ANNEXURE-1

Status of implementation of transmission projects under tariff based competitive bidding

S.N.	Name of the Project	Scope of works	BPC	Implementing Agency	Estm. cost (Rs crores)	Current Status
1	2	3	4	5	6	7
1.	Scheme for enabling import of NER/ER surplus by NR	(i) Bongaigaon-Siliguri 400 kV Quad D/C	PFC	Sterlite Technologies Ltd	1700	**LOI place on 7.1.2010,** **SPV acquired on 31.3.2010** **Trans. license received on 4.11.2010** **Approval u/s 164 received on 21.6.2011,** **Tariff adoption on 2.11.2010** **Original COD: March 2013** Issues related to ROW and forest clearance hampered the progress drastically. A) Byrnihat-Azara section -- All work completed except stringing of 0.407 Km of stringing over the campus of Regional Institute of Science and Technology, Meghalaya (RIST) which is under litigation in Apellant Tribunal for Electricity (APTEL) (refer Sl. No. 1 of Annexure A enclosed). **Byrnihat-Azara section shall be commissioned within 1 month of lifting of stay on stringing by APTEL.** (B) Azara-Bongaigaon section --- All work completed except 4 foundations, 4 tower erection and 6.7 Km stringing due to non- availability of forest clearance (refer Sl. No. 2 & 3 of Annexure-A enclosed). **Azara-Bongaigaon section shall be commissioned within 4 months of receipt of forest clearance.**
		(ii) Purnea-Biharsharif 400 kV D/C Quad D/C				(i) Total Line length : 464 ckm Line Completed.
2.	System Strengthening in NR for import of power from North Karanpura and other projects outside NR and System Strengthening in WR for import of power from North Karanpura and other projects outside Western Region and also for projects within Western Region.	1. Sipat/Korba (Pooling) –Seoni, S/C 2. Lucknow-Bareilly, S/C 3. Bareilly-Meerut 4. Agra-Gurgaon 5. Gurgaon-Gurgaon (PG) 6. Gurgaon S/S	REC	Reliance Power Transmission Company Ltd	2700	SPV acquired by Reliance on 20-05-2010 (Effective date) **Approval u/s 164 received on 12.08.2013** Matter was in CERC for revision of tariff and extension of date of commissioning. NKTCL filed an appeal in appellate tribunal challenging CERC order of 9.5.2013. Appellate Tribunal has given final judgment on 2.12.13 setting aside CERC order and allowing the appeal. NKTCL is initiating steps for implementing of order. The judgment of Appellate Tribunal accepts delay in clearance under section-164 as force

						majeure. According NKTCL have requested MoP to extend the validity of section 68 clearance vide their letter dtd 14.1.2014 **Work Yet to start.**
3.	Talcher-II Augmentation System	(i)Talcher II- Rourkela 400 kV D/C Quad line (ii)Talcher II – Behrampur 400 kV D/C line (iii)Behrampur-Gazuwaka 400 kV D/C line (iv)400/220 kV, 2x315 MVA Behrampur substation	REC	Reliance Power Transmission Company Ltd.	1400	LOI issued on 18-12-2009 SPV acquired by Reliance on 27-04-2010 (Effective date) Matter was in CERC for revision of tariff and extension of date of commissioning. TTCL filed an appeal in appellate tribunal challenging CERC order of 9.5.2013. Appellate Tribunal has given final judgment on 2.12.13 setting aside CERC order and allowing the appeal. TTCL is initiating steps for implementing of order. The judgment of Appellate Tribunal accepts delay in clearance under section-164 as force majeure. According TTCL have requested MoP to extend the validity of section 68 clearance vide their letter dtd 14.1.2014 **Work yet to start.**
4.	Transmission System Associated with Krishnapattnam UMPP-Synchronous interconnection between SR and WR (Part-B)	(i) Raichur-Sholapur 765 kV S/C line-1	REC	Consortium of Patel-Simplex- BSTranscomm	440	**LOI placed on 16.12.2010** **SPV acquired on 7.1.2011** **Trans. license received on 24.8.2011** **Approval u/s 164 received on 29.8.2011** **Tariff adoption on 12.8.2011** **Original COD : Jan 2014** 543/544 Foundations constructed Pile cap work under progress 543/544 towers erected 191.07/208.08 ckm strung **Scheduled date of completion: 6/2014**
5.	System strengthening common for WR and NR	(i) Dhramjaygarh-Jabalpur 765 kV 1xD/C 765 kV lines (one D/C line under PGCIL scope)	PFC	Sterlite Transmission Projects Private Ltd.	1720	(i) LOI placed on 31.01.2011 (ii) Special Purpose Vehicle acquired on 31.03.2011 iii) Scheduled Completion Date is 31.03.2014. (iv) Transmission License granted on 12.10.2011. (v) Tariff adoption approval on 28.10.2011 (vi) **Clearance under Section 164 : received on**

		(ii) Jabalpur-Bina 765 kV lines – 1X S/C line (1XD/C line under PGCIL scope)				**12.07.2013** (1) Severe row problem being faced (2) Forest Clearance awaited (3) Land for compensatory afforestation not available
6.	System strengthening for WR		PFC	Sterlite Transmission Projects Private Ltd	2900	**LOI placed on 19.1.2011** **SPV acquired on 31.3.2011** **Trans. license received on 12.10.2011** **Approval u/s 164 received on29.01.2013** **Tariff adoption on28.10.2011** **Original COD : Mar2014** **Main issue land for compensatory afforestation** **Scheduled date of completion: 6/2014**
		(i) Jabalpur-Bhopal 765 kV S/C line				(i) Severe row problem & delay in forest clearance has affected progress. PGCIL started bay execution at Jabalpur.
		(ii) Bhopal-Indore 765 kV S/C line				Severe row problem & delay in forest clearance has affected progress. PGCIL started bay execution at Jabalpur
		(iii) 765/400 kV substation at Bhopal, with 2x1500 MVA 765/400 kV				
		(iv)Bhopal-Bhopal (MPPTCL) 400 kV D/c quad line.				MPPTCL started Bay erection at Bhopal
		(v) Aurangabad-Dhule 765 kV S/C line				Severe row problem & delay in forest clearance has affected progress.

		(vi) Dhule-Vadodara 765 kV S/C line				(ii) Severe row problem & delay in forest clearance has affected progress. PGCIL yet to start bay execution at Vadodara s/s
		(vii) 765/400 kV substation at Dhule with 2x1500 MVA 765/400 kV				CEA Inspection is over ready for energisation by 31.1.14. Bay yet to be completed by MSETCL s/s at Dhule s/s
		(viii) Dhule - Dhule(Mh) D/C Line				Severe row problem & delay in forest clearance has affected progress.
7.	Transmission system associated with IPPs of Nagapattinam/ Cuddalore Area- Package A	(i) Nagapattinam Pooling Station-Salem 765 kV D/C line. (ii) Salem-Madhugiri 765 kV S/C line	PFC	PGCIL	1025	Special Purpose Vehicle acquired on 29/03/2012 Tr. License issued on 15.7.2013 and tariff adoption by CERC on 9.5.2013. **Clearance U/s 164 received on 9.12.2013.** **Work has been awarded on 16.5.2014**
8.	Transmission System associated with IPPs of Vemagiri Area-Package A	(i) Vemagiri Pooling Station–Khammam 765 kV 1xD/C (1st ckt.) line. (ii) Khamam-Hyderabad 765 kV 1xD/C (1st ckt.) line.	REC	PGCIL	1300	Special Purpose Vehicle acquired on 18/04/2012 Put on hold as commissioning of the associated generating station is delayed due to non-availability of gas. **As per the order of CERC dtd. 27.9.2013 the execution of project has been terminated.**
9.	Transmission System required for evacuation of power from Kudgi TPS (3x800 MW in Phase-I) of NTPC Limited.	(i)Kudgi TPS – Narendra (New) (ii)Narendra (New) – Madhugiri (iii)Madhugiri - Bidadi	REC	M/s L&T Infrastructure Development Projects Limited	1240	(i) LOI placed on31/07/13 (ii) Special Purpose Vehicle acquired on 30.8.2013 (iii) Performance guarantee submitted on 22.8.2013 (iv) Tr. License application filed in CERC on2.9.2013 and application for tariff adoption filed on 2.9.2013. Tr. License issued on 7.1.2014 and tariff adoption by CERC on 8.1.2014. (v) Clearance U/s 164 – issued 24.4.2014 Status of the project execution activities : **Commencement of various activity** **Awarded EPC contract 7.1.2014** **Financial closure on 24.2.2014**
10.	Transmission system for system strengthening in SR for import of power from ER	Srikakulam PP – Vemagiri-II Pooling Station D/c line Khammam(existing) – Nagarjuna Sagar D/c line	REC	PGCIL	1180	1. LOI placed on 31.07.13 2. Special Purpose Vehicle acquired on 30.8.2013 3. Tr. License issued on 8/1/2014 and tariff adoption by CERC on 23/1/2014 4. Clearance U/s 164 – received on 22.05.2014

