacuation of power from Hydro Electric plants in Himachal Pradesh: In order to review the evacuation arrangements for various upcoming Hydro Electric Projects (HEP) in Himachal Pradesh, a team comprising of officers from CEA, CTU, HPPTCL, HPPCL and Directorate of Energy (GoHP) visited different sites in Distt. Kullu, Lahaul & Spiti and Kinnaur from 10th June to 14th June 2018. A meeting was held at HPPTCL office in Shimla on 15.6.2018 for taking a final view on the proposals which emerged during the visit to project sites and to know the status of developmental of HEPs in upper part of Satluj basin. Following issues were discussed in the meeting:

9.1 Transmission System for evacuation of power from Nakhtan (4x115 MW) HEP:

9.1.1 The issue regarding evacuation of power of Nakhtan HEP (4x115 MW) was discussed in the 39th meeting of Standing Committee on Power System Planning of Northern Region (SCPSPNR) held on 29-30th May, 2017 and accordingly a site visit was undertaken to the project site on 10.6.2018 to take a view on the ROW related issues.

9.1.2 In the valley, HPPTCL has already awarded one 132/33 kV, 2x31.5 MVA substation at Barsaini along with Barsaini-Charor 132 kV D/C line to evacuate 58 MW of power from small HEPs in the area. This system is not adequate to transmit power of Nakhtan HEP. It was agreed that a separate 400 kV system would be required to evacuate power of Nakhtan HEP. The proposed arrangement shall be LILO of 400 kV Banala-Hamirpur line of PGCIL at Nakhtan due to non-availability of space for 400 kV bays at Banala. The estimated route length of LILO is of the order of 55 kms. The proposal is tentative and shall be finalized after further studies and receipt of application for grant of connectivity and LTA from the HPPCL, the developer of the generation project.

9.1.3 To a query about the project capacity and commissioning schedule of the project, HPPCL informed that DPR of Nakhtan HEP is under preparation and the project is planned to be commissioned by 2025-26. It was also informed that capacity of Nakhtan HEP could vary by ± 25 MW.

9.2 Transmission System for grant of connectivity to Luhri HEP (210 MW).

9.2.1 The team visited the 3 sites of Luhri-I, II and III on 14.6.2018 along with officers of SJVNL and it is now proposed that all the three stages of Luhri HEP shall inject their power at 220 kV level in to 400/220 kV proposed ISTS pooling station tentatively identified at a place Nange located near Luhri-II HEP. System beyond 400/220 kV pooling station shall be finalized after system studies.

9.2.2 During the meeting held on 15.6.2018, CTU informed that connectivity applications for Luhri-I and III have been received but Long Term Open Access applications are yet to be received. It was also informed that the Connectivity application for Luhri-III has been rejected due to non-conformity with the detailed procedure for grant of connectivity and SJVNL would have to apply again for Luhri–III connectivity. SJVNL was requested to expedite the application of LTA so that transmission system could be finalized and taken up for implementation as per the tariff policy.

9.3 LTA for 155 MW of power from Bajoli Holi HEP (180 MW).
(in continuation of item no. 4 of the main agenda)

9.3.1 In the meeting held on 15.6.2018, M/s GMR Bajoli Holi HEP informed that their project shall be ready to evacuate 155 MW of power by March, 2019 on best effort basis. GMR also informed that M/s Greenko is agreeable to proposed interim evacuation of power of Bajoli Holi HEP through their 220 kV Budhil-Chamera-III HEP line. It was agreed that a separate meeting in this regard shall be held at CEA.

9.3.2 HPPTCL furnished the status of the transmission system under implementation by them. As per HPPTCL, 220 kV D/C line from Bajoli Holi HEP to 400/220 kV Lahal pooling station (18 Kms) has been awarded on 5th December 2017 and construction has commenced with benching on some locations in progress. The line is targeted for completion in October, 2019. 400 kV Lahal-Rajera D/C line (37 Kms) has also been awarded on 2nd April 2018 and is likely to be completed in April, 2020. For interim evacuation till 400 kV Lahal-Rajera line is completed, 3 kms long, 220 kV Lahal–Budhil line, which is under construction and targeted for completion in November, 2018, shall be utilized.

9.3.3 Representative of GMR informed that Regarding query from M/s GMR about start of LTA, GM (CTU-planning) clarified LTA to Bajoli Holi HEP can be started only after the commissioning of 400 kV Lahal-Rajera D/C line by HPPTCL.

9.4 Grant of connectivity and Long Term Open Access to HPPCL-450 MW Shongtong Karcham HEP:

(in continuation of item no. 4 of the main agenda)

9.4.1 The team visited thye sites of power house and pot head yard of Shongtong Karcham HEP on 13.6.2018 and progress of ongoing works was noted.

9.4.2 In the meeting held on 15.6.2018, HPPCL informed that the project is anticipated to be commissioned by December, 2023. It was agreed that HPPCL shall confirm the COD in writing to CTU/CEA by 18.6.2018. The status of major hydro projects upstream of Shongtong Karcham HEP as furnished by Energy Directorate which is given at Annexure-F.

9.4.3 Keeping in view the status of development of the upstream projects, in the meeting held on 15.6.2018, it was decided that final decision with regard to review of the transmission scheme would be taken in next meeting of SCPSPNR.

9.5 Evacuation arrangement for Solar Park (1000 MW) in Spiti Valley:

9.5.1 The team visited locations of proposed Solar Park in Kaza Tehsil of Distt. Lahaul & Spiti on 12.6.2018 and CEA/CTU agreed in principle to the proposal of HPPTCL, which envisages pooling of power from all the locations to 400/220 kV pooling station at Kaza (tentative) and construction of 400 kV D/C line up to Wangtoo 400/220 kV substation.

9.5.2 HPSEBL informed that HPSEBL is the nodal agency for development of Solar Park but the work shall be awarded by SECI. He also informed that confirmation regarding consumption of 20% of power from Solar Park by DISCOM is yet to be given.

9.6 Review of Transmission Plan for Ravi Basin:

9.6.1 Matter regarding development of 400 kV Lahal–Rajera corridor on 220 kV Chamera-III-Rajera (PG) D/C line was discussed in the meeting held on 15.6.2018 as 220 kV Chamera-III-Rajera line is built on 400 kV towers charged on 220 kV, wherein, CTU informed that the 400 kV towers constructed for the line may be the truncated one. CTU to confirm the type of towers.

10.0 Agenda by CTU:

10.1 Additional 1X500 MVA, 400/220kV ICT at Saharanpur (PG) 400/220kV substation:

10.1.1 400kV Saharanpur (PG) substation in Uttar Pradesh has present installed capacity of 2x315 MVA, 400/220kV ICTs. Presently the following 220kV substation is being fed from this substation:

- 220kV substation Saharanpur: 2x160MVA, 220/132kV ICTs
- 220kV substation Nanauta: 2x200MVA, 220/132kV ICTs

The maximum power flow at Saharanpur (PG) 400/220kV substation is about 420MW. During outage of one transformer for maintenance activities or because of any forced outages, remaining transformer gets overloaded and as such are not adequate to cater the load demand.

10.1.2 Further, UPPTCL vide letter no. 1497/ETD-I/ SRE dated 2/04/2018 intimated the planning of following 220kV transmission system:

- 220kV Saharanpur (PG) – Sarsawa D/c Transmission Line
- LILO of 220kV Khara – Shamli Transmission Line at Saharanpur (PG)
- Capacity enhancement at 220/132kV Saharanpur (UP) from 2x160MVA to 2x200MVA

10.1.3 Therefore, connected capacity at 220kV level shall increase to 1380 MVA. In order to feed the above mentioned quantum of load, UPPTCL has requested to augment the transformation capacity at 400/220kV Saharanpur (PG) substation under Regional system strengthening scheme. Accordingly, it is proposed to augment the capacity of Saharanpur (PG) 400/220 kV substation by 1x500 MVA ICT.

Members may like to deliberate.

10.2 80 MVAR Bus Reactor at Kurukshetra:

Kurukshetra is connected to Champa Pooling Station in Western region through high capacity HVDC link and to Northern Region grid through various other AC links. Details of the same is given below:

- LILO of Abdullapur - Sonepat 400 kV D/C at Kurukshetra (Tripple)
- 400KV D/c Kurukshetra - Jallandhar line (Quad) (one ckt via Nakodar (PSTCL))
- 400KV D/c Kurukshetra –Malerkotla line
- 400kV D/c Kurukshetra – Jind line
- +/- 800KV HVDC Bipole link between Champa Pooling Station - Kurukshetra line (with provision to upgrade HVDC terminal to 6000MW at later date)
  Phase-I ie 3000MW of this HVDC link has been commissioned and is in operation and Phase-II of the same is to be commissioned shortly.

During winter low load conditions in Northern region, the hydro & thermal generations in Himachal Pradesh, Punjab & Haryana remains out of service most of the times. During this season Kurukshetra HVDC terminal has been experiencing persistent high voltages. To mitigate the problem, installation of 1 Nos. of 500MVAR TCR (Thyristor Controlled Reactors) at Kurukshetra 400 kV bus has been discussed and agreed in 39th SCM of NR. The commissioning of TCR would take time (approx. 2 to 3 years).
An 80 MVAR shunt reactor (part of filter bank) was planned with Champa – Kurukshetra Bipole-II. However, considering high voltage problem at Kurukshetra, 80MVAR shunt reactor has been commissioned.

Members may like to note.

10.3 Ownership of 4x105 MVA ICT & 2x63 MVAR Bus Reactor along with GIS bay at Dehar (BBMB) S/s.

BBMB vide letter dated 17/05/2018 informed that in 38th TCC and 41st NRPC meeting held on 27th & 28th February, 2018 it was decided that the matter regarding ownership of ICTs and Bus reactors along with GIS bay at Dehar BBMB S/s shall be discussed in separate meeting.
Accordingly, a meeting held on 14.05.2018 at Committee room of BBMB, Chandigarh with representatives of all the partner states of BBMB and it was agreed that ownership of 4x105 MVA, 400/220 kV ICT & 2x63 MVAr Bus reactor at Dehar(BBMB) shall remain with POWERGRID as part of regional system strengthening and the assets become a part of POC pool. O&M shall be borne by BBMB for which the charges would be reimbursed by POWERGRID.

Members may like to note.

10.4 Charging of 63 MVAR line reactor of Lucknow-Sohawal 400kV line as bus reactor.

For transfer of power from ER to NR, Balia-Lucknow 400kV D/c line was planned. The length of complete line was about 320 km. Hence, to compensate the reactive power generation and to control voltage along the line, line reactors of 63 MVAr were planned at both ends.

Subsequently, 400/220kV, 2x315MVA, substation at Sohawal was planned by Loop in Loop out of both circuits of Balia-Lucknow 400kV D/c line at Sohawal under Northern Regional Transmission Strengthening Scheme. The same has been discussed and agreed in the 26th Meeting of Northern Regional Power Committee, held on 13/10/2008. In the approved scheme, provision for adequate reactive compensation was also kept so as to ensure smooth operation of transmission system under various voltage scenarios. With the LILO of both circuits of Balia-Lucknow 400kV D/c at Sohawal and new reactive compensation, 2x63 MVAr reactors at Lucknow were not required in the line and the same was shifted to Sohawal for use as Bus reactor.

As per earlier practice, only main elements of transmission scheme i.e. lines and substation were discussed and agreed in the Standing Committee meetings. Generally the reactive compensation was finalized by CTU at the DPR stage when more accurate details about line lengths and voltage profile become available. Accordingly, 2x63MVAR Bus reactor at Sohawal, which is a part of "Northern Regional Transmission Strengthening Scheme", was incorporated in the DPR. Subsequently, after investment approval the scope of work including the reactors has been also circulated to the constituents.

Members may like to note.

10.5 Implementation of 500MVAr Thyristor Controlled Reactor(TCR) at Kurukshetra 400kV bus

During seasonal low load conditions (winter season) in Northern Region, the hydro & thermal generations in Himachal Pradesh, Punjab & Haryana, remains out of service most of the times except for peak hours. During winter off peak conditions, there is high voltage condition in the area and addition of filter bank for operation of the HVDC system aggravates the problem at the Kurukshetra bus even though 125MVAr bus reactor at Kurukshetra remains online. This problem of high voltage poses constraints for the operation of the HVDC bipole in Kurukshetra and restricts the HVDC system operation to a lower power order, which impacts the total power import capacity of the Northern region. Considering the fact that this load generation scenario in Northern Region is expected to remain in future, 500 MVAr TCR (Thyristor Controlled Reactor) has been agreed at Kurukshetra & under implementation by POWERGRID.

This 500MVAr TCR shall be helpful to mitigate the high voltage and daily peak & off peak variation. This will mitigate the high voltage problem at Kurukshetra and also ensure reliable operation of HVDC link even in low generation (mainly hydro and renewable) scenario in Northern region.

Based on budgetary quotations, the estimated cost of the project is about ₹ 267 Cr. including Interest during construction (IDC). However, the final price would be known at the time of finalisation of award.

Members may note.

10.6 Revocation of 850 MW Connectivity granted to M/s GVK Ratle Hydro Electric Project Pvt. Ltd (GVKRHEPPL)

GVK Ratle Hydro Electric Project Pvt. Ltd. was granted connectivity for 850MW power vide letter dated 16.12.2013. Further, LTA for transfer of 690MW power was also granted to GVK Ratle Hydro Electric Project Pvt. Ltd. vide letter dated 03.02.2014. Subsequently, LTA was revoked on account of M/s GVKRHEPPL's failure to sign the LTA agreement vide letter dated 30.11.2017. In the said letter notice for revocation of 850MW Connectivity granted to M/s GVKRHEPPL was also served.

M/s GVKRHEPPL vide letter dated 09.12.2017 informed that project works has been suspended and PPA with PDD J&K govt. has been terminated while the matter is pending for adjudication. In addition, the implementation activities at site are in stand still condition.

Keeping above in view, the connectivity granted to M/s GVK Ratle Hydro Electric Project Pvt. Ltd (GVKRHEPPL) vide intimation dated 16.12.2013 is may be revoked with immediate effect on account of insufficient progress.

Members may discuss.

10.7 2 nos. of 220kV bays at 400/220kV, 4x315MVA Abdullapur (PG) Substation

2 nos. of 220kV bays at 4x315MVA, 400/220kV Abdullapur (PG) Substation were agreed in 39th meeting of SCPSPNR held on 29-30th May, 2017. The bays shall be used for feeding the proposed 220kV Substation at Rajhokheri. Further, during 37th meeting of Empowered Committee on Transmission held on 20.09.2017, it was decided to implement the above bays through TBCB route. Subsequently, HVPNL vide letter no. 15/cw-579 dated 29.05.2018 requested the shifting of this matter back to standing committee considering the construction of 220kV Substation at Rajokheri is of utmost importance.