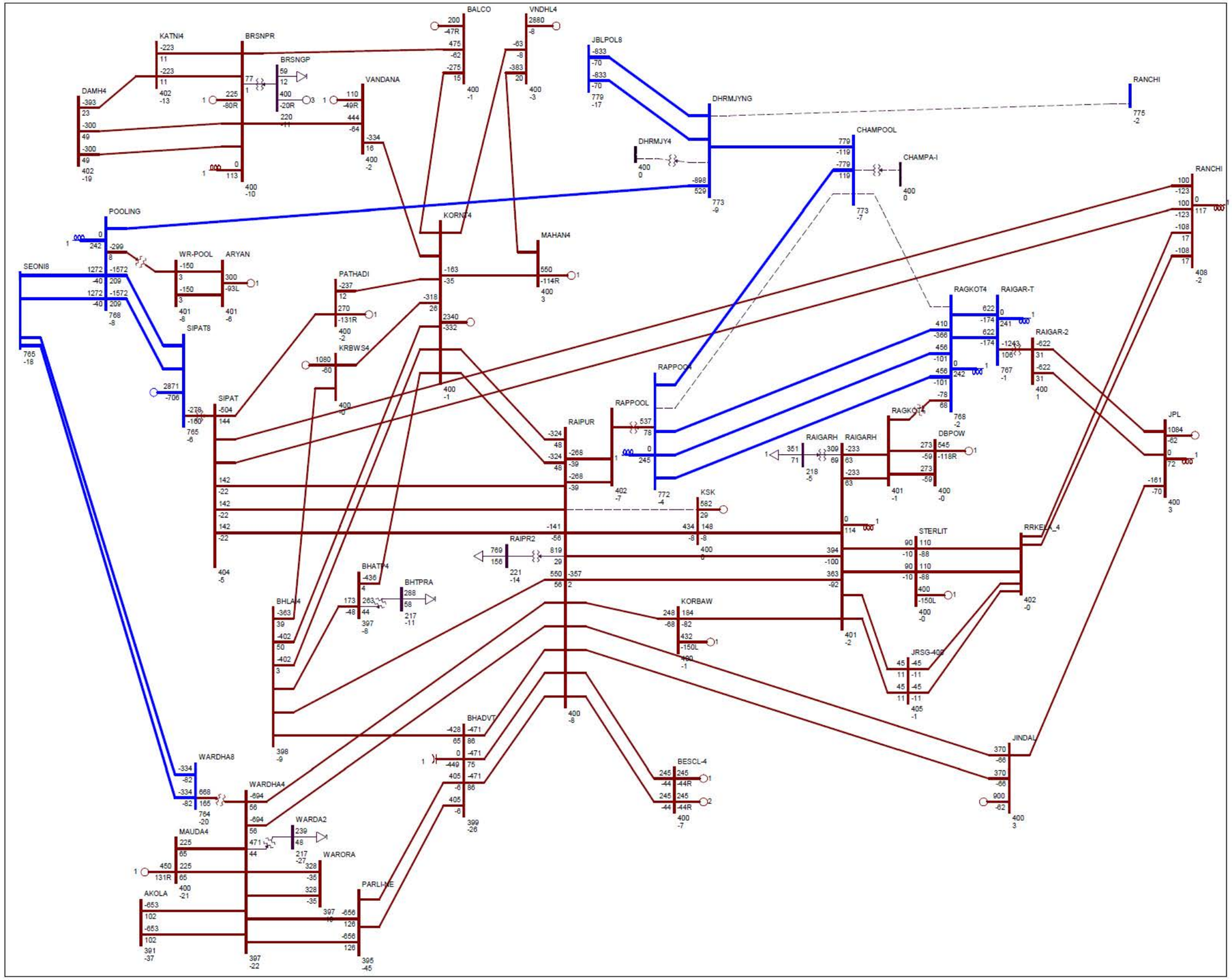
						Status of the project execution activities : **Work has been awarded on 28.2.2014 to Tata Proj. Icomm, L&T**
11	Transmission System for Patran 400kV S/S	LILO of both circuits of Patiala-Kaithal 400kV D/c at Patran (Triple snow Bird Conductor) Creation of 2x500 MVA, 400/220 kV Substation at Patran	PFC	Techno Electric and Engineering Company Ltd.	200	(i) LOI placed on 17.09.2013 (ii) Special Purpose Vehicle acquired on 13.11.2013 (iii) Scheduled Completion Date is 13.05.2016. (iv) Application for adoption of tariff filed in CERC. Hearing on 18.03.2014. (v) Application for grant of License filed in CERC. Hearing on 18.03.2014 **Clearance under Section 164 : Request not received in MoP**
12	Eastern Region System Strengthening Scheme-VI	Creation of 2x500 MVA, 400/220 kV GIS Substation at Darbhanga with space for future extension (1x500 MVA) Creation of 2x200 MVA, 400/132 kV GIS Substation at Mothihari with space for future extension (1x200 MVA) Muzaffarpur(PG)- Darbhanga 400 kV D/c line with triple snowbird conductor LILO of Barh –Gorakhpur 400 kV D/c line at Mothihari, 400kV 2xD/C quad	PFC	Essel Infraprojects Ltd.	540	(i) LOI placed on 17.10.2013 (ii) Special Purpose Vehicle acquired on 10.12.2013 (iii) Scheduled Completion Date is 01.07.2016. (iv) Application for adoption of tariff filed in CERC on Hearing on 27.02.2014. (v) Application for grant of License filed in CERC. Hearing on 27.02.2014. **Clearance under Section 164 : Request not received in MoP**
13	Part ATS for RAPP U-7&8 in Rajasthan	RAPP - Shujalpur 400kV D/C line	PFC	Sterlite Grid Ltd	310	(i) LOI placed on 17/09/13 (ii) Special Purpose Vehicle acquired on 12/03/2014 (iii) Scheduled Completion Date is 28.02.2016. (iv) **Clearance under Section 164 : Request not received in MoP**
14	ATS of Unchahar TPS	Unchahar - Fatehpur	REC	PGCIL	70	(i) LOI placed on 14/02/14. (ii) Special Purpose Vehicle acquired on 24/03/2014. (iii) Transmission license application filed in CERC on 25/03/14. (iv) Tariff adoption by CERC: under process in CERC for adoption. (v) Clearance under Section 164 : Request not received in MOP Scheduled completion : 23/09/2016
15	Eastern Region System Strengthening Scheme-VII	Purulia PSP(WB) – Ranchi (PG)	PFC	Sterlite Grid Ltd.	370	(i) LOI placed on 17.09.2013 (ii) Special Purpose Vehicle acquired on 09.12.2013

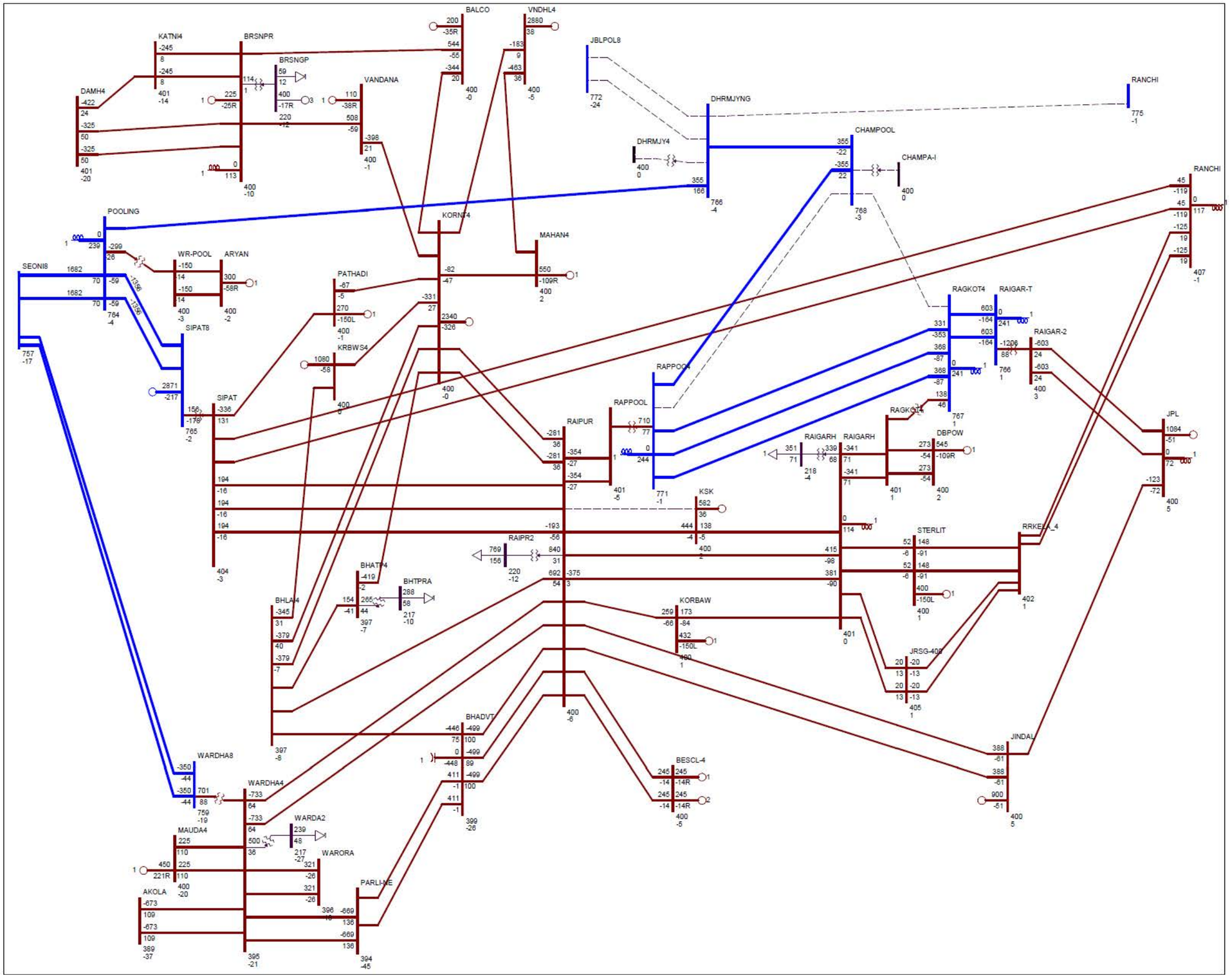
						(iii) Scheduled Completion Date is 09.03.2016. (iv) Application for adoption of tariff filed in CERC. Hearing on 27.02.2014. (vi) Application for grant of License filed in CERC. Hearing on 27.02.2014. **Clearance under Section 164 : Request not received in MoP**
16.	NR System strengthening Scheme-NRSS-XXXI(Part-A)	Establishment of 7x105 MVA (1 phase), 400/220 kV GIS at Kala amb LILO of both ckt of Karcham Wangtoo-Abdullapur 400 kV D/c line at Kala Amb(on M/C tower) 40% series compensation on 400 kV Karcham Wangtoo – Kala Amb D/C line at Kala Amb end	REC	PGCIL	225	(i) LOI placed on 26/02/14. (ii) Special Purpose Vehicle acquired on 12/05/2014. (iii) Transmission license application filed in CERC on 13/05/14. (iv) Tariff adoption by CERC: under process in CERC for adoption. (v) Clearance under Section 164 : Request not received in MoP Scheduled completion : 12/07/2017
17.	Northern Region System Strengthening Scheme, NRSS-XXXI (Part-B)	Kurukshetra-Malerkotla Malerkotla-Amritsar	RECTPCL	M/s Essel Infraprojects Ltd	265	(i) LOI placed on 26/02/14. (ii) Special Purpose Vehicle acquired on 12/05/2014. (iii) Transmission license application filed in CERC on 13/05/14. (iv) Tariff adoption by CERC: under process in CERC for adoption. Scheduled completion : 12/09/2016
	Total				**17585**	

ANNEXURE-2

CHAMPA POOLING STATION CONTINGENCY ARRANGEMENT – LOAD FLOW

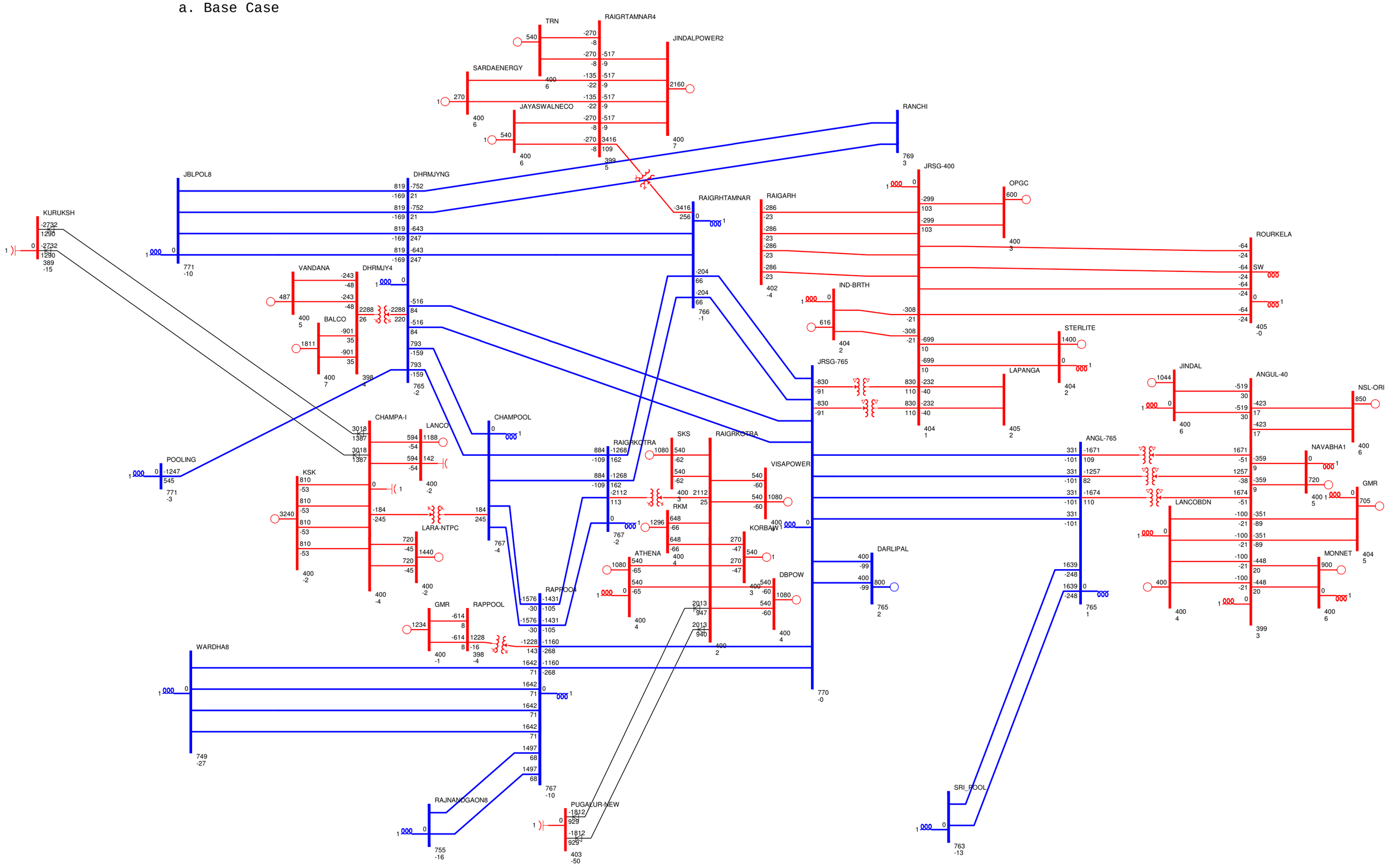
Annexure-2



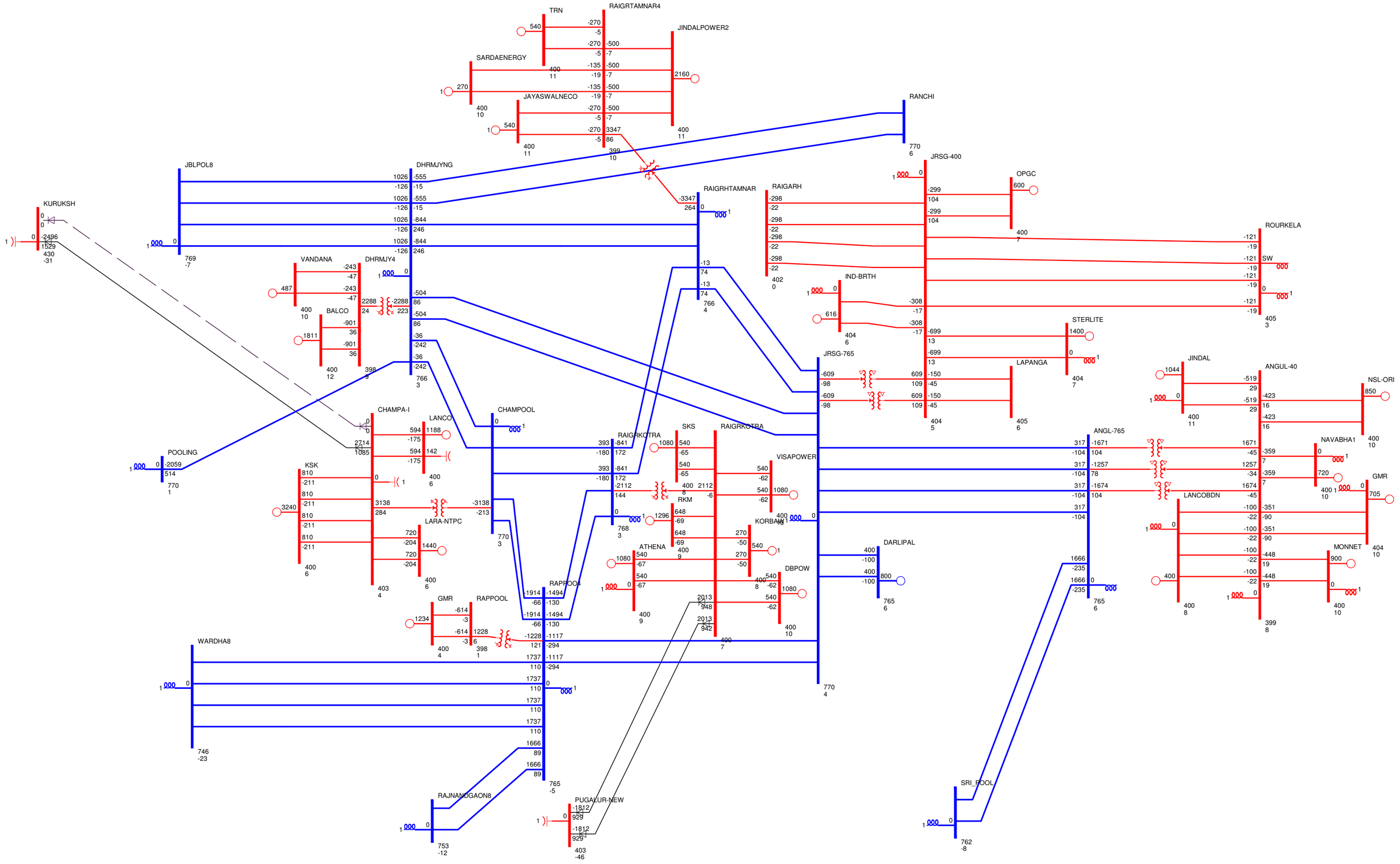

BALCO
VNDHL4
KATNI4
BRSNPR
BRSNGP
JBLPOL8
DAMH4
VANDANA
RANCHI
DHRMJYNG
DHRMJY4
CHAMPOOL
CHAMPA-I
POOLING
KORNT4
MAHAN4
WR-POOL
ARYAN
SEONI8
PATHADI
RAGKOT4
RAIGAR-T
RAIGAR-2
SIPAT8
KRBWS4
RAPPOOL
SIPAT
RAIPUR
RAGKOT4
RAIGARH
DBPOW
JPL
KSK
STERLIT
RRKELA_4
RAIPR2
BHATP4
BHTPRA
BHLA4
KORBAW
JRSG-400
BHADVT
BESCL-4
JINDAL
WARDHA8
WARDHA4
WARDA2
MAUDA4
WARORA
PARLI-NE
AKOLA