Members may discuss.

10.8 High Voltage at Agra

Agra is connected to Bishwanath Chariyali and Alipurduar in North Eastern Region through high capacity HVDC link and to Northern/Western region grid through various other 765kV links. Details of the same is given below:

- Agra – Gwalior 765kV D/c line
- Agra – Fatehpur 765kV D/c line
- Agra – Jhatikara 765kV S/c line
- Agra – Aligarh 765kV S/c line
- +/- 800KV HVDC Bipole link between Agra – Alipurduar -Bishwanath Chariyali MTDC Link

Further, Agra is also connected to Northern Grid through number of 400kV AC links.

+/- 800KV HVDC Bipole link between Agra – Alipurduar -Bishwanath Chariyali MTDC Link is an important link for import/export of power to/from NR. Agra 765 & 400kV bus experiences very high voltage during various operating conditions. This result in operational problem associated with HVDC Bipole.

Therefore, for smooth and reliable operation of HVDC Bipole, 1 Nos. of TCR (Thyristor Controlled Reactors) of capacity 500 MVAr is proposed to be installed at Agra 400 kV bus.

Members may discuss.

10.9 Downstream network by State Utilities from ISTS Stations

Augmentation of transformation capacity in various existing substations as well as addition of new substations along with line bays for downstream network are under implementation at various locations in Northern Region. States are requested to implement the 220kV system for proper utilization of the line bays and inform the status of planned 220kV system identified with following sub-stations:

S. No.	Substation	Downstream network requirement	Schedule	Remarks
1	400/220kV , 3x315 MVA Samba	2 nos. bays utilized under ISTS. Balance 4 Nos to be utilized	Commissioned	LILO of 220kV Hiranagar-Jatwal line LILO 220kV Jatwal – Gladni line LILO of 220kV Bishnha – Hiranagar D/c line LoA has been issued and Material has reached the site. Targeted Completion – Nov 2018 **PDD, J&K to respond.**
2	400/220kV, 2x315 MVA New Wanpoh	6 Nos. of 220 kV bays to be utilized	Commissioned	220kV New Wanpoh –Mirbazar D/c line Targeted Completion – Nov 2018 **PDD, J&K to respond.**
3	400/220kV, 2x315 MVA Parbati Pooling Station	2 Nos. of 220 kV bays to be utilized.	Commissioned	220kV Charor- Banala D/c line (18km) Targeted Completion- Oct’17 Anticipated – Mar’18 Yet to be commissioned. **HPSEBL to respond.**
4	400/220kV, 2x500 MVA Kurukshetra (GIS)	8 nos. of 220 kV bays to be utilized	Commissioned	LILO of one circuit of Kaul-Pehowa 220kV D/c line LILO of one circuit of Kaul-Bastara 220kV D/c line Work awarded with contractual completion date 02/01/2018. Target Completion-Mar’19 **HVPNL to respond.**

S. No.	Substation	Downstream network requirement	Schedule	Remarks
5	400/220kV, 2x500 MVA Bagpat GIS	3 nos. of 220 kV downstream lines to Shamli, Muradnagar and Bagpat commissioned. Balance 5 Nos. of 220 kV bays to be utilized	Commissioned	Bagpat- Baraut 220kV S/c Line LILO of 220kV Muradnagar II - Baghpat (PG) at Baghpat UP UPPTCL stated that it has severe RoW issue. Bagpat(PG)-Modipuram New 220kV D/c-exp. by Oct.18 **UPPTCL to respond.**
6	400/220 kV, 2x315 MVA Saharanpur	2 nos. 220 kV downstream lines commissioned. (Saharanpur (UP) and Nanauta) Balance 4 Nos. of 220 kV bays to be utilized	Commissioned	LILO of 220 kV Khara- Shamli at Saharanpur PG Saharanpur(PG)-Sarsawa (new) 220kV D/c Target Completion – Apr/May'18 **UPPTCL to respond.**
7	400/220kV, 2x315 MVA Dehradun	Out of 6 bays, only two bays used. Balance 4 bays to be utilised.	Commissioned	2 bays for 220 kV Dehradun – Jhajra line One bay for proposed Naugaon S/s 2 bays for proposed S/s at Selakui **UPPTCL to respond.**
8	400/220 kV, 2x315 MVA Sohawal	6 Nos 220 kV bays to be utilized.	Commissioned	2 nos of bays utilized for Sohawal 220kV UP. 2 nos for Barabanki 220 kV s/s under construction-April/May'18 2 nos of bay of utilized for 220kV New Tanda-Sohawal line and expected to be completed by April/May -2018. **UPPTCL to respond.**
9	Shahjahanpur, 2x315 MVA 400/220 kV	Partially utilized. Balance 5 Nos. of 220 kV bays to be utilized.	Commissioned	One bay used for 220 kV Shahjahnpur-Hardoi line commissioned. 2 no of bays for 220kV Shahjahnpur - Azimpur D/c line **UPPTCL to respond.**
10	02 nos. bays at Moga	Partially utilized. Balance 2 nos. of 220kV bays to be utilized.	Commissioned	PSTCL informed that Moga–Mehalkalan 220kV D/c line is under construction. **PSTCL to respond.**

S. No.	Substation	Downstream network requirement	Schedule	Remarks
11	Hamirpur 400/220 kV 2x 315 MVA Sub-station (Augmentation by 3x105 MVA ICT)	04 nos. 220 kV downstream lines commissioned under ISTS. Balance two bays to be utilised by HPSEBL	Sep'18	2x220 kV bays to be utilized for connecting 220/132kV Kangoo substation of HPSEBL by 220 kV Kangoo-Hamirpur D/c line. **HPSEBL to respond.**
12	Kaithal 400/220 kV 1x 315 MVA Sub-station	July 2017 (Shifting of Transformer from Ballabhgarh).	Commissioned	220kV Kaithal(PG)- Neemwala D/c line - Work awarded on 25.10.2016. Tentative completion date is 23.05.2018. 220kV S/s Neemwala-Tenders opened for NIT dated 23.05.2016. **HVPNL to respond.**
13	Sikar 400/220kV, 1x 315 MVA S/s	2 Nos. of 220 kV bays	Commissioned	RRVPNL representative stated that studies would be conducted to formulate how bays could be utilized. **RRVPNL to respond.**
14	400/220kV Kota Sub-station (1 No. of 400 kV Bay)	1 No. of 400 kV Bay	Commissioned for Anta-Kota 400 kV S/c line of RRVPNL	Work order has been awarded to M/s GE and expected to be completed by April/May-18 **RRVPNL to respond.**
15	Bhiwani 400/220kV S/s	6 nos. of 220kV bays	Commissioned	**HVPNL to respond.**
16	Jind 400/220kV S/s	6 nos. of 220kV bays	Commissioned	**HVPNL to respond.**

Establishment of new 400/220kV substations in Northern Region:

Sl. No.	Name of Substation	MVA Capacity	Expected Schedule	Downstream connectivity furnished by States in 41st NRPC
1	400/220kV Dwarka-I GIS	4x 500	Oct'18	**DTL to update**
2	400/220kV Tughlakabad GIS	4x 500	Oct'18	
3	220/66kV Chandigarh GIS	2x 160	Feb'19	8 nos. of 66kV bays. **Chandigarh to respond.**
4	400/220kV Jauljivi GIS	2x315	Dec'2019	2 bays for 220kV AlmoraJauljibi line

Sl. No.	Name of Substation	MVA Capacity	Expected Schedule	Downstream connectivity furnished by States in 41st NRPC
				2 bays for 220kV Brammah-Jauljibi line **PTCUL to respond.**
5	400/220kV Sohna Road Sub-station (TBCB)	2x500	May'19	8 nos. of 220kV bays. **HVPNL to respond.**
6	400/220kV Prithla Sub-station (TBCB)	2x500	May'19	8 nos. of 220kV bays. **HVPNL to respond.**
7	400/220kV Kadarpur Sub-station (TBCB)	2x500	May'19	8 nos. of 220kV bays. **HVPNL to respond.**
8	400/220kV Kala Amb GIS (TBCB)	2x315	Commissioned	HPSEBL has planned one no. of 220kV D/c line from Kala Amb 400/220kV S/s to 220/132kV Kala Amb S/s. Details for remaining 4 nos. of line bays may be provided. **HPSEBL to respond.**
9	400/220kV Amargarh GIS (TBCB)	2x315	Oct'18	JKPDD to confirm for LILO of 220kV D/c Zainkote - Delina line at Amargarh. **PDD, J&K to respond.**

11.0 Proposal to connect Lalitpur TPS with 765 kV PGCIL substation Bina through 765 kV line for stability. (Agenda by UPPTCL)

11.1 UPPTCL vide their letter dated 19.6.2018 has forwarded the proposal to connect Lalitpur TPS with 765 kV PGCIL substation Bina through 765 kV line for stability.

11.2 UPPTCL has informed that 3x660 MW Lalitpur Thermal Power Station is an important Intra-state generating project. Its evacuation system was approved in 32nd standing committee meeting of CEA on 31-08-2013 as follows :-

1- Generation at 765 kV & 765/220 kV 2x315 MVA Transformers (by Developer)
2- Lalitpur TPS-Agra(UP) 765 kV 2xSC line- 400 Km each (with 50% series compensation)
3- Agra-Agra(PG) 400 kV one ckt LILO at Agra(UP)
4- Agra-Moradnagar 400 kV SC line LILO at Agra(UP)
5- LILO of Agra Moradnagar 400 kV SC line at Math
6- Agra-Math 400 kV SC line
7- Agra(UP)-Agra South 400 kV DC line
8- LILO of Jabalpur-Orai 765 kV SC Inter-State Transmission (ISTS) Line at Lalitpur TPS to provide stable operation of plant.
9- Lalitpur TPS-Jhansi 220 kV D/C line

11.3 LILO of Jabalpur-Orai 765 kV PGCIL SC line referred above was however cancelled later by PGCIL due to long LILO length thus generator is presently in radial mode. The distance from plant to Agra (765) substation is reduced from 400 Km to 335 km due to passage from M.P. and thus in normal conditions, the plant is evacuating power on radial mode satisfactorily mainly on Lalitpur-Agra 765 kV 2xS/C lines and partially on 220 kV lines to 220 kV Jhansi & Lalitpur substation. It is further to inform that Lalitpur to Agra area is prone to high winds and storm and recently both 765 kV line tripped jeopardizing evacuation. To prevent any effect on generation due to any disturbance on 765 kV lines, it is felt necessary that such large capacity generators should be anchored with a nearby strong grid substation. The plant is located in a chicken-neck area and there does not exist any intra-state 765, 400 kV grid substation. Creation of 400 kV level at Lalitpur TPS and constructing 400 kV DC line Parichha-Lalitpur DC line-100 Km was also considered but the line survey suggests that it cannot be constructed due to lot of city area and forest etc. on way. Connection of Lalitpur TPS with Bina 765 kV PGCIL S/S located at a shorter distance 0f 60-70 km through 765 kV lines appear to be quite suitable and was deliberated in 39th Standing Committee Meeting of CEA and also meetings at Lucknow. Bina PGCIL substation being in other state, the construction of lines could preferably be done under ISTS. The acceptance has somehow not materialized in spite of its merit of plant needing anchoring and access to strong grid and help in reduction of WR-NR congestion. To obviate any commercial issues arising due to construction under ISTS, UPPTCL alternatively propose to construct the lines under intra-state schemes.

11.4 Considering commitment by U.P. Govt. for power for all, the uninterrupted supply from generators need to be all time ensured. Hence following 765 kV line alongwith bay is proposed::-

- **Lalitpur TPS-Bina(PGCIL) 765 kV DC line- 70 Km(To be constructed by UPPTCL).**
- **765 kV Bays at 765 kV Bina(PGCIL) Substation- 2 Nos(To be constructed by UPPTCL).**

Members may like to discuss.

Annexure-A

Minutes of Meeting held on 7.5.2018 to deliberate on the issue related to transmission system for evacuation of power from Khurja STPP (2x660 MW) of THDC

A meeting was held on 7.5.2018 in CEA under the Chairmanship of Chief Engineer (PSPA–I) to deliberate on the issues related to transmission system for evacuation of power from Khurja STPP (2x660 MW) of THDC. List of participants is enclosed at Annexure-I.

1. M/s THDC stated that they are implementing Khurja STPP (2x660 MW) in District Bulandshahr (UP) (with provision of one more unit of 660 MW in future) with expected date of commissioning as November 2022 (for 1st Unit) and April 2023 (for 2nd Unit). The project site is at National Highway-9 between Khurja and Aligarh. All the major clearances such as environmental clearance, water commitment etc. are in place. THDCIL also informed that PPA's have already been signed (prior to 5th January 2011) with following entities as beneficiary:
   a) Delhi (BSES Rajdhani Power Limited) 125 MW
   b) Uttar Pradesh (UPPCL) 792 MW
   c) Uttarakhand (Uttarakhand Power Corporation Limited) 328 MW
   d) Rajasthan (Jaipur Vidyut Vitran Nigam Limited, Jodhpur Vidyut Vitran Nigam Ltd.) 328 MW
   e) Himachal Pradesh (Himachal Pradesh State Electricity Board Limited) 200 MW as beneficiary states.

   THDC requested CEA / CTU to plan a suitable power evacuation system for 2 x 660 MW Khurja STPP.

2. CEA stated that as per the information provided by THDC, UP has share of 60% of the total power from the plant and remaining 40% power is for the other states in Northern Region. As majority of the power is purchased by UP, the evacuation system may be planned by UP provided other beneficiaries agrees to pay intrastate transmission charges for their share of power.

3. CTU stated that if transmission system for evacuation of 40% of power from Khurja generation is to be developed under ISTS, then nearest ISTS point is Aligarh 765/400kV S/S of POWERGRID and Khurja STPP can get connected with ISTS through Khurja STPP - Aligarh 400kV D/C line.
4. UPPTCL stated that for drawl of their share of power from Khurja STPP, LILO of Aligarh - Shamli 400kV D/c line at Khurja STPP may be considered. If the evacuation system for entire capacity has to be planned by UPPTCL, then creation of three voltage levels i.e. 765kV, 400kV and 220kV at Khurja STPP may be required for consumption and further disbursal of the power. And in that case THDC should assure UPPTCL for payment of intra state transmission charges for balance 40% of ISTS power.
5. After deliberations, following was agreed:
   i) THDC to share the startup power arrangement and the switchyard voltage level as mentioned in DPR of Khurja STPP.

ii) THDC to apply for connectivity to UPPTCL for Khurja STPP.