ANNEXURE-3

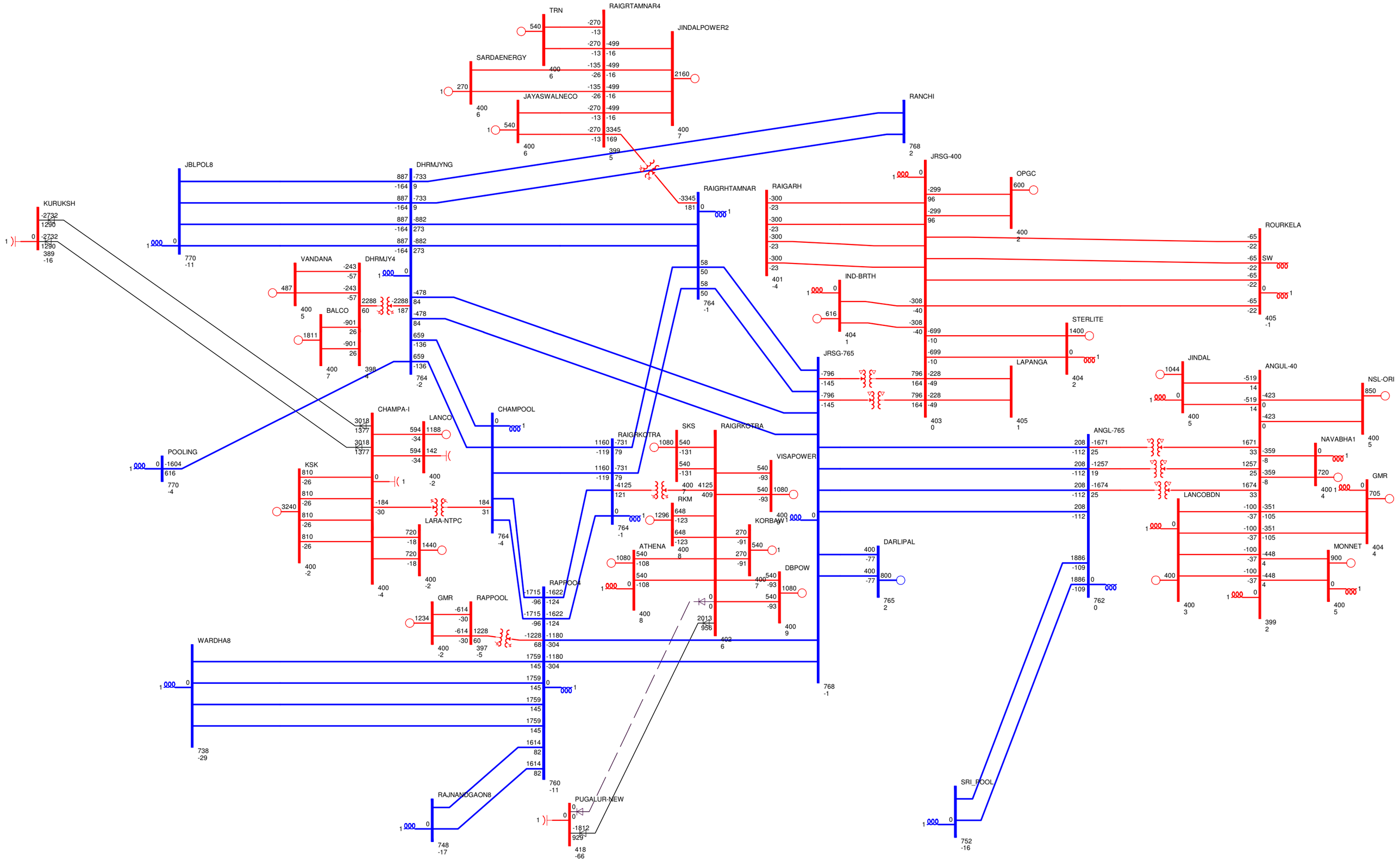
JHARSUGUDA - RAIPUR 765 kV D/C LINE, LILO of Jharsuguda-Dharamjaygarh 765kV D/c at Raigarh (Tamnar)
Champa-Kurukshetra HVDC Bipole- 6000MW, Raigarh (Tamnar)-Pugulur HVDC Bipole- 4000MW
a. Base Case



JHARSUGUDA - RAIPUR 765 kV D/C LINE, LILO of Jharsuguda-Dharamjaygarh 765kV D/c at Raigarh (Tamnar)
Champa-Kurukshetra HVDC Bipole- 6000MW, Raigarh (Tamnar)-Pugulur HVDC Bipole- 4000MW
b. Champa-Kurukshetra HVDC one pole (3000MW) outage

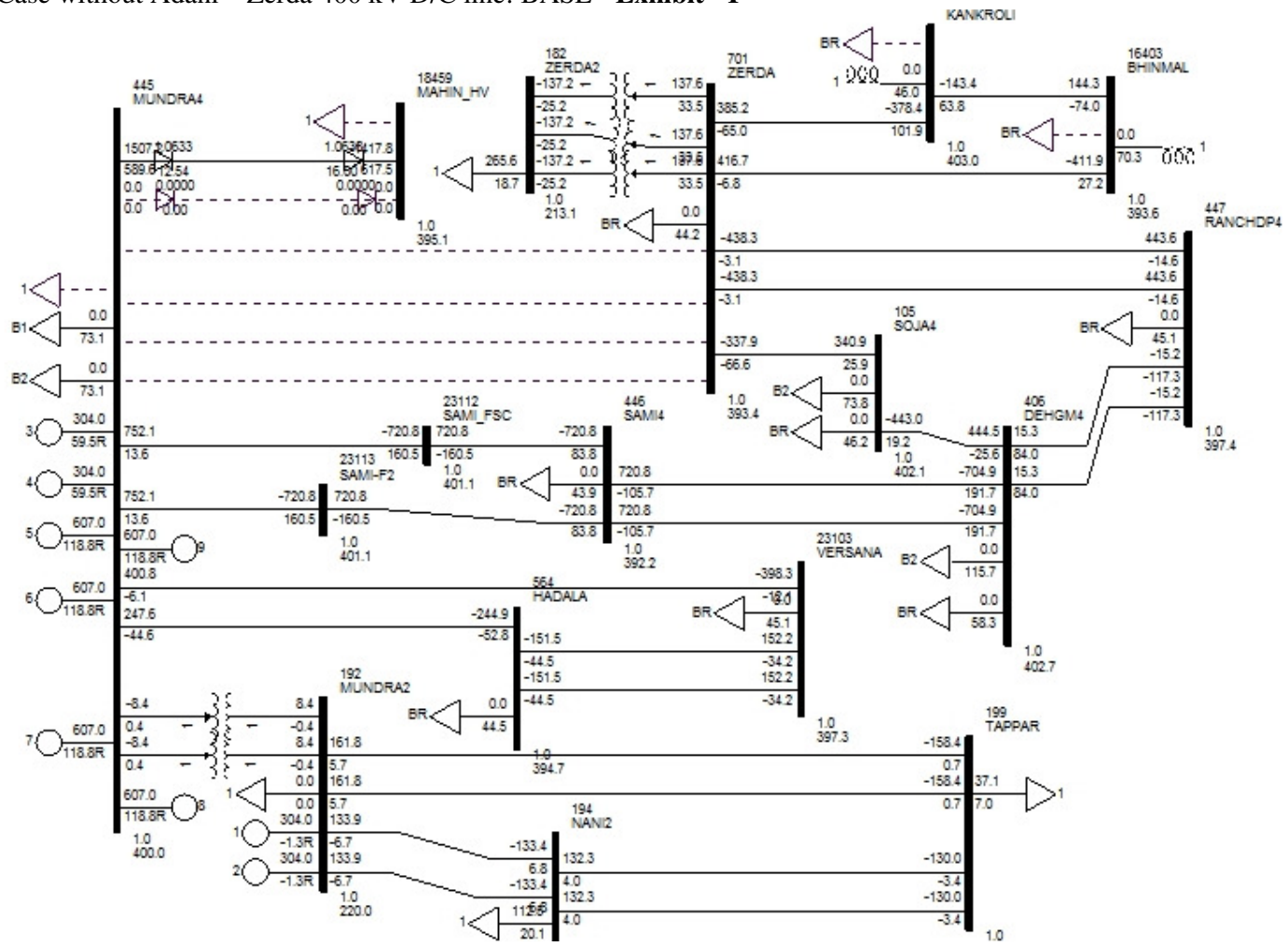


JHARSUGUDA - RAIPUR 765 kV D/C LINE, LILO of Jharsuguda-Dharamjaygarh 765kV D/c at Raigarh (Tamnar)
Champa-Kurukshetra HVDC Bipole- 6000MW, Raigarh (Tamnar)-Pugulur HVDC Bipole- 4000MW
c. Raigarh (Tamnar) - Pugulur HVDC one pole (2000MW) outage