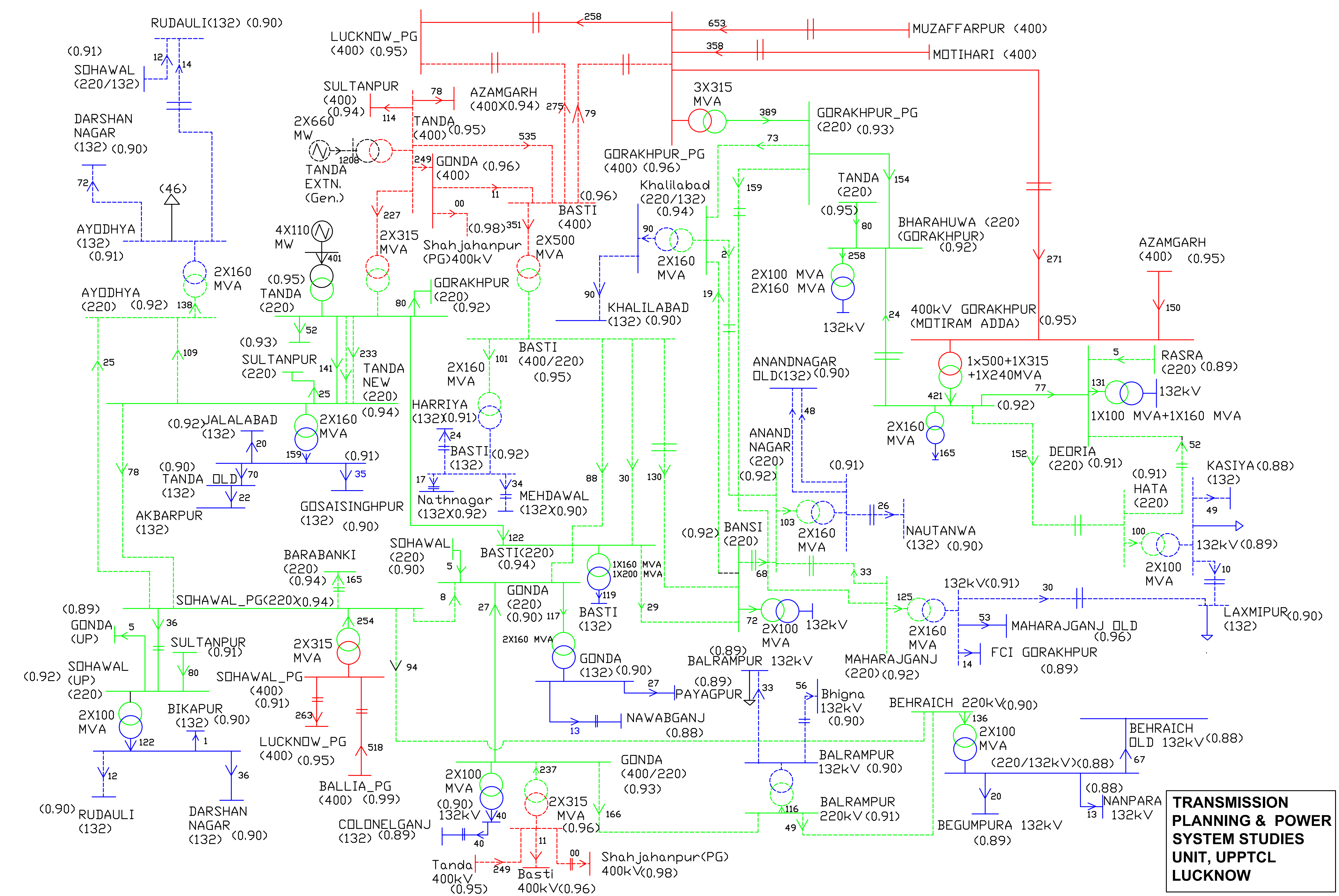
iii) THDC to furnish assurance to UPPTCL for sharing of intra state transmission charges corresponding to 40% (i.e. share of other beneficiaries) of installed capacity of Khurja STPP.

iv) UPPTCL to plan transmission system for evacuation of power from Khurja STPP (2x660 MW) keeping in view provision of one more unit of 660 MW in future.

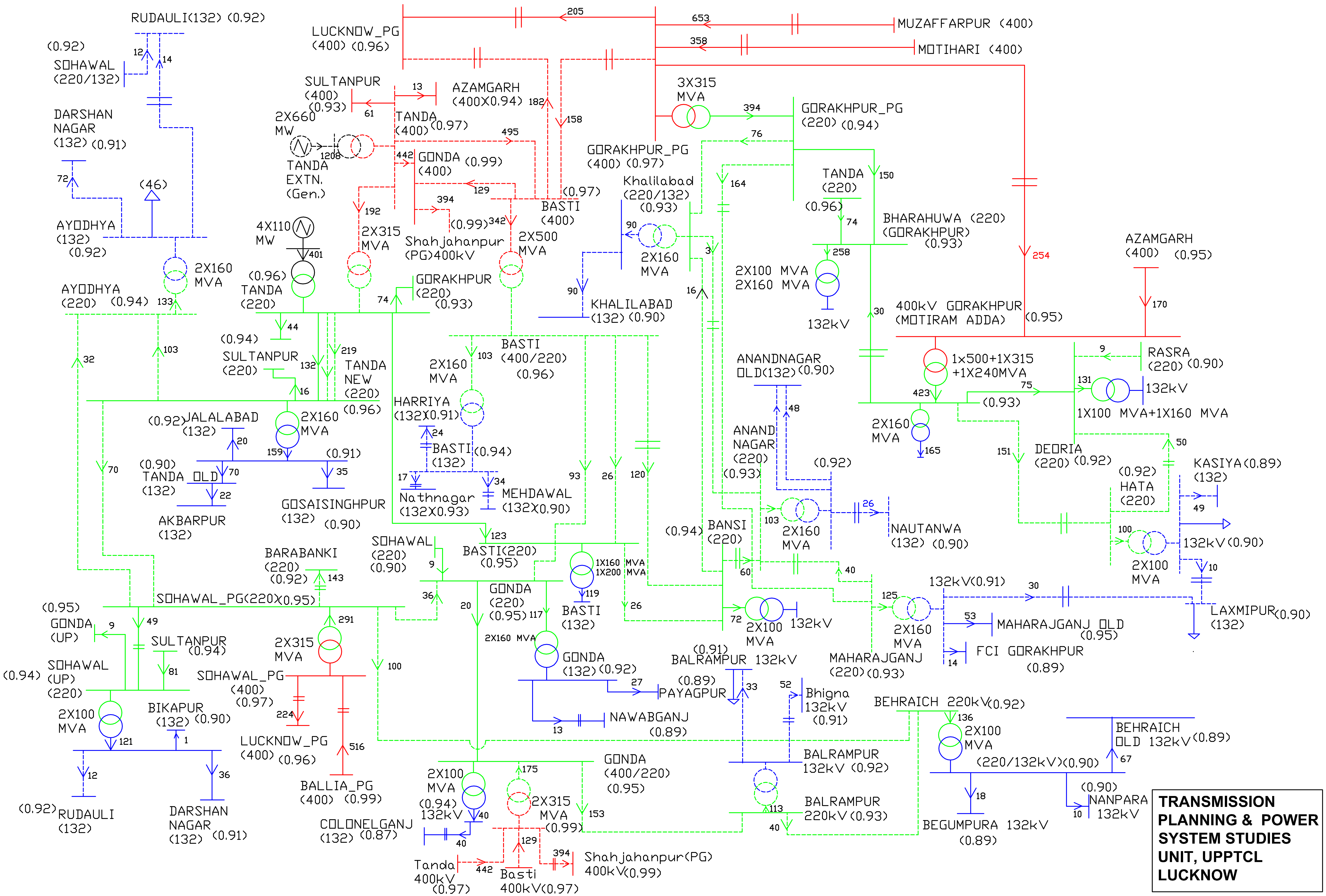
v) The proposal would be discussed in the forthcoming Standing Committee Meeting on Power System Planning for Northern region.

ANNEXURE-B

Ultimate Evacuation of Tanda Extn. (2x660 MW) with Tanda-Basti, Tanda-Gonda 400kV lines

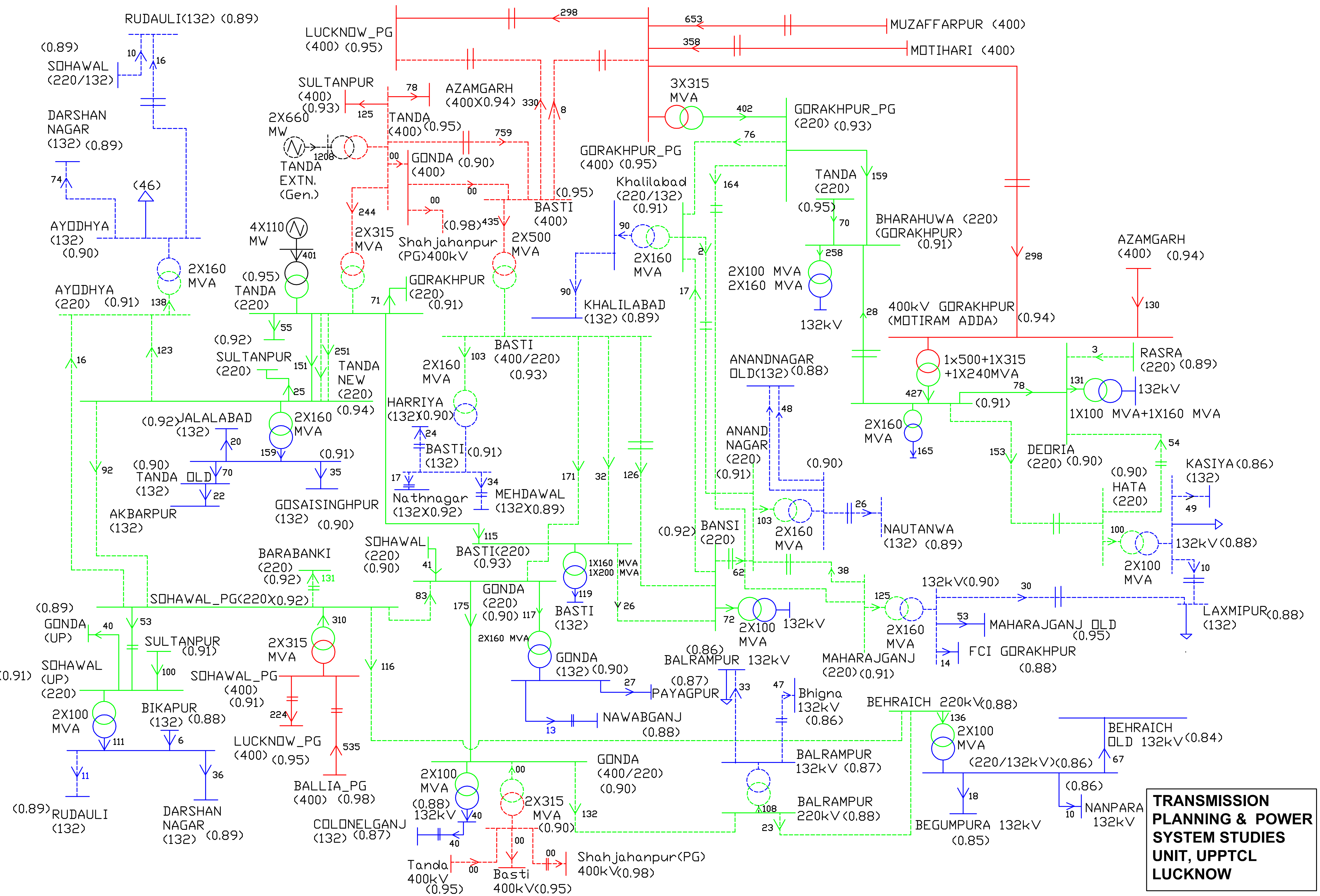


Ultimate Evacuation of Tanda Extn. (2x660 MW) with Basti, Gonda, Shahjahanpur 400kV lines



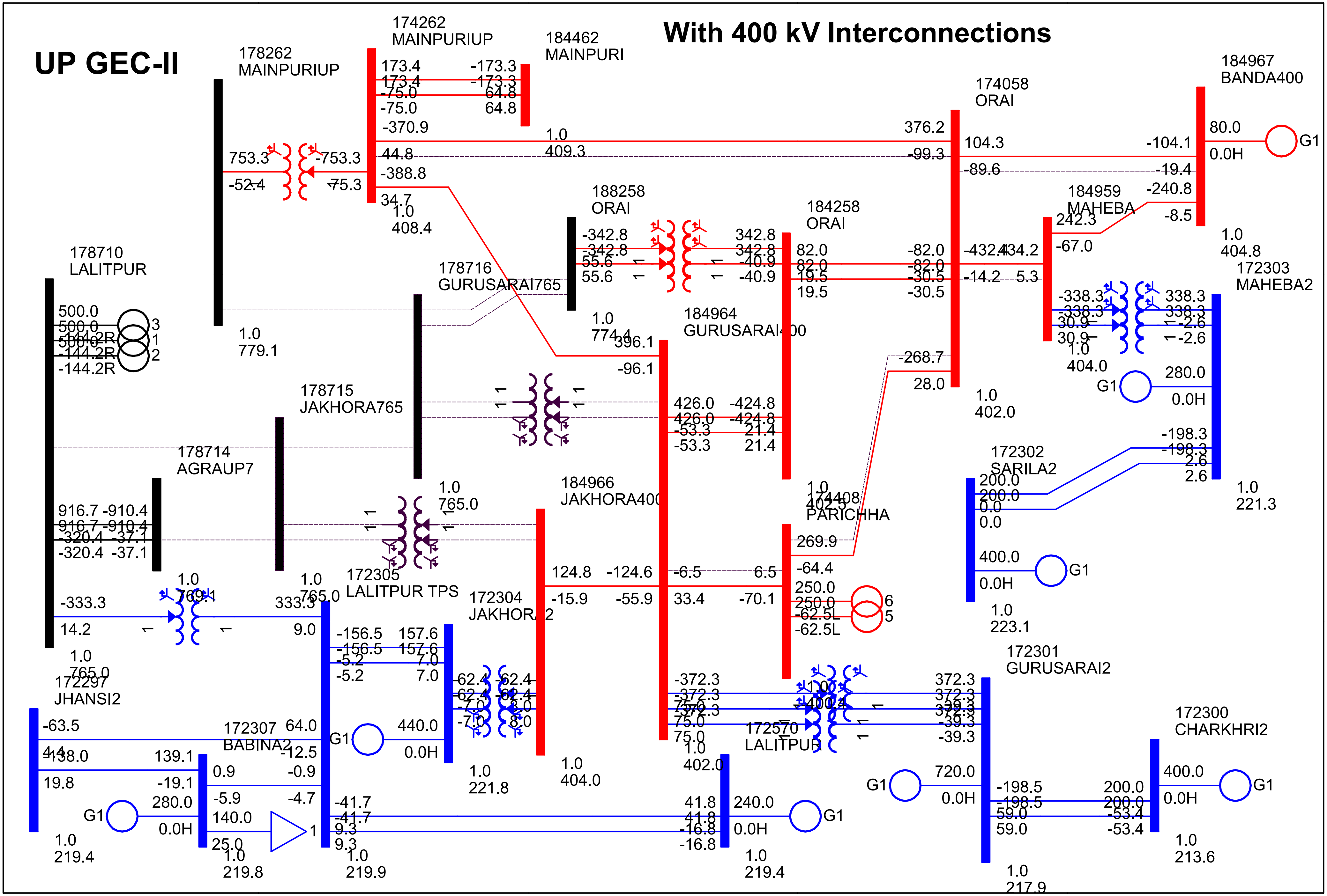
TRANSMISSION PLANNING & POWER SYSTEM STUDIES UNIT, UPPTCL LUCKNOW

Ultimate Evacuation of Tanda Extn. (2x660 MW) with Tanda-Basti 400kV



TRANSMISSION PLANNING & POWER SYSTEM STUDIES UNIT, UPPTCL LUCKNOW

Annexure - C


UP GEC-II
With 400 kV Interconnections
174262
MAINPURIUP
178262
MAINPURIUP
184462
MAINPURI
184967
BANDA400
174058
ORAI
188258
ORAI
184258
ORAI
184959
MAHEBA
172303
MAHEBA2
178710
LALITPUR
178716
GURUSARAI765
184964
GURUSARAI400
178715
JAKHORA765
178714
AGRAUP7
184966
JAKHORA400
174408
PARICHHA
172302
SARILA2
172305
LALITPUR TPS
172304
JAKHORA2
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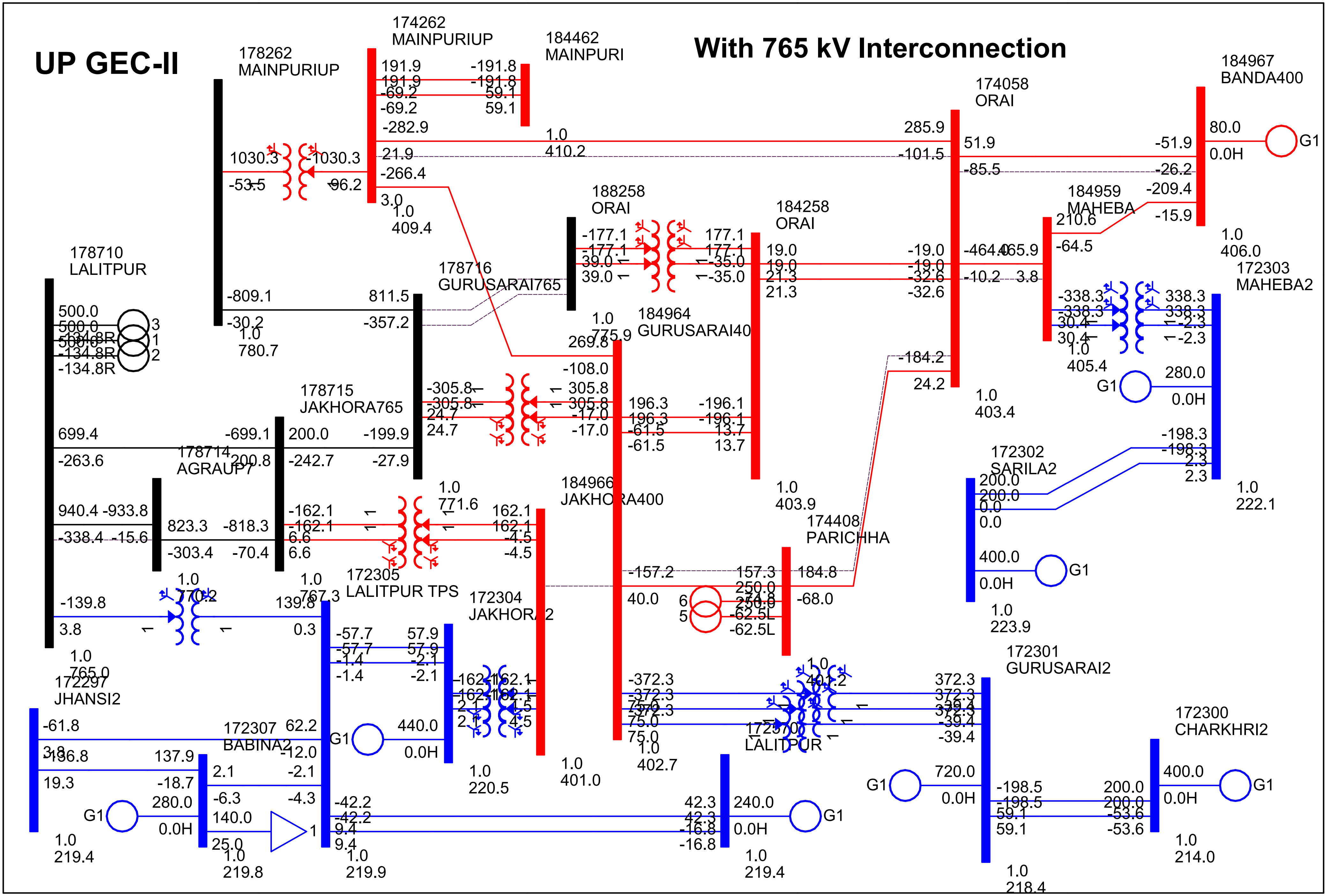
CHARKHRI2


UP GEC-II
With 765 kV Interconnection
178262
MAINPURIUP
174262
MAINPURIUP
184462
MAINPURI
174058
ORAI
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BANDA400
188258
ORAI
184258
ORAI
184959
MAHEBA
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MAHEBA2
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LALITPUR
178716
GURUSARAI765
184964
GURUSARAI40
178715
JAKHORA765
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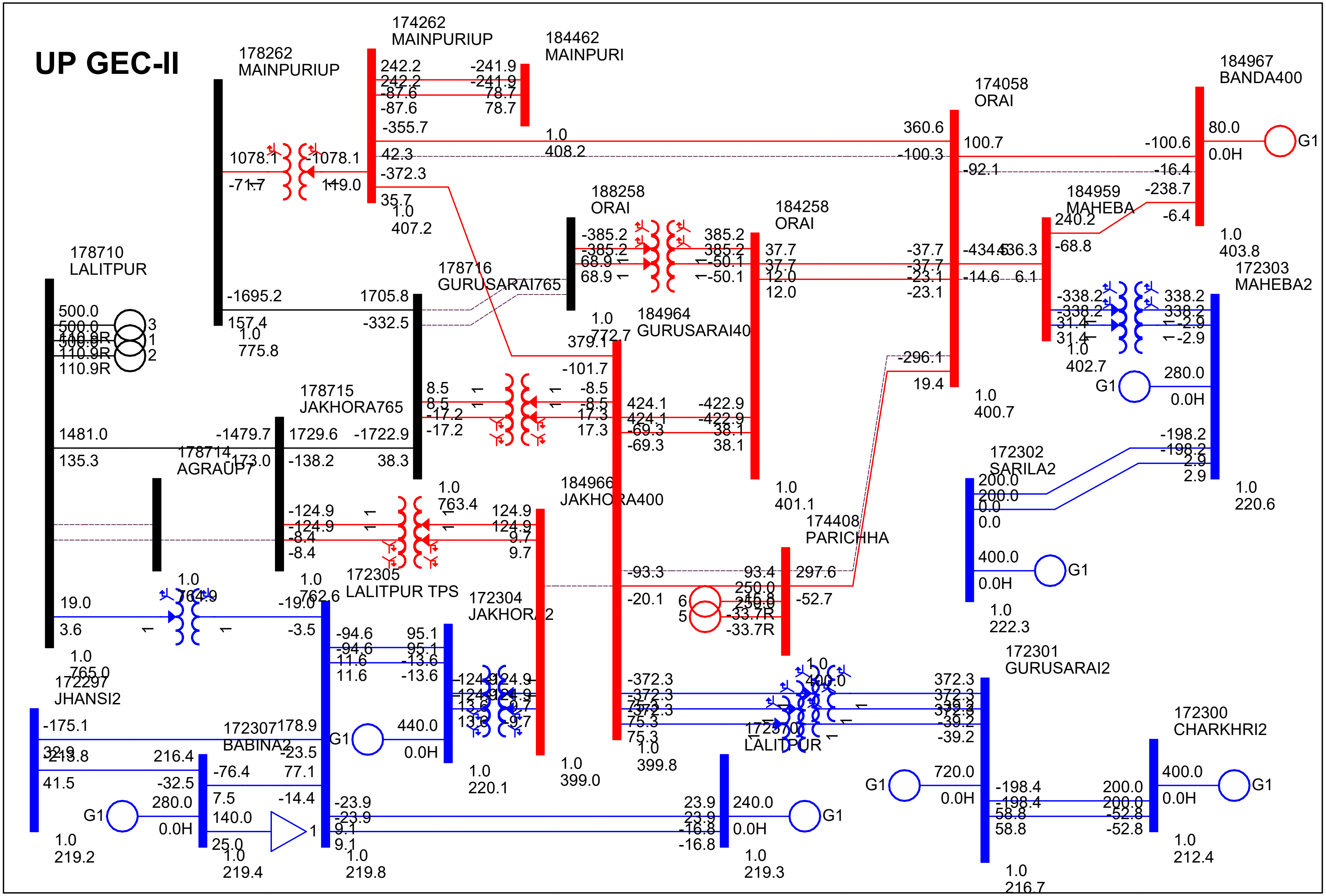
LALITPUR TPS
172304
JAKHORA2
172301
GURUSARAI2
172297
JHANSI2
172307
BABINA2
172370
LALITPUR
172300
CHARKHRI2
G1

With 765 kV Interconnection & outage of Lalitpur TPS-Agra 765 kV Sc and Jakhora-Agra 765 kV S/c line



Annexure-D

Minutes of Meeting held on 7.5.2018 to deliberate on the issues related to transmission system for evacuation of power from Singrauli STPP –III (2x660 MW) of NTPC.

A meeting was held on 7.5.2018 in CEA under the Chairmanship of Chief Engineer (PSPA–I) to deliberate on the issues related to transmission system for evacuation of power from Singrauli STPP –III (2x660 MW) of NTPC. List of participants is enclosed at Annexure-I.

1. M/s NTPC stated that they have planned to construct Singrauli STPP-III (2x660 MW) within the existing Singrauli TPS complex in UP. Tendering process for main plant, EPC package for the project is in advance stage and NIT has already been issued. Regarding sale of power from the project, NTPC stated that that they have commitment for purchase of 85% of power from UP. The investment approval is likely to be done by June-18 and the implementation time for the project is 44 months. NTPC requested to freeze the generation switchyard provisions for evacuation of power from Singrauli STPP-III (2x660 MW), so that the same could be included in their tender document.

2. UPPTCL stated UP has already committed for purchase of entire power from proposed Singrauli-III, therefore, the power could be stepped up at 765kV level and integrated with Anpara generation complex. UP is also planning for implementation of Anpara-E (2x660 MW) and Obra–D (800 MW) in Anpara and Obra complex respectively, in vicinity of Singrauli Generation Complex.

   CEA/CTU observed that the existing outlets from Anpara/Obra complex (765kV 2xS/c lines) may not be sufficient to evacuate the additional power from Singrauli St-III. Additional outlets need to be planned from Anpara/Obra complex in view of the planned generation projects (Anpara-E (2x660 MW), Obra –D (800 MW).

   NTPC stated that step up at 765kV level would not be possible as there would be space constraints for establishment of 765kV switchyard. NTPC further stated that two numbers of independent outlets are required for reliable evacuation of power from Singrauli St-III.

   UPPTCL stated that in case 765kV step up is not possible, then evacuation of power from Singrauli-III may be planned in the ISTS network.

3. CEA stated that keeping in view the high short circuit level in Singrauli, Anpara generation complex, Singrauli St-III may be connected to Vindhyachal 765/400kV pooling station through Vindhyachal St-IV through following link:
   - Singrauli-III – Vindhyachal IV 400kV D/c line

NTPC suggested interconnection of Singrauli St-III with Rihand St-III may also be planned as it would provide two numbers of independent outlets for reliable evacuation of power from both Singrauli St-III and Rihand St-III. NTPC further informed that Vindhyachal St- IV and Vindhyachal St-V are interconnected through 400kV twin moose line about three kms in length. Vindhyachal St-IV and Vindhyachal pooling station are interconnected through 400kV 2xD/c quad line. Vindhyachal St-V is also interconnected with Vindhyachal St –III through 400kV twin moose line which is normally kept open. Therefore, instead of new 400kV D/c quad line between Singrauli-III and Vindhyachal IV, the following is suggested:

i) LILO of both circuit of Vindhyachal-IV - Vindhyachal–V 400kV D/c line (twin) at Singrauli-III thus forming Vindhyachal- IV –Singrauli –III 400kv D/c line and Vindhyachal–V - Singrauli–III 400kv D/c line.
ii) Upgradation of Vindhyachal- IV –Singrauli –III 400kv D/c line with HTLS conductor
iii) Singrauli-III – Rihand-III 400kV quad D/c line (20 km)

4. CEA stated that with above suggestion Vindhyachal St-V would be radially connected to Singrauli St-III through a single 400 kV D/c line. Therefore, with shifting of one of the two nos. of 400kV quad lines (Vindhyachal St-IV - Vindhyachal Pool 400kV 2xD/c quad line) from Vindhyachal St-IV to Vindhyachal St-V would provide two number of 400kV outlets to Vindhyachal St-IV, Vindhyachal St-V, Singrauli St-III and Rihand St-III.

5. The matter was further deliberated and it was observed that availability of space at Vindhyachal St-V, Rihand St-III, Vindhyachal 765/400kV pooling station (for augmentation of 765/400kV ICT as overloading observed in preliminary studies during N-1 condition) and feasibility of 400kV link with Rihand St-III needs to be explored through a joint visit of CEA, CTU and NTPC.