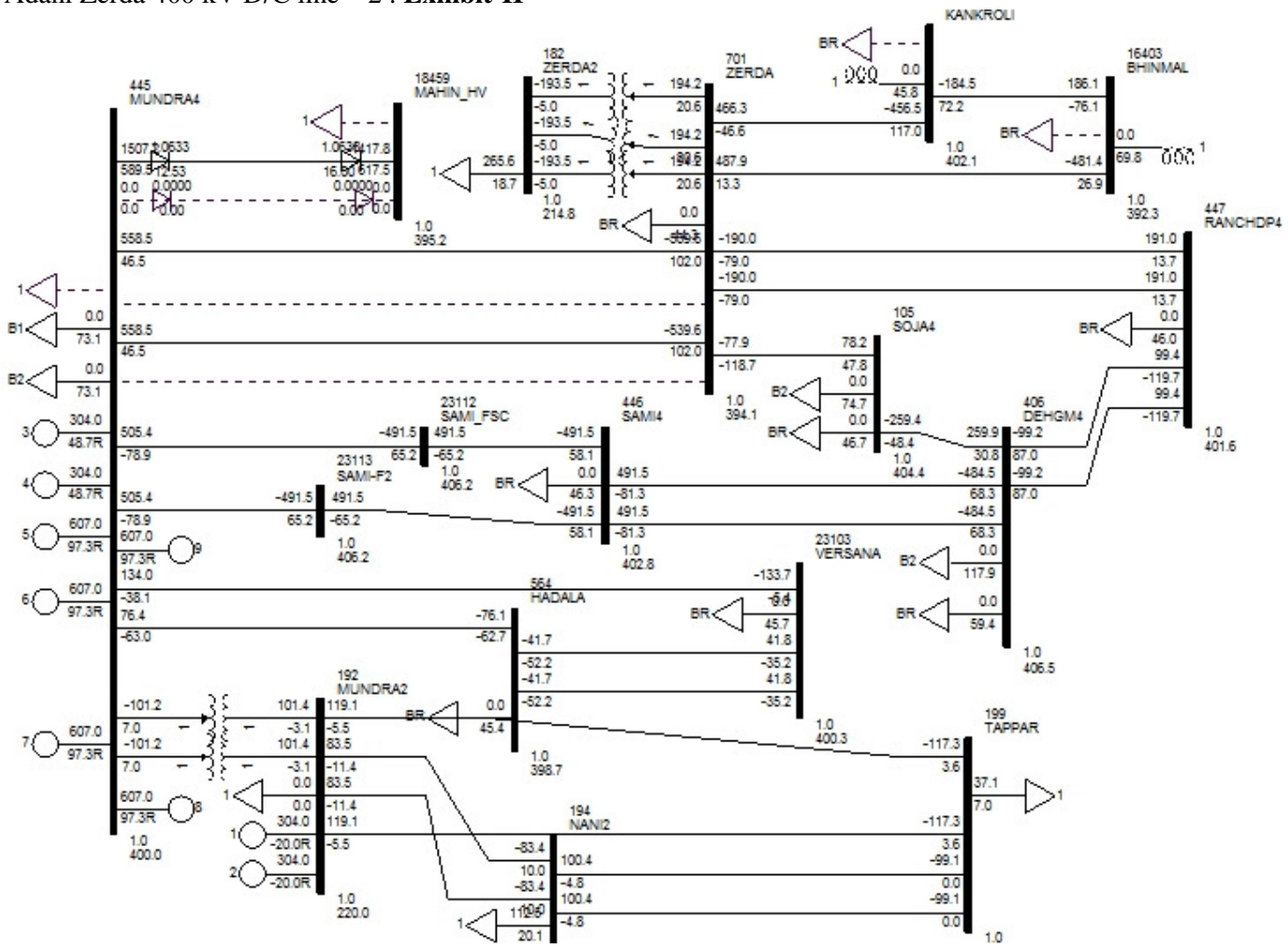


ANNEXURE-4

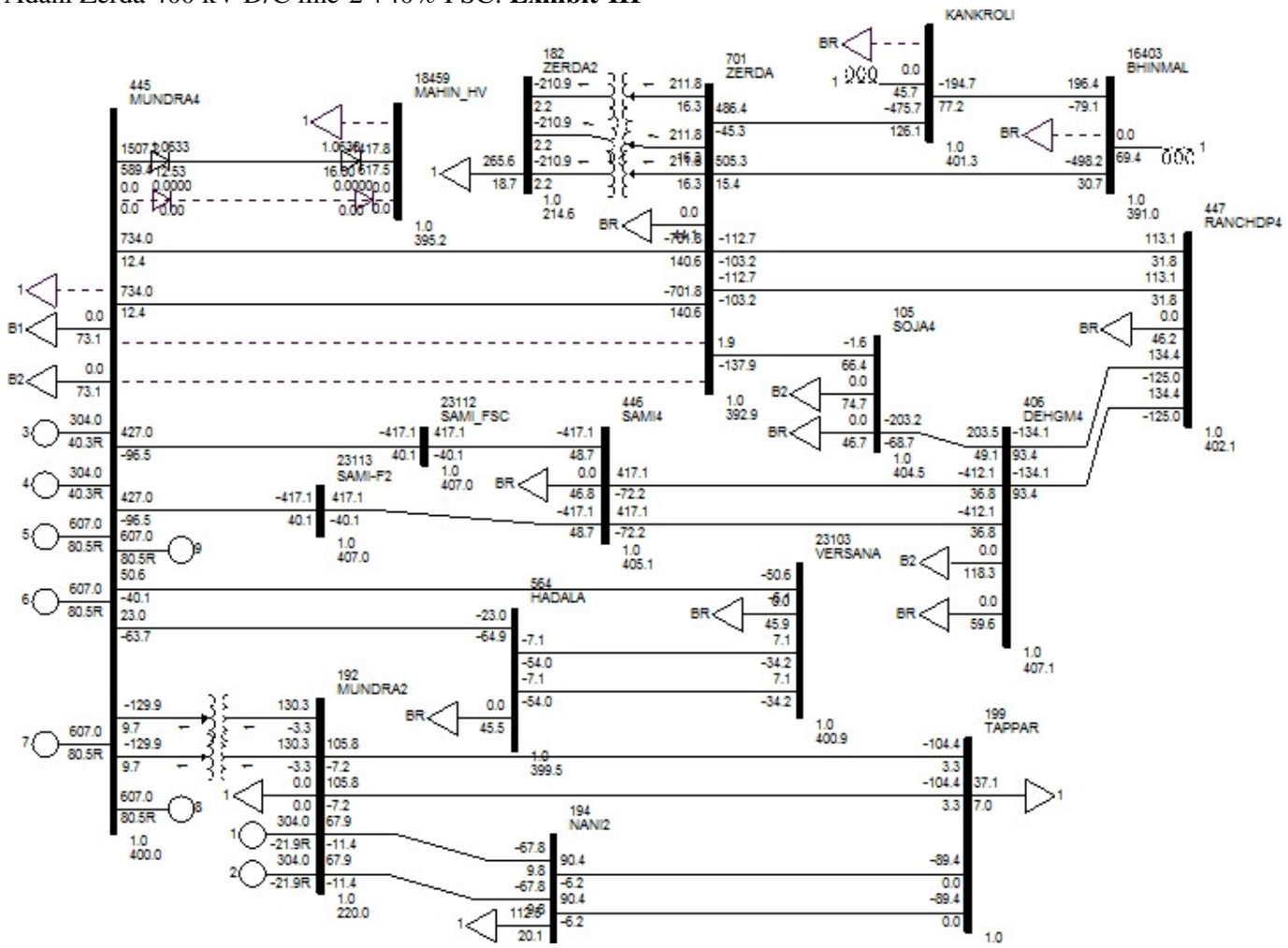
Present Case without Adani – Zerda 400 kV D/C line: BASE - **Exhibit - I**



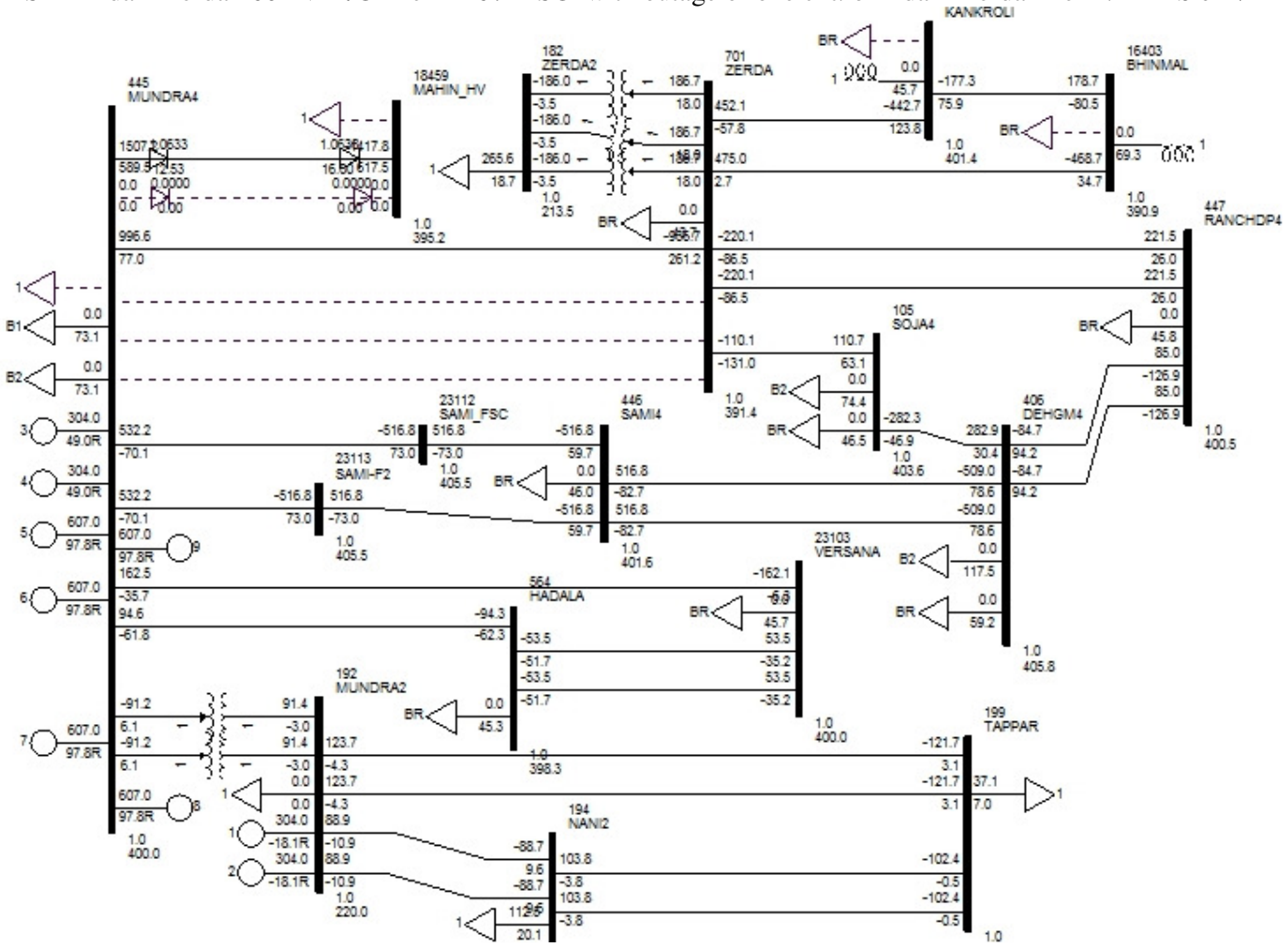
BASE + Adani Zerda 400 kV D/C line – 2 : **Exhibit-II**