6. As far as the provisions at the generation switchyard for evacuation of power from Singrauli St-III is concerned, the following was agreed:

i) Step up voltage of 400Kv.
ii) 6 nos. of 400kV line bays.
iii) 1x125 MVAR, 400 kV bus reactor.

Annexure-F

List of Major Hydro Projects Upstream of Shongtong HEP

1. Jhangi Thopan and Thopan Powari (960 MW) : Allotment of Project is expected during Current Year and commissioning is expected by 2029-30
2. Tidong –II (90 MW) : Awarded to Gammon India and is expected by 2027-28
3. Khab (636 MW) : No Planning as of now.
4. Yangthang – Khab (261 MW): Allocated to Gammon India, however they have given a request to HP for surrendering the project.
5. Ropa (205 MW) : Bids were invited, however no response received
6. Chango Yangthang (140 MW): Allocated to Bhilwara Group, however they have given a request to HP for surrendering the project.
7. Lara Sumte (104 MW) and Sumte – Khatang (130 MW) : Bids were invited, however no response received
8. Killing Lara (40 MW), Mane-Nadang (70 MW) and Lara (60 MW) : Projects dropped for the time being

ANNEXURE-E

Dynamic Voltage Analysis for DTL

Version 00

Delhi Transco Limited (DTL)
Dynamic Voltage Analysis

Project reference	3005577379
Date	2018-05-28
Editor	Mr. Rohith Varier
Release (techn.)	

Office address
Siemens Ltd EM DG PTI
Power Technologies International
Kalwa Works
Thane 40601, India

PM_TE_Report_EN Ver.3.00

siemens.com/power-technologies

Revision History

Rev.	Status / Changes	Date	Author
Version 00	Final Report	2018-05-28	Mr. Rohith Varier

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Executive Summary

Delhi Power System was established in 1905 when M/s. John Fleming Company was given the license for supply of power in Delhi. In 1958, Delhi Electric Supply Undertaking (DESU), a wing of the Municipal Corporation of Delhi, was formed. DVB under Government of NCT, Delhi was set up in 1997 under ESAct, 1948 replacing DESU. In July 2002, the erstwhile Delhi Vidyut Board was un-bundled under the provisions of DERA, 2000, Transfer Scheme Rules, 2001 etc. into six companies viz one Generation Company - Indraprastha Power Generation Company Limited (IPGCL), one Transmission Company - Delhi Transco Ltd, (DTL), and three Distribution Companies – BSES Rajdhani Power Limited, BSES Yamuna Power Limited & Tata Power Delhi Distribution Limited (BRPL, BYPL, TPDDL) and one Holding Company – Delhi Power Company Limited (DPCL). Pragati Power Corporation Limited (PPCL) which was established prior to the unbundling, was later included in the Generation Company.

Delhi Transco Limited (DTL) is a State Transmission Utility of the National Capital of Delhi. DTL is responsible for transmission at 220KV and 400KV levels besides upgradation and maintenance of EHV Network.

The transmission system of Delhi (220 kV and 400KV) comes under the purview of Delhi Transco Ltd. (DTL). There are altogether 6 nos. 400kV substations (including two nos of PGCIL) and 35 nos. 220 kV sub-stations in Delhi, supplying power to the five distribution utilities (viz. TPDDL, BRPL, BYPL, NDMC and MES), which cater to the load demands of the various areas of the Capital. Presently, Delhi is having a 400 kV D/C ring i.e. 400 kV Mandola - Dadri- Maharani Bagh - Samaypur – Bamnauli- Jhatikara More- Mundka - Bawana -Mandola D/C ring. With this 400kV Ring and underlying strong 220 kV network of DTL, demand is being served through the existing 220kV and 400kV systems.

As per the 19th Electric Power Forecast given in Delhi State Load Dispatch Center (SLDC), the peak load is observed to be 6538MW which is normally observed during peak summer conditions. During winter season in Delhi, the load varies from 4000MW during daytime to 1500MW during night. Such dynamic changes in load are attributed to the varying load pattern and consumer usage as given in Delhi SLDC website (www.delhisldc.org). As per the real time loading details for the year 2017-18, the approximate % consumption of loading is classified as follows: 50% is domestic, 25% is commercial, 13% is industrial and the remaining 12% are miscellaneous (public lighting, public water works, irrigation, bulk supply etc.).

In order to prepare for seasonal loading variations in future, the planning wing of DTL had conducted a feasibility study and estimated the loading patterns for the year 2021-22. Accordingly two major scenarios namely Off- Peak Load (1750MW) and Peak Load (8500MW) was modeled in Siemens PSS/E software whose analysis will give a reasonable idea about the future power system network of the state of Delhi.

Additionally, there was information about over-voltage issues addressed by various CEA, NRPC level OCC/GCC/Standing committees and studies were also done by CPRI as well as PGCIL, who have recommended for installation of shunt reactor across the Delhi EHV grid

network at 400/220kV voltage level. The locations and proposed reactor capacity were given in the 39th standing committee meeting held in May 2017.
DTL proposed to investigate the need of reactors at 22 locations, instead preferring to operate with reduced number of reactors and optimum SVC size to be installed at strategic locations.

Operational Scenarios

Normal operating scenario is defined as the power system network condition without any installation of shunt reactor at 400kV/220kV or injection of solar power at 33kV voltage level. Violations in voltage are observed inline with the data provided and as per the real time conditions mentioned in SLDC website. During off-peak load condition, major over-voltages were observed and during peak load condition, slight under-voltages were observed. Observations in over-voltage are consistent with the real time data plotted in SLDC website. Need of the hour is to reduce the occurrence of over-voltage condition, to maintain good voltage profile and network stability during small signal disturbances.

Case-1 is defined as Off-Peak Load condition for which in addition to the 2 shunt reactors proposed by PGCIL, the following locations are considered for installation of shunt reactors: 125MVar shunt reactor at 400kV Mundka and 6 reactors at 220kV locations which are 25MVar at 220kV Patparganj, 2x25MVar at 220kV Maharanibagh, 25MVar at 220kV Bamnoli, 2x25MVar at 220kV Harsh Vihar, 2x25MVar at 220kV Electric Lane and 25MVar at 220kV Mundka. Accordingly, the steady state and dynamic model is analysed by considering a fixed shunt reactor installed at the above mentioned locations.

Case-2 is defined as Off-Peak Load condition and is a similar variant of Case-1 condition. In addition to the 2 shunt reactors proposed by PGCIL, the following locations are considered for installation of shunt reactors: 50MVar at 220kV Maharanibagh and 50MVar at 220kV Harsh Vihar. SVC will be proposed at optimum location(s) and optimum size based on discussion with DTL.

Case-3 is defined as Off-Peak Load condition in which 125MVAr shunt reactors will be installed at 400kV Maharanibagh and 400kV Mandola as proposed by PGCIL in the standing committee meeting. Accordingly, the steady state and dynamic model is analysed by considering a fixed shunt reactor installed at the above two locations. The critical locations of over-voltage have been shortlisted for which SVC will be proposed at optimum location(s) and optimum size based on discussion with DTL.

Case-4 is defined as Peak load condition in which 1000MW is integrated at 33kV voltage level. During peak load condition, under voltages has been observed which will be compensated by addition of capacitive reactive power at shortlisted locations which will be finalized after discussion with DTL.

Observations

1) Over voltages are observed in Off- Peak Load (1750MW) condition which typically occurs at midnight between 2AM to 4AM in winter season. During this condition, the loading is below the natural surge impedance of the line. As a result, reactive power is

produced by the lines resulting in over voltage and this phenomenon is commonly called as Ferranti Effect.

2) Voltages are maintained at nominal operating level in Peak Load (8500MW) condition which typically occurs in summer season. During the condition, the loading at most locations is maintained nearby or above the natural surge impedance of the line. As a result, net reactive power is absorbed and voltage is reduced below the nominal value at some locations. However, the voltage limit is maintained within the tolerance limits as specified by CEA.

3) The power system study is conducted for split bus operating mode for 220kV substations which regulates the system voltage at 5 different zones. The most vulnerable zone for over-voltage is located near to 765kV Jhatikalan substation located nearby Bamnoli, Dwaraka and Mundka.

Recommendations

Following are the recommendations to prioritize the substations for installation of Shunt Reactor and Static Var Compensator (SVC) based on the results of contingency analysis, QV analysis, short circuit analysis and dynamic analysis.

1) 75MVar (inductive) to 200MVar (capactive) SVC* at 400kV Bamnoli substation, and 125MVar fixed reactor.

2) 125MVar fixed reactor at 400kV Mundka substation.

3) 50MVar fixed reactor at 220kV Maharnibagh, 220kV Harsh Vihar & 220kV Electric Lane.

4) 25MVar fixed reactor at 220kV Mundka.

1 Introduction

Delhi Power System was established in 1905 when M/s. John Fleming Company was given the license for supply of power in Delhi. In 1958, Delhi Electric Supply Undertaking (DESU), a wing of the Municipal Corporation of Delhi, was formed. DVB under Government of NCT, Delhi was set up in 1997 under ESAct, 1948 replacing DESU. In July 2002, the erstwhile Delhi Vidyut Board was un-bundled under the provisions of DERA, 2000, Transfer Scheme Rules, 2001 etc. into six companies viz one Generation Company - Indraprastha Power Generation Company Limited (IPGCL), one Transmission Company - Delhi Transco Ltd, (DTL), and three Distribution Companies – BSES Rajdhani Power Limited, BSES Yamuna Power Limited & Tata Power Delhi Distribution Limited (BRPL, BYPL, TPDDL) and one Holding Company – Delhi Power Company Limited (DPCL). Pragati Power Corporation Limited (PPCL) which was established prior to the unbundling, was later included in the Generation Company.

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As per the 19th Electric Power Forecast given in Delhi State Load Dispatch Center (SLDC), the peak load is observed to be 6538MW which is normally observed during peak summer conditions. During winter season in Delhi, the load varies from 4000MW during daytime to 1500MW during night. Such dynamic changes in load are attributed to the varying load pattern and consumer usage as given in Delhi SLDC website (www.delhisldc.org). As per the real time loading details for the year 2017-18, the approximate % consumption of loading is classified as follows: 50% is domestic, 25% is commercial, 13% is industrial and the remaining 12% are miscellaneous (public lighting, public water works, irrigation, bulk supply etc.).

In order to prepare for seasonal loading variations in future, the planning wing of DTL had conducted a feasibility study and estimated the loading patterns for the year 2021-22. Accordingly two major scenarios namely Off- Peak Load (1750MW) and Peak Load (8500MW) was modeled in Siemens PSS/E software whose analysis will give a reasonable idea about the future power system network of the state of Delhi.

Additionally, there was information about over-voltage issues addressed by various CEA, NRPC level OCC/GCC/Standing committees and studies were also done by CPRI as well as PGCIL, who have recommended for installation of shunt reactor across the Delhi EHV grid network at 400/220kV voltage level. The locations and proposed reactor capacity were given in the 39th standing committee meeting held in May 2017.

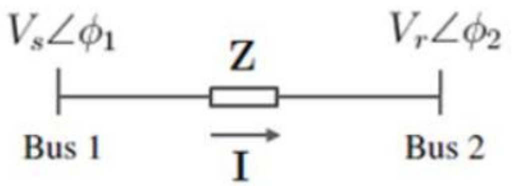
DTL proposed to investigate the need of reactors at 22 locations, instead preferring to operate with reduced number of reactors and optimum SVC size to be installed at strategic locations.

2 Reactive Power & Voltage Control

Reactive power (As per NERC) is defined as “The portion of electricity that establishes and sustains the electric and magnetic fields of alternating-current equipment. Reactive power must be supplied to most types of magnetic equipment, such as motors and transformers. It also must supply the reactive losses on transmission facilities. Reactive power provided by generators, synchronous condensers or electrostatic equipment such as capacitors directly influence electric system voltage. It is usually expressed in kilovars (kVar) or megavars (MVar).”

Real power is the component of apparent power that does real work, defined as the component of the current in phase with the voltage. Reactive power is produced when the current waveform is out of phase with the voltage waveform due to inductive (current lags voltage) and capacitive (current leads voltage) loads, and is measured in volt-ampere reactive (var). Fundamentally, reactive power is necessary to produce the electric and magnetic fields inherent in an alternating current (AC) network and AC loads such as motors. Neglecting line resistance and capacitance (Z = jωL), reactive power transfer across a short transmission line can be expressed as

$$Q_r = \frac{V_r}{X}(V_s \cos\delta - V_r)$$



where Vs and Vr are the sending and receiving end voltage magnitudes, respectively; X is the line reactance; and δ is the phase angle difference (“power angle”) between the two ends of the line. It is clear from this equation that reactive power is a function of voltage difference, angle difference, and electrical impedance; however, angle difference has a relatively small influence while voltage difference and impedance are much stronger drivers. For this reason, voltage control is tightly coupled with reactive power control, and vice versa.

Voltage is supported through supply of reactive power; hence, reactive power is required to transfer large amounts of real power across the grid for serving the loads. Reactive power must be supplied locally mainly because of its dependence on voltage difference, and it is usually necessary to site reactive devices very near or at the location that is deficient; typically reactive power supply is provided where it is needed to minimize losses. Voltage stability is the ability of a power system to maintain acceptable voltage at all buses under normal and contingency operating conditions.

For efficient and reliable operation of power systems, the control of voltage and reactive power should satisfy the following objectives:

- Voltages at the terminals of all equipment in the system are within acceptable limits. Both utility and customer equipment are designed to operate at a certain voltage rating. Prolonged operation of the equipment at voltages outside the allowable range could adversely affect their performance and possibly cause them damage.

- System stability is enhanced to maximize utilization of the transmission system.

- Reactive power flow is minimized so as to reduce I^2R and I^2X losses to a practical minimum. This ensures that the transmission system operates efficiently, mainly for active power transfer.

The problem of maintaining voltages within the required limits is complicated by the fact that the power system supplies power to a vast number of loads and is fed from many generating units. As loads vary, the reactive power requirements of the transmission system vary. Since reactive power cannot be transmitted over long distances, voltage control has to be effected by using special devices dispersed throughout the system. This is in contrast to the control of frequency which depends on the overall system active power balance. The proper selection and coordination of equipment for controlling reactive power and voltage are among the main challenges.

2.1 Production and Absorption of reactive power

Synchronous Generators can generate or absorb reactive power depending on the excitation. When overexcited they supply reactive power, and when underexcited they absorb reactive power. The capability to continuously supply or absorb reactive power is limited by the field current, armature current and end-region heating limits.

Overhead lines, depending on the load current, either absorb or supply reactive power. At loads below the natural surge impedance loading, the lines produce net reactive power and at loads above the natural loading, the lines absorb reactive power.

Underground cables, owing to their high capacitance, have high natural loads. They are always loaded below their natural loads, and hence generate reactive power under all operating conditions.

Transformers always absorb reactive power regardless of their loading. At no load, the shunt magnetizing reactance effects predominate and at full load, the series leakage inductance effects predominate.

Loads normally absorb reactive power. A typical load bus supplied by a power system is composed of a large number of devices. The composition changes depending on the day, season and weather conditions. The composite characteristics are normally such that a load bus absorbs reactive power. Both active power and reactive power of the composite loads vary as a function of voltage magnitudes. Loads of low-lagging power power factors cause excessive voltage drops in the transmission network and are uneconomical to supply.

Compensating devices are usually added to supply or absorb reactive power and thereby control the reactive power balance in a desired manner.

3 Workflow of Power System Study

The steady state and dynamic model network of the Delhi Transco Limited (DTL) has been built in Siemens PSS/E software. The network model is based on the steady state file prepared by Delhi Transco Limited (DTL) in .sav format. The working model has been prepared for two scenarios, namely Off- Peak Load (1750MW) and Peak Load (8500MW). The files were completely checked for input data. Whenever discrepancies were observed or clarifications were required, officials from DTL and Siemens are in regular contact to investigate and optimize the best suitable corrective actions to be taken.

Officials from Siemens visited DTL to discuss the observations of steady state simulation for base case condition. Corresponding inputs to prepare dynamic model for generators and loads were obtained during the meeting. DYRE file, i.e. dynamic raw data file has been prepared by Siemens using the dynamic data prepared from a snapshot file of PGCIL project. The data from the PGCIL file was used to prepare dynamic model for generators for All India network.

3.1 Characteristics of Delhi Power System

The transmission system of Delhi (220 kV and 400KV) comes under the purview of Delhi Transco Ltd. (DTL). There are altogether 6 nos. 400kV substations (including two nos of PGCIL) and 35 nos. 220 kV sub-stations in Delhi, supplying power to the five distribution utilities (viz. TPDDL, BRPL, BYPL, NDMC and MES), which cater to the load demands of the various areas of the Capital. Presently, Delhi is having a 400 kV D/C ring i.e. 400 kV Mandola - Dadri- Maharani Bagh - Samaypur – Bamnauli- Jhatikara More- Mundka - Bawana -Mandola D/C ring. With this 400kV Ring and underlying strong 220 kV network of DTL, demand is being served through the existing 220kV and 400kV systems.

3.2 Generating Sites and Sources

The transmission planning has been carried out with a basic principle and objective of ZERO generation within Delhi, which does not imply either existing generators are required to be winded up or new generators (city centric) are not allowed. The generating sources are present at Pragati, Bawana and Badarpur TPS. As per the 5 year plan of DTL, an additional 1000MW of solar PV will be pooled at 33kV voltage level.

The generating sources for Off-peak load (1750MW) are given as follows:
300MW at 400kV Bawana-G, 165MW at 220kV Pragati & 80MW at 66kV Delhi GAS

The generating sources for Peak load (8500MW) are given as follows:
650MW at 400kV Bawana-G, 265MW at 220kV Pragati & 80MW at 66kV Delhi GAS

3.3 Load Centres and Types

The load centres are distributed at 66kV and 33kV voltage levels which primarily define the operational criteria of Off-peak (1750MW) and Peak (8500MW) database.

3.4 System configuration

The power system study is performed by considering the reactors to be installed at the following substations under the purview of PGCIL: 2x240 MVar reactors at 765kV Jhatikalan, 125 MVAr reactor at 400 kV Maharanibagh, 125 MVar reactor at 400 kV Mandola, 125 MVar reactor at 400 kV Dwaraka and 125 MVar reactor at 400kV Tughlakabad.

For the year 2021-22, approximately 20km of overhead line connecting the substations from Tughlakabad to RK Puram to Masjid Moth are planned to be converted to underground cables. In addition to the presence of 700MVAr capacitance in the network which are distributed at 66kV voltage level, the incorporation of underground cables will increase the capacitance of the network.

According to the 5-year plan by DTL, 1000MW solar parks would be pooled at 33kV network which would be distributed at a maximum of 40MW per bus. The impact of solar parks will be maximum during peak summer season.

3.5 Case Scenarios

The power system network of DTL is analyzed for different case scenarios based on suitable operating conditions of the network along with considering the operation of 220kV substations in split bus operating mode instead of parallel operating mode. Description for different case scenarios are given as follows:

Normal operating scenario is defined as the power system network condition without any installation of shunt reactor at 400kV/220kV or injection of solar power at 33kV voltage level. Violations in voltage are observed inline with the data provided and as per the real time conditions mentioned in SLDC website. During off-peak load condition, major over-voltages were observed and during peak load condition, slight under-voltages were observed. Observations in over-voltage are consistent with the real time data plotted in SLDC website. Need of the hour is to reduce the occurrence of over-voltage condition, to maintain good voltage profile and network stability during small signal disturbances.

Case-1 is defined as Off-Peak Load condition for which in addition to the 2 shunt reactors proposed by PGCIL, the following locations are considered for installation of shunt reactors: 125MVar shunt reactor at 400kV Mundka and 6 reactors at 220kV locations which are 25MVar at 220kV Patparganj, 2x25MVar at 220kV Maharanibagh, 25MVar at 220kV Bamnoli, 2x25MVar at 220kV Harsh Vihar, 2x25MVar at 220kV Electric Lane and 25MVar at 220kV Mundka. Accordingly, the steady state and dynamic model is analysed by considering a fixed shunt reactor installed at the above mentioned locations.

Case-2 is defined as Off-Peak Load condition and is a similar variant of Case-1 condition. In addition to the 2 shunt reactors proposed by PGCIL, the following locations are considered for installation of shunt reactors: 50MVar at 220kV Maharanibagh and 50MVar at 220kV Harsh Vihar. SVC will be proposed at optimum location(s) and optimum size based on discussion with DTL.

Case-3 is defined as Off-Peak Load condition in which 125MVAr shunt reactors will be installed at 400kV Maharanibagh and 400kV Mandola as proposed by PGCIL in the standing committee meeting. Accordingly, the steady state and dynamic model is analysed by considering a fixed shunt reactor installed at the above two locations. The critical locations of over-voltage have been shortlisted for which SVC will be proposed at optimum location(s) and optimum size based on discussion with DTL.

Case-4 is defined as Peak load condition in which 1000MW is integrated at 33kV voltage level. During peak load condition, under voltages has been observed which will be compensated by addition of capacitive reactive power at shortlisted locations which will be finalized after discussion with DTL.

4 Power Flow Analysis

Power Flow Analysis is one of the most common computational procedures used for understanding the steady state characteristics of power system. A power flow calculation determines the state of the power system for a given load and generation distribution. The operation of power systems requires such calculations to analyze the steady-state performance of the power system under various operating conditions and to study the effects of changes in equipment configuration. The power flow studies are used to determine the component or circuit loadings, steady-state bus voltages, Reactive power flows, Transformer tap settings, system losses & performance under emergency conditions. The power flow model is also the basis for several other types of studies such as short-circuit and dynamic stability studies. The power flow model supplies the network data and an initial steady-state condition for these studies. The output of study determines the voltage, current, active, reactive power and power factor in a power system. These studies will alert the user to the conditions that may cause overloads or poor voltage levels.

4.1 Criteria for voltage stability

In steady-state operation, voltages are maintained within scheduled voltage ranges on the bulk power grid, with individual elements such as generators and dynamic reactive resources maintaining a terminal voltage set point value. Manual readjustment of network elements is performed to maintain these schedules throughout the day as load and transfer levels change. Automatic devices also continuously operate to maintain their set points. In these conditions, the system is at a planned operating condition in which all facilities are in-service or out-of-service on planned maintenance7. The grid is said to be operating in a "secure" state, meaning that there are no existing operating limit violations and analytical tools show no violations of emergency limits following any defined outage conditions. In the event that the analytical tools identify a post-contingency low (or high) voltage, actions are taken pre-contingency to mitigate this potential future state. This usually consists of inserting (or removing) shunt reactive devices on the system. All system controls are considered in (modeling) this system condition, including under-load tap changer action, automatic action of continuously responding resources, and voltage control modes.

In normal operation ('N-0') of the grid, with all elements to be available in service in the time horizon of study, it is required that all the system parameters like voltages, loadings, frequency should remain within permissible normal limits. The grid may however be subjected to disturbances and it is required that after a more probable disturbance i.e. loss of an element ('N-1' or single contingency condition), all the system parameters like voltages, loadings, frequency shall be within permissible normal limits. Normal thermal ratings and normal voltage limits represent equipment limits that can be sustained on continuous basis. Emergency thermal ratings and emergency voltage limits represent equipment limits that can be tolerated for a relatively short time which may be one hour to two hour depending on design of the equipment.

As per CEA planning criteria, it is recommended to maintain the voltages within the operating range shown in Table 4-1.

Table 4-1: Voltage tolerance limits as per CEA planning criteria

Voltages (p.u.)				
	Normal rating		Emergency rating	
Voltage (kV)	Maximum (p.u.)	Minimum (p.u.)	Maximum (p.u.)	Minimum (p.u.)
765	1.05	0.95	1.05	0.93
400	1.05	0.95	1.05	0.93
230	1.07	0.90	1.07	0.88
220	1.11	0.90	1.11	0.88
132	1.10	0.92	1.10	0.90
110	1.12	0.90	1.12	0.88
66	1.10	0.91	1.10	0.89

However, after suffering one contingency, grid is still vulnerable to experience second contingency, though less probable ('N-1-1'), wherein some of the equipments may be loaded up to their emergency limits. To bring the system parameters back within their normal limits, load shedding/re-scheduling of generation may have to be applied either manually or through automatic system protection schemes (SPS). Such measures shall generally be applied within one and a half hour (1½ hour) after the disturbance.

4.2 Normal Operating Scenario

The normal operating scenario is defined as the network conditions which are considered on a regular schedules withour reasonable variations and deviations. In order to prepare for seasonal loading variations in future, the planning wing of DTL had conducted a feasibility study and estimated the loading patterns for the year 2021-22. Accordingly two major scenarios namely Off- Peak Load (1750MW) and Peak Load (8500MW) was modeled in PSS/E software whose analysis will give a reasonable idea about the future power system network of the state of Delhi.

Accordingly, the normal operating scenario is defined separately for two seasons, winter and summer.

During winter season in Delhi, the load varies from 4000MW during daytime to 1500MW during night. Such dynamic changes in load are attributed to the varying load pattern and consumer usage as given in Delhi SLDC website (www.delhisldc.org). As per the real time loading details for the year 2017-18, the approximate % consumption of loading is classified as follows: 50% is domestic, 25% is commercial, 13% is industrial and the remaining 12% are miscellaneous (public lighting, public water works, irrigation, bulk supply etc.).

During summer season in Delhi, the load variation is maintained within reasonable limits compared to the variations observed during winter season. Presently, the peak load is observed to be 6700MW, as per details given in Delhi SLDC website (www.delhisldc.org). During peak loading, the voltage profile is maintained with occurrences of under-voltage in the network. According to the next 5-year plan by DTL, 1000MW solar parks would be pooled at 33kV network which would be distributed at a maximum of 40MW per bus. The impact of solar parks will be maximum during peak summer season.

4.3 Results for Normal Operating Scenario

The results for normal operating scenario are compiled with the power system network condition without any installation of shunt reactor at 400kV/220kV or injection of solar power at 33kV voltage level. Violations in voltage are observed inline with the data provided and as per the real time conditions mentioned in SLDC website. During off-peak load condition, major over-voltages were observed and during peak load condition, slight under-voltages were observed. Observations in over-voltage are consistent with the real time data plotted in SLDC website. Need of the hour is to reduce the occurrence of over-voltage condition, to maintain good voltage profile and network stability during small signal disturbances. Ranking of substations is done based on the voltage level. For off-peak load case, substations are ranked as per highest voltage violations and for peak load case, substations are ranked as per lowest voltage violations.

4.3.1 Off-Peak Load Results

Power flow analysis is conducted on Off- Peak Load (1750MW) which is the load predicted in Delhi during the year 2021-22. In Table 4-2, a list of substations is indicated whose voltage levels are sustained to operate above the normal voltage but within acceptable limits as per Table 4-1.

Table 4-2: Off-Peak Load operating voltages during normal operation

Substation Name	Voltage Level	Voltage (p.u)
187708 JHATI-PG 76	765 kV	1.0416
184463 JHATIKALA-PG40	400 kV	1.0408
184434 BAHADURGARH 40	400 kV	1.0404
184455 MUNDKA 40	400 kV	1.04
154426 BAWANA-G 40	400 kV	1.0387
184427 BAWANA 40	400 kV	1.0388
184444 JHATIKRASP 40	400 kV	1.038
184497 DWARKA 40	400 kV	1.0371
184428 BAMNAULI4 40	400 kV	1.0366
184496 GOPAL PUR 40	400 kV	1.0357
152209 MEHRAULI_BM 22	220 kV	1.0452
152296 BUDELLA 22	220 kV	1.0451
152297 ZAKHIRA 22	220 kV	1.045
152224 DIAL 22	220 kV	1.0444
152202 BAMNOLI2 22	220 kV	1.0443
152240 PAPANKALA-II22	220 kV	1.0442
152298 BHARTAL 22	220 kV	1.0442
152214 PAPANKALAN-122	220 kV	1.0441
152250 PPK-III 22	220 kV	1.0442
152295 DWARKA 22	220 kV	1.0442
152221 NARAINA 22	220 kV	1.044
152223 NAJAFGARH_BM22	220 kV	1.0439

Substation Name	Voltage Level	Voltage (p.u)
152244 MUNDKA 22	220 kV	1.0381
152243 PEERAGARHI 22	220 kV	1.038
152242 WAZIRPUR 22	220 kV	1.0378
152210 NAZAFGARH_BW22	220 kV	1.0375
152289 JHATIKALAN 22	220 kV	1.0374

4.3.2 Peak Load Results

Power flow analysis is conducted on Peak Load (8500MW) which is the load predicted in Delhi during the year 2021-22.