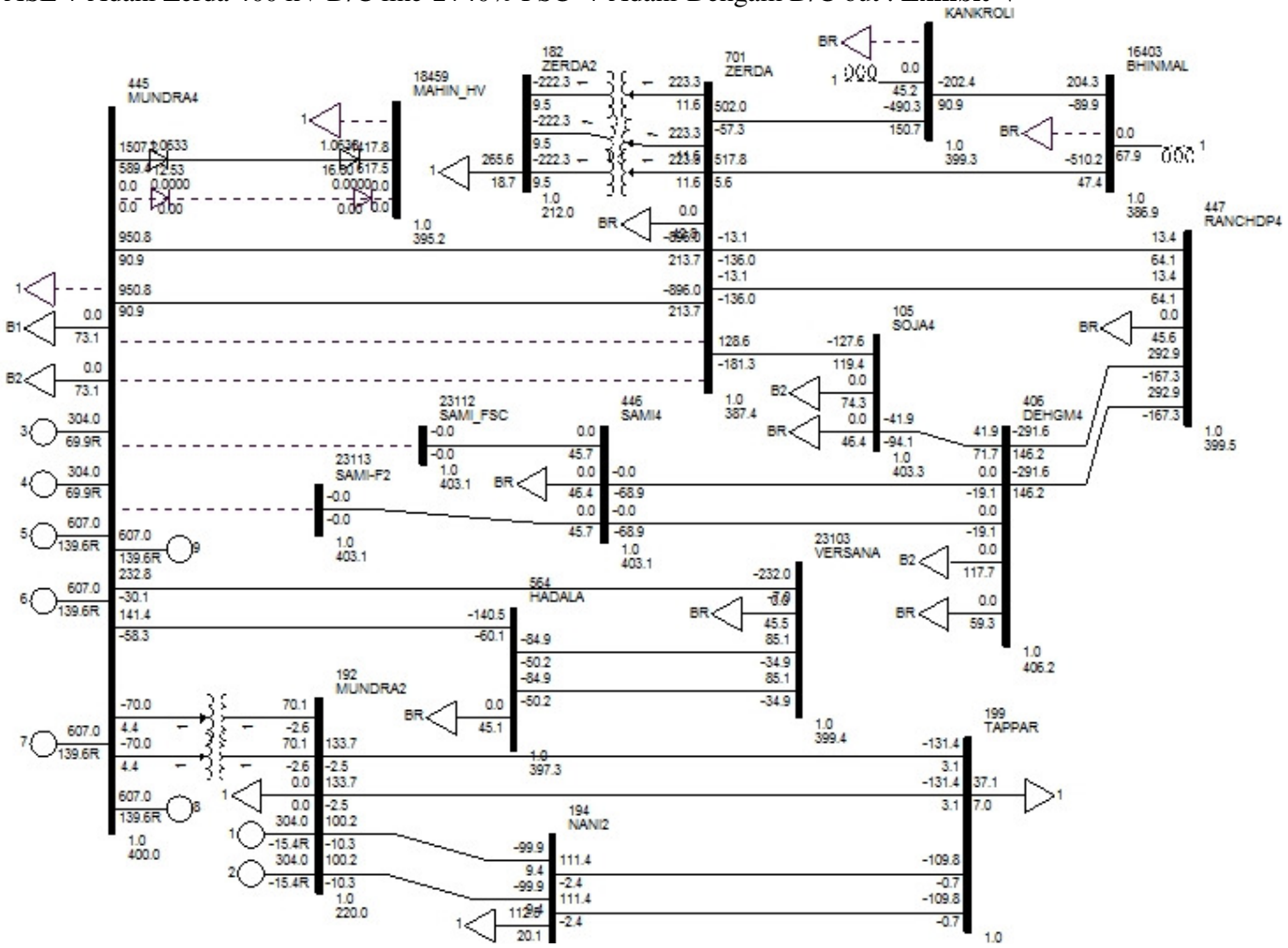
BASE + Adani Zerda 400 kV D/C line-2 +40% FSC: **Exhibit-III**



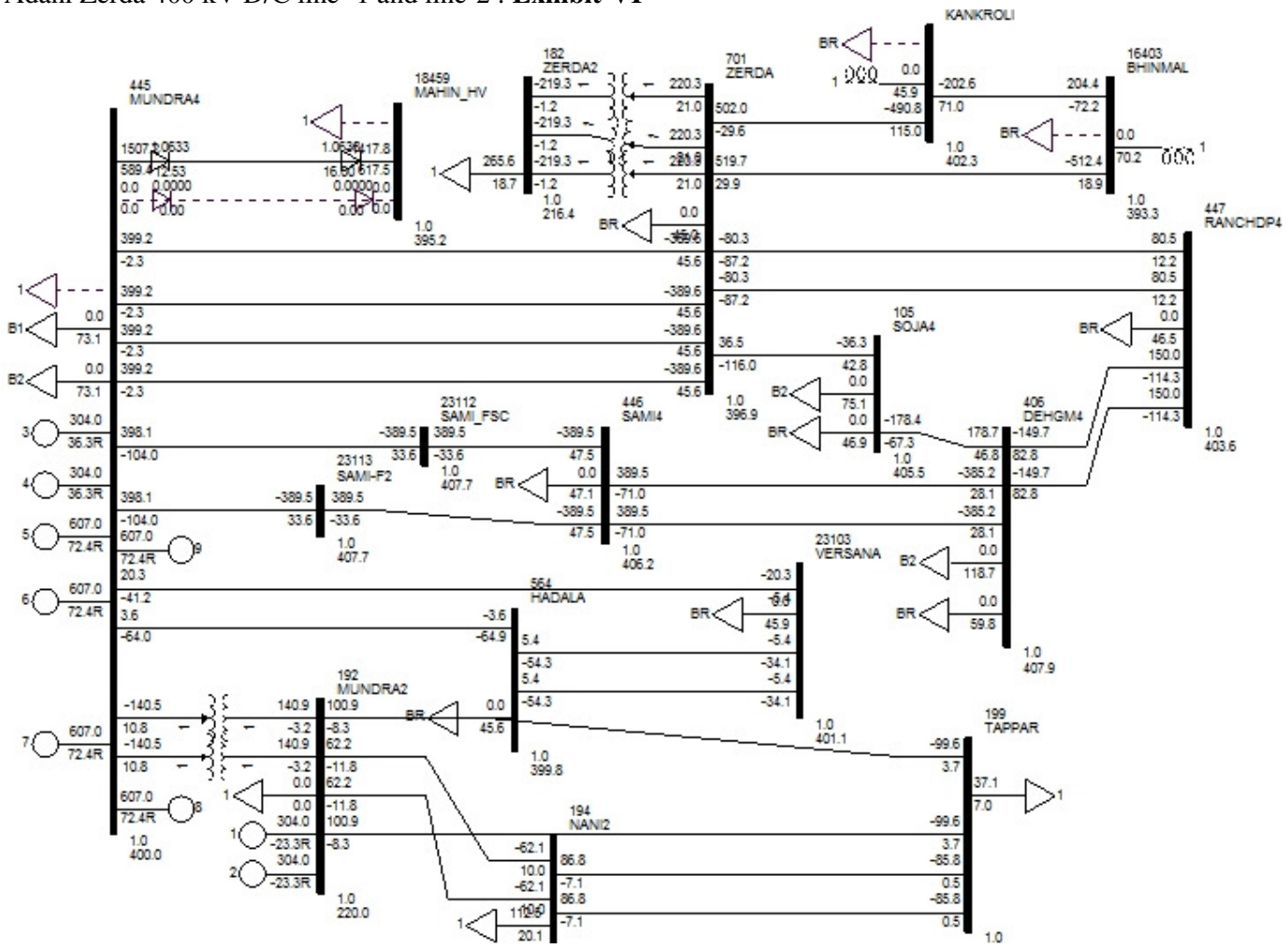
BASE + Adani Zerda 400 kV D/C line-2+40% FSC with outage of one ckt. of Adani-Zerda line-2 : **Exhibit-IV**



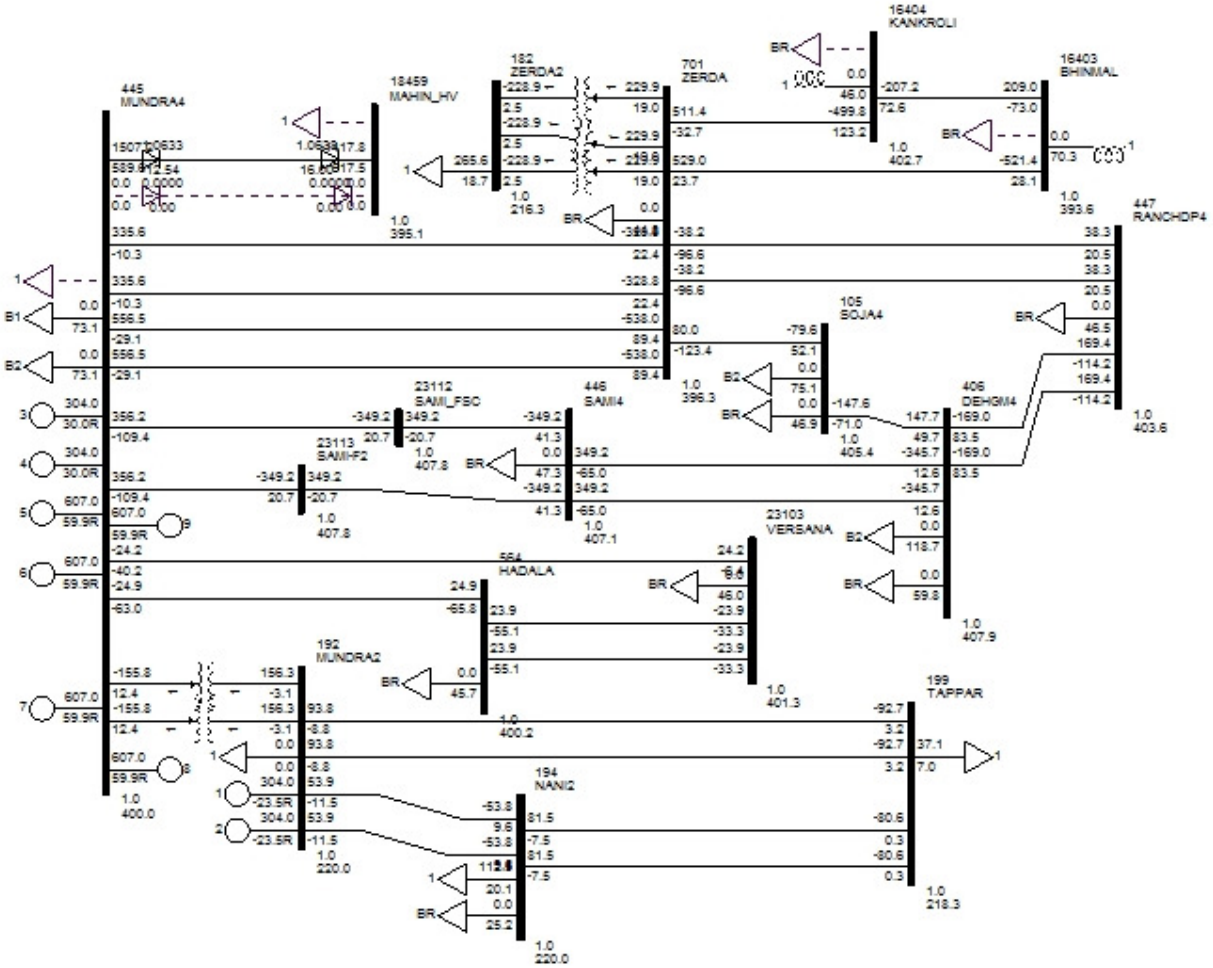
BASE + Adani Zerda 400 kV D/C line-2+40% FSC + Adani-Dehgam D/C out : **Exhibit-V**