Table 4-3: Peak Load operating voltages during normal operation

Substation Name	Voltage Level	Voltage (p.u.)
152227 RIDGEVALLEY 22	220 kV	0.9445
152249 R. K.PURAM-222	220 kV	0.9451
152211 VASANTKUJ 22	220 kV	0.9464

4.4 Observations for Normal Operating Scenario

1) Over voltages are observed in Off- Peak Load (1750MW) condition which typically occurs at midnight between 2AM to 4AM in winter season. During this condition, the loading is below the natural surge impedance of the line. As a result, reactive power is produced by the lines resulting in over voltage and this phenomenon is commonly called as Ferranti Effect.

2) Voltages are maintained at nominal operating level in Peak Load (8500MW) condition which typically occurs in summer season. During the condition, the loading at most locations is maintained nearby or above the natural surge impedance of the line. As a result, net reactive power is absorbed and voltage is reduced below the nominal value at some locations. However, the voltage limit is maintained within the tolerance limits as specified by CEA.

3) The power system study is conducted for split bus operating mode for 220kV substations which regulates the system voltage at 5 different zones. The most vulnerable zone for over-voltage is located near to 765kV Jhatikalan substation located nearby Bamnoli, Dwaraka and Mundka.

5 Contingency Analysis

The objective of contingency analysis is to identify the network elements that are violating system operational/planning criteria. The transmission network has to always fulfill the N-1 criteria. Contingency analysis is conducted to ensure all transmission equipment will operate within their respective normal thermal ratings and voltage limits when the system is operating with all scheduled elements in service (Normal condition), and within its emergency thermal ratings and voltage limits immediately after a disturbance involving the loss of an element (single contingency or “N-1” condition), but without operator intervention. The system should be capable of such performance at all times, including operations during minimum and maximum forecasted load conditions. This “N-1” condition applies to both steady state and stability requirements. In addition to satisfactory performance for normal system conditions and for single contingencies, the system should be able to withstand extreme (more severe but less probable) disturbances without suffering voltage collapse, cascading or instability.

For voltage criteria testing, contingency analysis routinely checks for both voltage drop criteria and absolute voltage criteria. The voltage drop is calculated as the decrease in bus voltage from the initial steady state power flow to the post-contingency power flow and it ranges from 2% to 6% depending on the adopted value by the region/utility. The absolute voltage criteria is examined for the same contingency set and it constitutes the acceptable lower and upper bus voltage magnitude limits immediately after a disturbance, e.g. 0.95 pu and 1.05 pu.

Contingency analysis is performed for both Off- Peak Load (1750MW) and Peak Load (8500MW) using the worst case operational conditions which are pre-defined for each case.

5.1 Results for Contingency Analysis

N-1 contingency analysis is performed using a criteria based on 10 worst case contingencies which can result in voltage collapse in the system of DTL. Similar to normal operating scenario, the ranking of substations is done based on the voltage level. For off-peak load case, substations are ranked as per highest voltage violations and for peak load case, substations are ranked as per lowest voltage violations.

5.1.1 Off-Peak Load Results

Contingency analysis is conducted on Off- Peak Load (1750MW) which is the load predicted in Delhi during the year 2021-22. In Table 4-2, a list of substations is indicated whose voltage levels are sustained to operate above the normal voltage but within acceptable limits as per Table 4-1. The 10 worst case contingency cases are given below:

Case-1: OPEN LINE FROM BUS 154426 TO BUS 184434 CKT 1
'BAWANA-G 400.00' TO 'BAHADURGARH 400.00'

Case-2: OPEN LINE FROM BUS 184463 TO BUS 187708 CKT 1
'JHATIKALA-PG 400.00' TO 'JHATI-PG 765.00'

Case-3: OPEN LINE FROM BUS 184427 TO BUS 184455 CKT 1
'BAWANA 400.00' TO 'MUNDKA 400.00'

Case-4: OPEN LINE FROM BUS 184455 TO BUS 184463 CKT 1
'MUNDKA 400.00' TO 'JHATIKALA-PG 400.00'

Case-5: OPEN LINE FROM BUS 184444 TO BUS 187708 CKT 4
'JHATIKRASP 400.00' TO 'JHATI-PG 765.00'

Case-6: OPEN LINE FROM BUS 152239 TO BUS 152244 CKT 1
'KANJHAWALA 220.00' TO 'MUNDKA 220.00'

Case-7: OPEN LINE FROM BUS 152248 TO BUS 184495 CKT 3
'TUGHLKABAD_2 220.00' TO 'TUGHLAKABAD 400.00'

Case-8: OPEN LINE FROM BUS 152248 TO BUS 184495 CKT 2
'TUGHLKABAD_2 220.00' TO 'TUGHLAKABAD 400.00'

Case-9: OPEN LINE FROM BUS 182222 TO BUS 184495 CKT 1
'TUGHLAKABAD 220.00' TO 'TUGHLAKABAD 400.00'

Case-10: OPEN LINE FROM BUS 184428 TO BUS 184444 CKT 1
'BAMNAULI4 400.00' TO 'JHATIKRASP 400.00'

Table 5-1: Off-Peak Load operating voltages during contingency operation

Substation Name	Voltage Level	Base Case (p.u.)	Case-1 (p.u.)	Case-2 (p.u.)	Case-3 (p.u.)	Case-4 (p.u.)	Case-5 (p.u.)	Case-6 (p.u.)	Case-7 (p.u.)	Case-8 (p.u.)	Case-9 (p.u.)	Case-10 (p.u.)
187708 JHATI-PG 76	765 kV	1.0416	1.042	1.0416	1.0416	1.0412	1.0416	1.0416	1.0419	1.0421	1.0415	1.0416
184463 JHATIKALA-PG40	400 kV	1.0408	1.0414	1.0408	1.0408	1.0401	1.0407	1.0407	1.0409	1.041	1.0405	1.0402
184434 BAHADURGARH 40	400 kV	1.0404	1.0403	1.0404	1.0404	1.0411	1.0404	1.0401	1.0404	1.0404	1.0402	1.0403
184455 MUNDKA 40	400 kV	1.04	1.0407	1.04	1.04	1.0392	1.04	1.04	1.04	1.0401	1.0391	1.0396
154426 BAWANA-G 40	400 kV	1.0387	1.0383	1.0387	1.0387	1.0373	1.0387	1.038	1.0387	1.0387	1.0383	1.0385
184427 BAWANA 40	400 kV	1.0388	1.0383	1.0387	1.0387	1.0373	1.0387	1.0381	1.0387	1.0388	1.0383	1.0386
184444 JHATIKRASP 40	400 kV	1.038	1.0383	1.0379	1.0379	1.0375	1.0378	1.0379	1.0386	1.036	1.0378	1.0378
184497 DWARKA 40	400 kV	1.0371	1.0374	1.037	1.037	1.0366	1.0369	1.037	1.0359	1.0353	1.0369	1.0369
184428 BAMNAULI4 40	400 kV	1.0366	1.0368	1.0365	1.0365	1.0361	1.0364	1.0364	1.0345	1.0349	1.0364	1.0364
184496 GOPAL PUR 40	400 kV	1.0357	1.0354	1.0357	1.0357	1.0346	1.0357	1.0351	1.0356	1.0357	1.0353	1.0355
152209 MEHRAULI_BM 22	220 kV	1.0452	1.0456	1.0452	1.0452	1.0448	1.045	1.0451	1.0436	1.0435	1.045	1.045
152296 BUDELLA 22	220 kV	1.0451	1.0455	1.0451	1.0451	1.0447	1.045	1.045	1.0436	1.0434	1.0449	1.0449
152297 ZAKHIRA 22	220 kV	1.045	1.0455	1.045	1.045	1.0446	1.0449	1.0449	1.0435	1.0434	1.0448	1.0448
152224 DIAL 22	220 kV	1.0444	1.0448	1.0444	1.0444	1.0439	1.0442	1.0443	1.0428	1.0427	1.0442	1.0441
152202 BAMNOLI2 22	220 kV	1.0443	1.0447	1.0442	1.0442	1.0438	1.0441	1.0442	1.0426	1.0426	1.044	1.044
152240 PAPANKALA-II22	220 kV	1.0442	1.0446	1.0442	1.0442	1.0438	1.044	1.0441	1.0426	1.0425	1.044	1.0439
152298 BHARTAL 22	220 kV	1.0442	1.0446	1.0442	1.0442	1.0438	1.044	1.0441	1.0426	1.0425	1.044	1.044
152214 PAPANKALAN-122	220 kV	1.0441	1.0445	1.0441	1.0441	1.0437	1.0439	1.044	1.0426	1.0424	1.0439	1.0438
152250 PPK-III 22	220 kV	1.0442	1.0446	1.0441	1.0441	1.0437	1.044	1.0441	1.0426	1.0425	1.0439	1.0439
152295 DWARKA 22	220 kV	1.0442	1.0446	1.0441	1.0441	1.0437	1.044	1.0441	1.0426	1.0425	1.0439	1.0439
152221 NARAINA 22	220 kV	1.044	1.0444	1.044	1.044	1.0435	1.0438	1.0439	1.0425	1.0423	1.0438	1.0437
152223 NAJAFGARH_BM22	220 kV	1.0439	1.0444	1.0439	1.0439	1.0435	1.0437	1.0438	1.0423	1.0423	1.0436	1.0436

Substation Name		Voltage Level	Base Case (p.u.)	Case-1 (p.u.)	Case-2 (p.u.)	Case-3 (p.u.)	Case-4 (p.u.)	Case-5 (p.u.)	Case-6 (p.u.)	Case-7 (p.u.)	Case-8 (p.u.)	Case-9 (p.u.)	Case-10 (p.u.)
152244	MUNDKA 22	220 kV	1.0381	1.0411	1.0381	1.0381	1.0371	1.0381	1.0382	1.038	1.0381	1.0373	1.0375
152243	PEERAGARHI 22	220 kV	1.038	1.041	1.038	1.038	1.037	1.038	1.0381	1.0379	1.038	1.0372	1.0374
152242	WAZIRPUR 22	220 kV	1.0378	1.0408	1.0378	1.0378	1.0369	1.0378	1.0379	1.0378	1.0378	1.037	1.0373
152210	NAZAFGARH_BW22	220 kV	1.0375	1.0404	1.0375	1.0375	1.0365	1.0375	1.0376	1.0374	1.0374	1.0367	1.037
152289	JHATIKALAN 22	220 kV	1.0374	1.0377	1.0374	1.0374	1.0369	1.0372	1.0373	1.038	1.0355	1.0372	1.0372

5.1.2 Off-Peak Load Results

Contingency analysis is conducted on Peak Load (8500 MW) which is the load predicted in Delhi during the year 2021-22. In Table 4-2, a list of substations is indicated whose voltage levels are below the normal voltage but within acceptable limits as per Table 4-1.

The 10 worst case contingency cases are given below:

Case-1: OPEN LINE FROM BUS 184444 TO BUS 187708 CKT 4
'JHATIKRASP 400.00' TO 'JHATI-PG 765.00'

Case-2: OPEN LINE FROM BUS 184463 TO BUS 187708 CKT 1
'JHATIKALA-PG 400.00' TO 'JHATI-PG 765.00'

Case-3: OPEN LINE FROM BUS 152248 TO BUS 184495 CKT 3
'TUGHLKABAD_2 220.00' TO 'TUGHLAKABAD 400.00'

Case-4: OPEN LINE FROM BUS 152248 TO BUS 184495 CKT 2
'TUGHLKABAD_2 220.00' TO 'TUGHLAKABAD 400.00'

Case-5: OPEN LINE FROM BUS 184427 TO BUS 184455 CKT 1
'BAWANA 400.00' TO 'MUNDKA 400.00'

Case-6: OPEN LINE FROM BUS 184455 TO BUS 184463 CKT 1
'MUNDKA 400.00' TO 'JHATIKALA-PG 400.00'

Case-7: OPEN LINE FROM BUS 184444 TO BUS 184497 CKT 1
'JHATIKRASP 400.00' TO 'DWARKA 400.00'

Case-8: OPEN LINE FROM BUS 182222 TO BUS 184495 CKT 1
'TUGHLAKABAD 220.00' TO 'TUGHLAKABAD 400.00'

Case-9: OPEN LINE FROM BUS 152239 TO BUS 152244 CKT 1
'KANJHAWALA 220.00' TO 'MUNDKA 220.00'

Case-10: OPEN LINE FROM BUS 152244 TO BUS 184455 CKT 1
'MUNDKA 220.00' TO 'MUNDKA 400.00'

Table 5-2: Peak Load operating voltages during contingency operation

Substation Name	Voltage Level	Base Case (p.u.)	Case-1 (p.u.)	Case-2 (p.u.)	Case-3 (p.u.)	Case-4 (p.u.)	Case-5 (p.u.)	Case-6 (p.u.)	Case-7 (p.u.)	Case-8 (p.u.)	Case-9 (p.u.)	Case-10 (p.u.)
152227 RIDGEVALLEY 22	220 kV	0.9445	0.9448	0.9444	0.939	0.939	0.9438	0.9443	0.9434	0.9408	0.9445	0.9444
152249 R. K.PURAM-222	220 kV	0.9451	0.9453	0.945	0.9396	0.9396	0.9444	0.9449	0.944	0.9414	0.9451	0.9449
152211 VASANTKUJ 22	220 kV	0.9464	0.9466	0.9462	0.9409	0.9409	0.9457	0.9461	0.9452	0.9427	0.9463	0.9462

5.2 Observations for Contingency Analysis

1) Contingency analysis is conducted on the system for Off-Peak and Peak load case for which 10 worst case criterias are identified which can result in voltage violation.

2) Overvoltages are observed in Off- Peak Load (1750MW) condition which typically occurs at midnight between 2AM to 4AM in winter season. During this condition, the loading is below the natural surge impedance of the line. As a result, reactive power is produced by the lines resulting in over voltage and this phenomenon is commonly called as Ferranti Effect.

6 QV Analysis

Objective of this task is to perform QV analysis on all 400kV and 220kV substations. Slope of QV-curve indicates the sensitivity of the bus with respect to reactive power change. Therefore, calculate the slope of curve æV/æQ for each substation for base case and prioritize the substations based on high æV/æQ.

QV analysis provides the sensitivity of bus voltage with respect to injections of reactive power at a given bus location. The purpose of QV analysis is to determine how much reactive margin a particular bus has before voltage collapse would occur under pre- and post-contingency operating conditions. A system is defined as voltage stable if the V-Q sensitivity is positive for every bus and voltage unstable if V-Q sensitivity is negative for any one bus. QV curves are generated by placing a fictitious generator at the bus being analyzed. The voltage set point of the dummy generator is varied over a range and its var output is adjusted to meet this scheduled set point. The vertical axis output of a QV curve shows the output of the generator Mvar and the horizontal axis shows the voltage set point. Positive Q represents reactive power output from the dummy generator while negative Q represents reactive power consumption. The base case operating point is represented by the intersection of the curve with the x-axis (zero reactive power output of the dummy generator) of the curve. As voltage decreases from this point, reactive power is consumed by the fictitious generator. The minimum point (“bottom”) of the curve represents the voltage stability point, which is the maximum allowable increase in load Mvar at the tested bus. The Q value at this minimum point is defined as the reactive power margin for this bus. That value must be below the x-axis (negative value, meaning consumption) for stable operating condition; otherwise a minimum above the x-axis is an unstable operating condition.