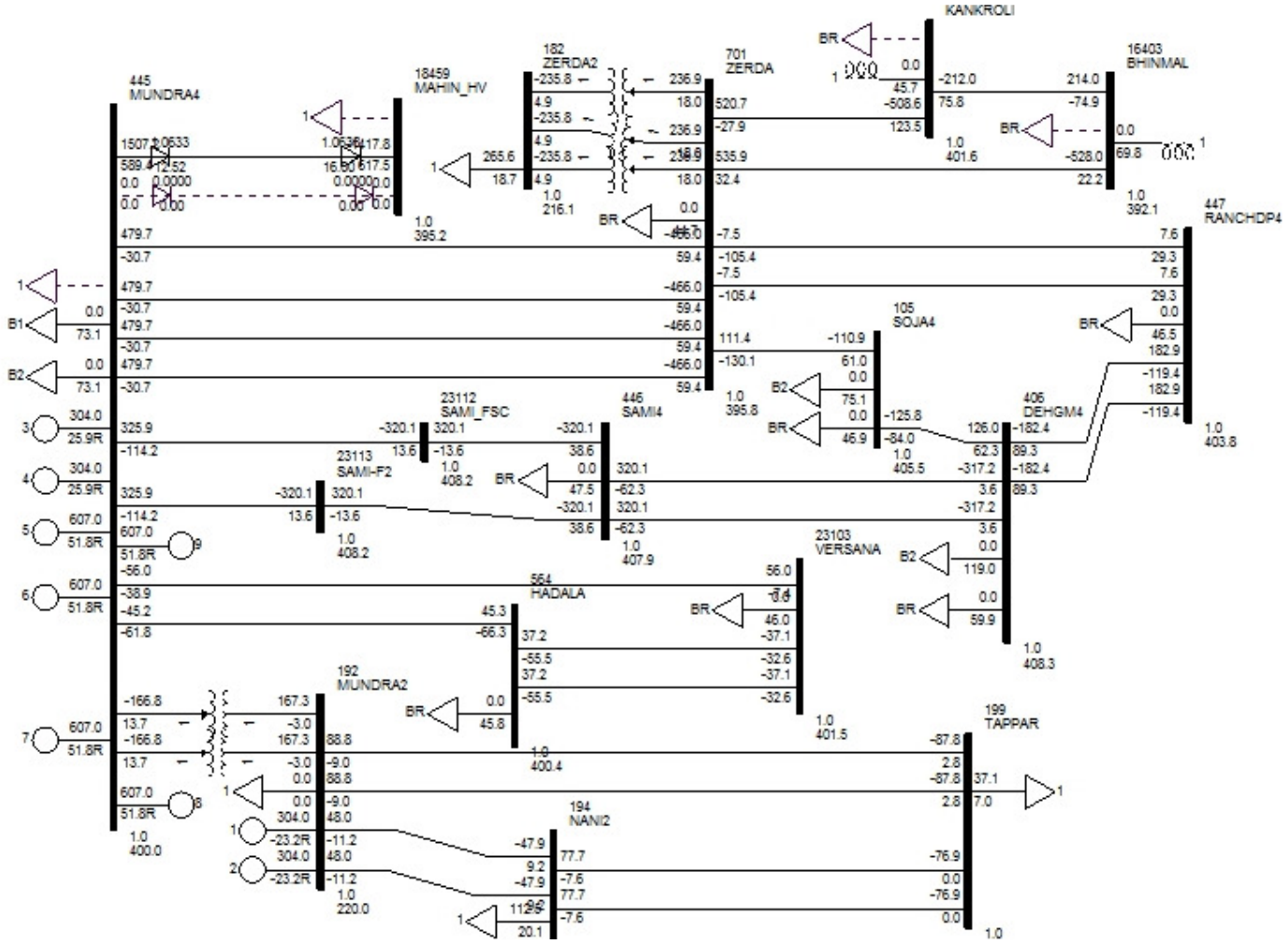
BASE + Adani Zerda 400 kV D/C line -1 and line-2 : **Exhibit-VI**



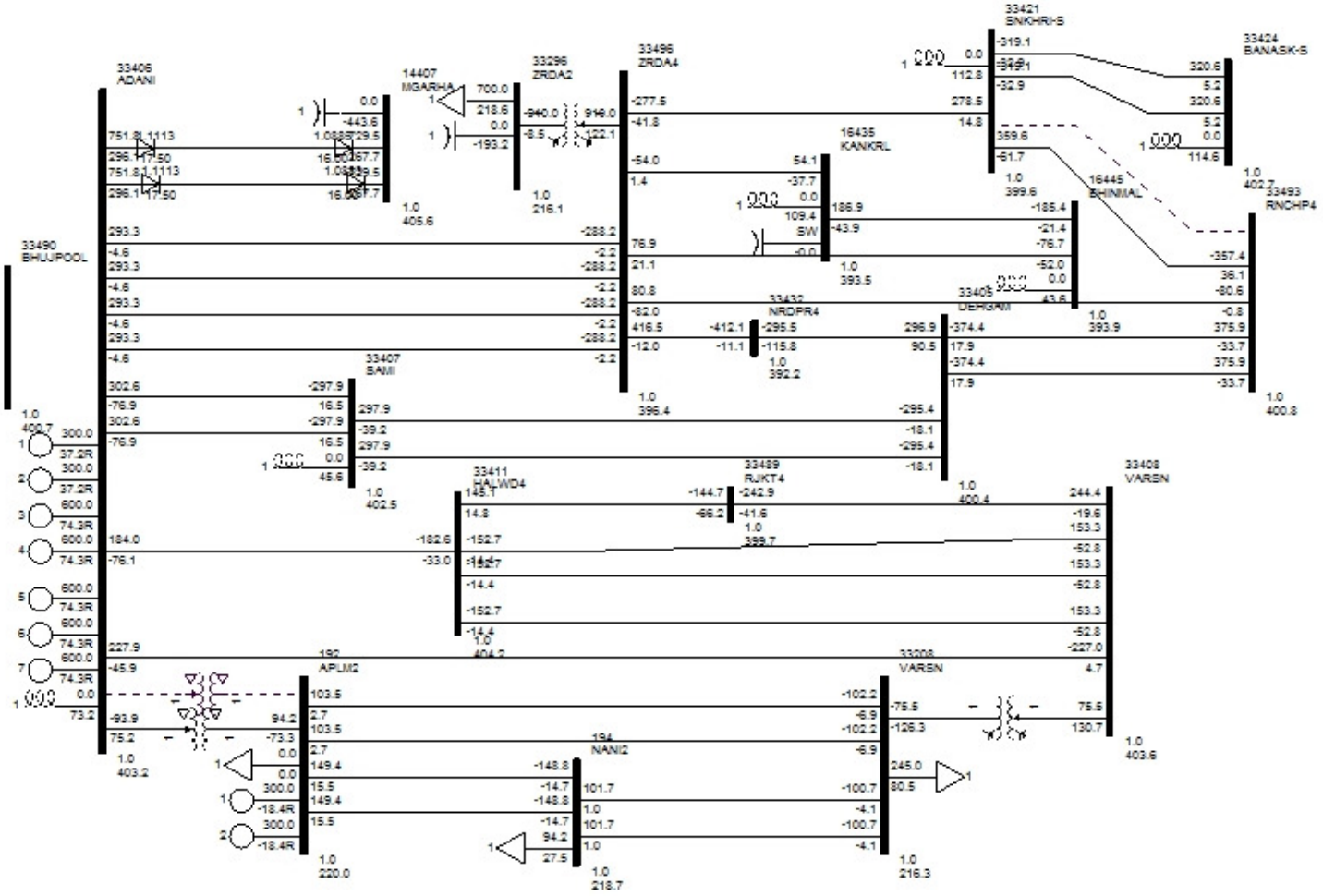
BASE + Adani Zerda 400 kV D/C line-1 and line-2 + 40% FSC on line-2: **Exhibit-VII**