QV analysis is performed for both pre-contingency and post-contingency operating conditions. For post-contingency simulations, the contingent line is removed from service to establish a new operating condition. Then QV curves are generated for that condition to establish the stability points for that contingency event. Prior to varying the voltage setpoint of the dummy generator, all static var devices are typically locked (switched shunts, LTCs, etc.). Dynamic reactive devices (i.e., devices expected to respond prior to voltage collapse) are allowed to respond as the set point voltage of the dummy generator is varied. When a nearby reactive device reaches its maximum or minimum output limit, there is a discontinuity in the QV curve. A main advantage of QV analysis is that reactive power requirements can be computed without being affected by load flow convergence problems. At the same time, being a full AC power flow implementation, it is capable of representing all system effects and controls without numerical compromise. However, the method has the drawback that a bus, representative of a particular voltage collapse condition, must be preselected.

6.1 QV Curves

QV analysis is conducted for the buses which are most vurnerable to over-voltage condition as observed from power flow and contingency analysis. Ranking of substations based on higher voltage is shown below:

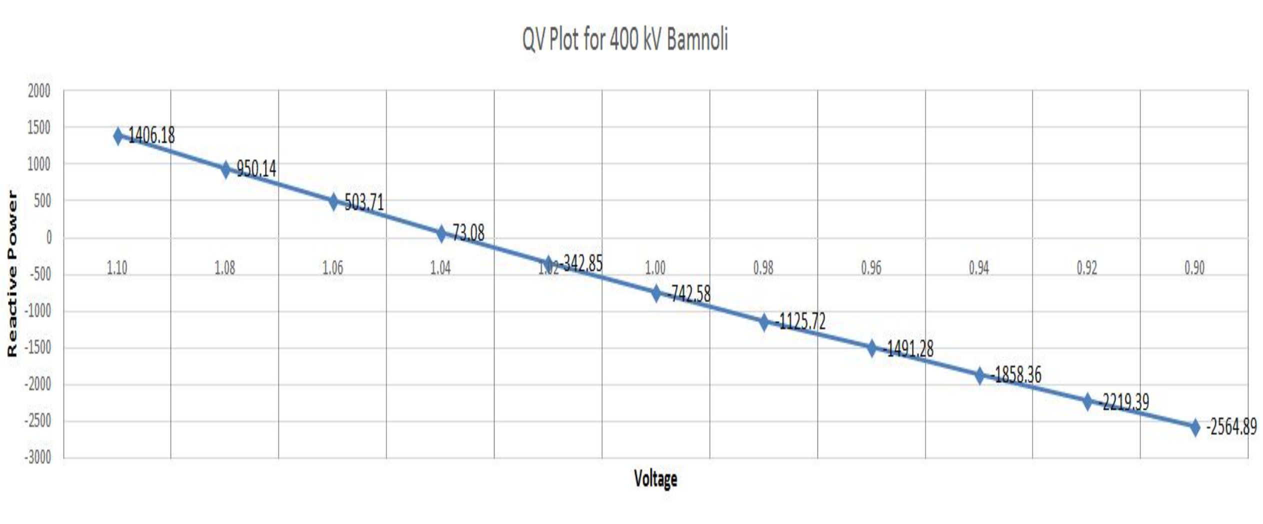


Figure 6-1: QV Plot for 400kV Bamnoli

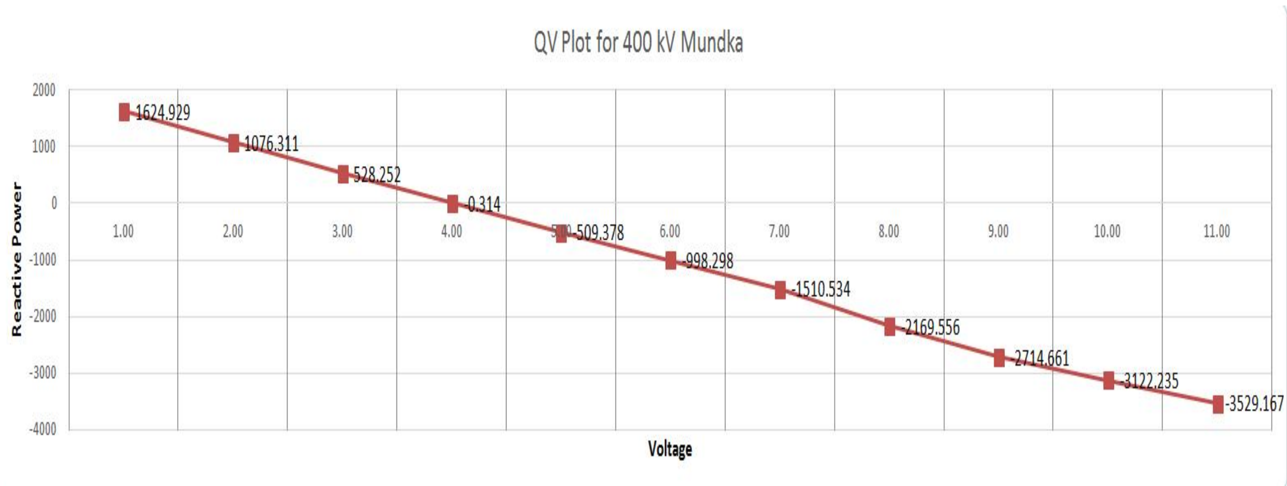


Figure 6-2: QV Plot for 400kV Mundka

7 Short Circuit Analysis

Short circuit analysis is performed by creating 3-phase faults at all locations in the network. The strength of system voltage is often expressed in terms of its short circuit capacity at the bus. A system with high short circuit capacity is strong and stiff, whereas the system with lower short circuit capacity is more vurnerable to voltage changes.

Table 7-1: Short Circuit Results

Substation Name	Short Circuit MVA
152289 JHATIKALAN 22	6029.71
152224 DIAL 22	12978.93
152242 WAZIRPUR 22	13055.97
152297 ZAKHIRA 22	13722.07
152243 PEERAGARHI 22	14697.64
152296 BUDELLA 22	14855.78
152221 NARAINA 22	17507.46
152298 BHARTAL 22	17915.07
152244 MUNDKA 22	18089.54
152210 NAZAFGARH_BW22	18613.48
152223 NAJAFGARH_BM22	18613.48
152240 PAPANKALA-II22	18698.88
152202 BAMNOLI2 22	18796.25
152214 PAPANKALAN-122	18796.64
152250 PPK-III 22	18952.6
152295 DWARKA 22	19034.81
184497 DWARKA 40	22035.43
184444 JHATIKRASP 40	24612.09
184463 JHATIKALA-PG40	26569.43
184455 MUNDKA 40	28421.12
187708 JHATI-PG 76	35810.39

8 Dynamic Simulation Analysis

Following the clearing of a fault, voltage will swing back up and then swing down. On the swing back down following the clearing of a fault, avoiding excessively large transient voltage dips is important both from a power quality perspective and from a bulk electric reliability perspective. The swing should not be so large as to cause additional facilities to trip (load or generation). Also, the dip should not be so large as to cause a voltage collapse. Many factors influence how large the transient dip is, including pre-contingency MW transfer levels, MW load levels, pre-contingency voltage levels and pre-contingency dynamic reactive reserve levels. A smaller MW transfer amount, a higher pre-contingency voltage, and larger amount of well-situated local dynamic reactive reserve will result in a smaller transient voltage dip following a disturbance. If a simulation shows that a transient voltage dip is unacceptably large, the dip can be reduced by either reducing MW transfer levels, increasing pre-contingency voltages by bringing on more static reactive devices or dynamic reactive devices, or increasing dynamic reactive reserve by bringing on more well-situated local static reactive devices (thereby reducing output of dynamic reactive devices in pre-contingency).

The voltage drop and recovery resulting from a system short circuit or fault depends on the location of the fault in relation to the measured voltage, and may vary from zero to a few percent of normal. Following the fault clearing, the voltage passes through a transient recovery period before settling to the post-fault value. During this oscillatory transient period, additional voltage dips typically occur immediately after the voltage attempts to return to the pre-fault level due to motor reacceleration. The starting voltage, dynamic voltage response, and duration of the response are a measure of the system strength. During the fault period, active power transferred from the generators to the system is reduced, causing the generators' internal angles to advance. When the fault is cleared, the generators have to supply the pre-fault active load again and their internal angle moves toward their pre-fault value. This slowing of the local generators draws inrush decelerating power from the remote generators and, coupled with motors' demand for accelerating power (the motors have slowed down during the lower fault voltage), causes a new voltage dip on the system. This second dip in voltage is then followed by an oscillatory transition to the post-fault steady-state voltage, as the machine prime mover power is again in balance with the electric load.

The system must be designed and operated to meet system performance criteria for conditions ranging from the peak period of a heavy load day through an extremely light load period such as the early morning hours during the winter season. Maximum voltage limits should not be exceeded in real-time on both a pre- and post-contingency basis. While high voltage conditions are not as likely to propagate across the interconnection as extremely low voltage conditions, they can result in significant equipment damage.

Dynamic performance is checked by performin the following activity:

1. The unconverted case is solved for steady state power flow condition.
2. Generators are converted from steady state to dynamic model by using ZSORCE for machine impedance, dynamic generator model, excitor and turbine governor model depending on the type of machine used in the plant.
3. Steady state constant MVA loads are converted to dynamic loads by allotting the appropriate % constant current in active power load and % constant admittance in reactive power load. The dynamic load modeling in PSS/E is done considering the following criteria from :
   Large Motor- 13.92%

Small Motor-25%
Discharge Lighting-20%
Constant Power-0.5%
Transformer exciting current-0.1%

4. ORDR is performed
5. FACT is performed
6. TYSL is done and convergence is achieved in 1 iteration.
7. Read DYRE file and initialize the network.
8. Simulation setup and dynamic simulation is run for 1 minute.
9. Disturbance is created at the shortlisted substations by creating 3-phase fault.
10. Fault is cleared and is checked for critical clearing time.
11. Voltage dip at 400kV Bamnoli and 400kV Mundka is checked by creating channels and plotting the system behavior.

A typical dynamic voltage dip is shown at 400kV Bamnoli substation.

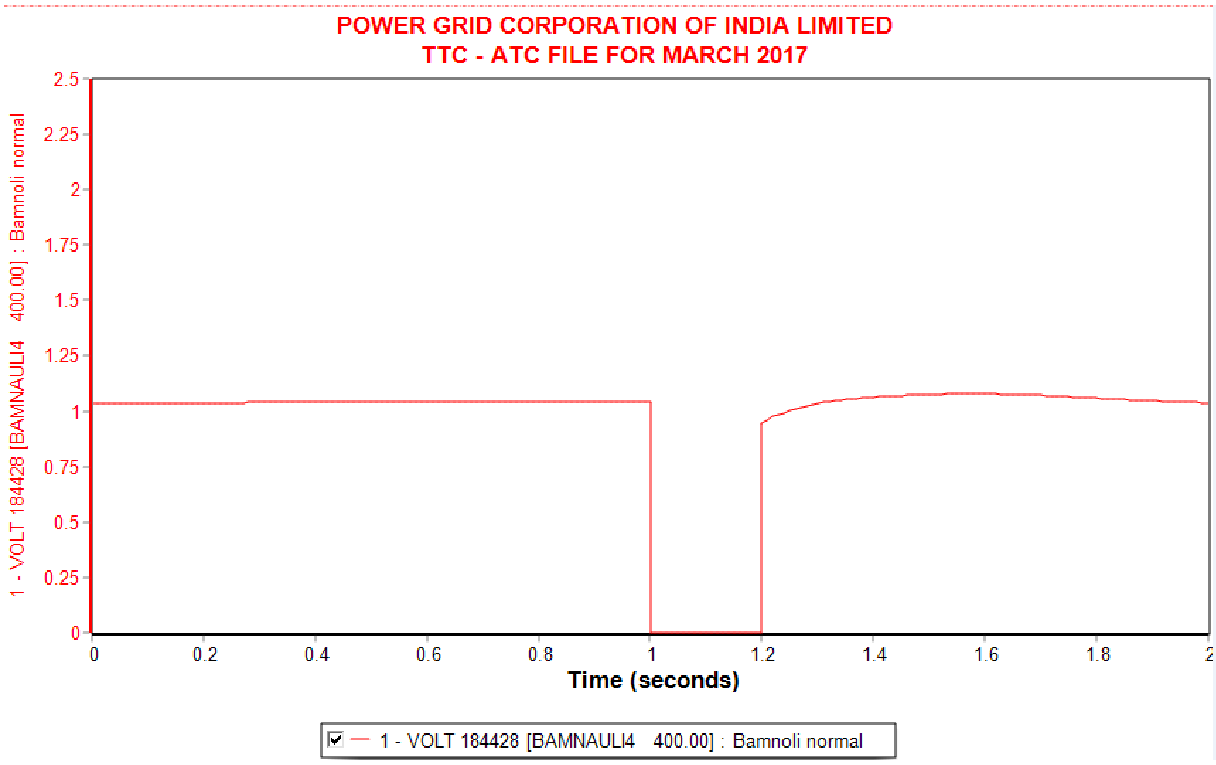


Figure 8-1: Dynamic voltage profile at 400kV Bamnoli

9 Determination of location and size of Shunt reactor and SVC

Objective of this task is to prioritize the substations for installation of Shunt Reactor and Static Var Compensator (SVC) based on the results of contingency analysis, QV analysis, short circuit analysis and dynamic analysis.

The selection is done considering the operating scenarios for normal operation and the 4 different cases. Final allocation would be done after verifying the geographical constraints and the amount of space available to install the equipment.

The final recommendations are given below:

1) 75MVar (inductive) to 200MVar (capactive) SVC* at 400kV Bamnoli substation, and 125MVar fixed reactor.

2) 125MVar fixed reactor at 400kV Mundka substation.

3) 50MVar fixed reactor at 220kV Maharnibagh, 220kV Harsh Vihar and 220kV Electric Lane

4) 25MVar fixed reactor at 220kV Mundka.

*SVC location has been enlisted to be decided based on the requirement of fixed or variable shunt reactor element at the respective substations.