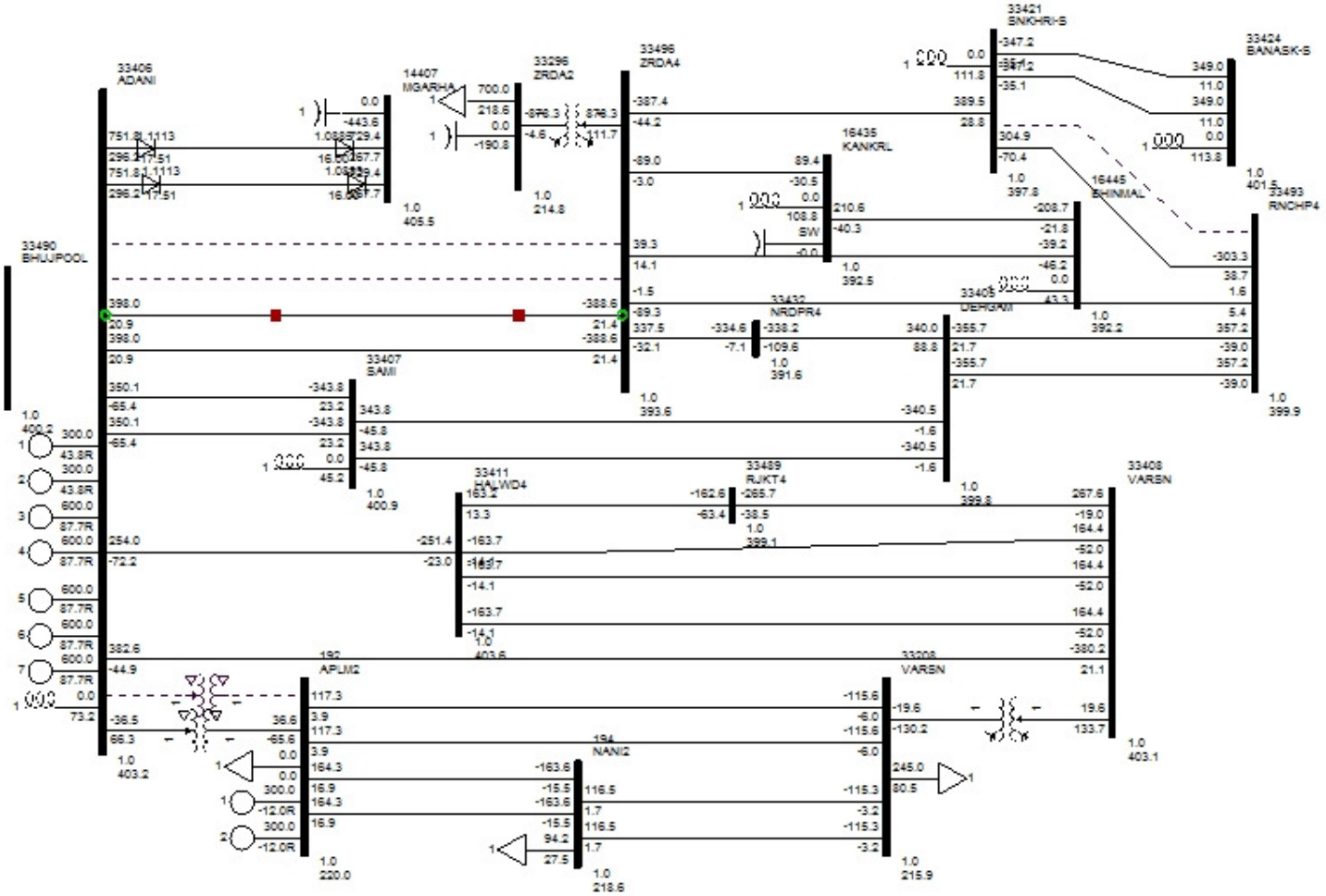
BASE + Adani Zerda 400 kV D/C line-1 and line-2 + 40% FSC on both D/C lines: **Exhibit-VIII**



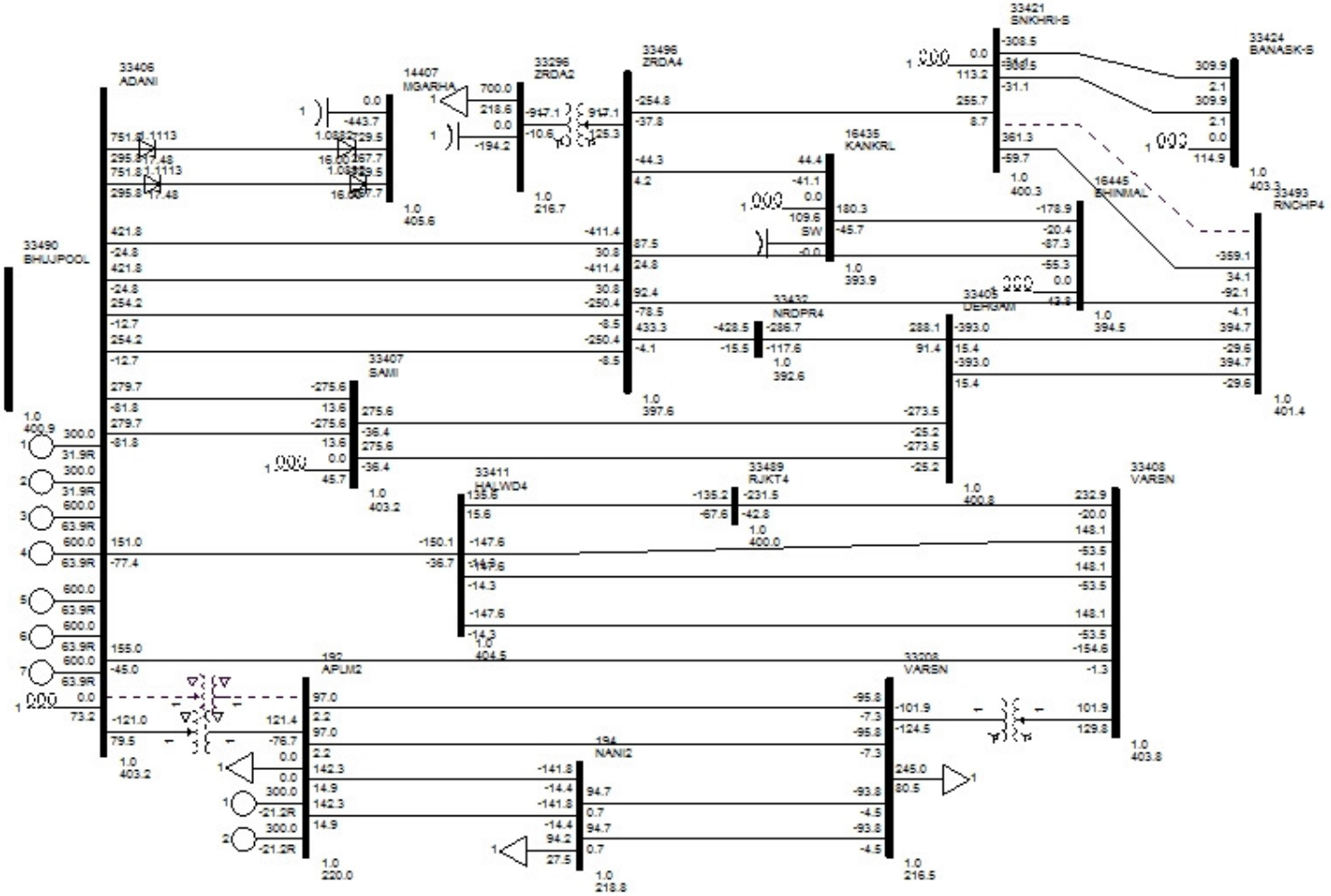
Base Case (2016-17) with Adani Zerda 400 kV D/C line- and line-2 – **Exhibit-IX**



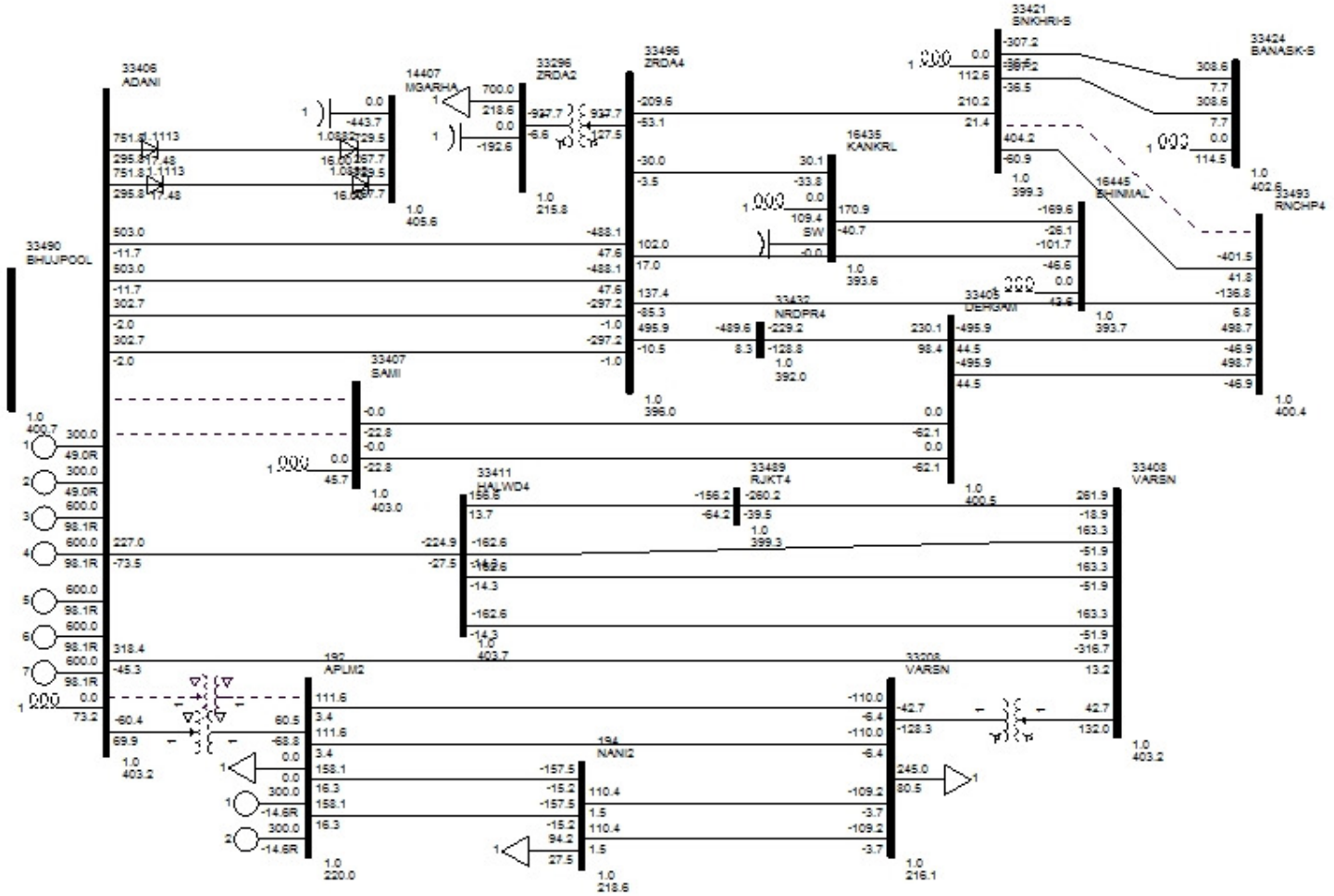
Base Case (2016-17) + outage of Adani Zerda 400 kV D/C line-1 – **Exhibit-X**



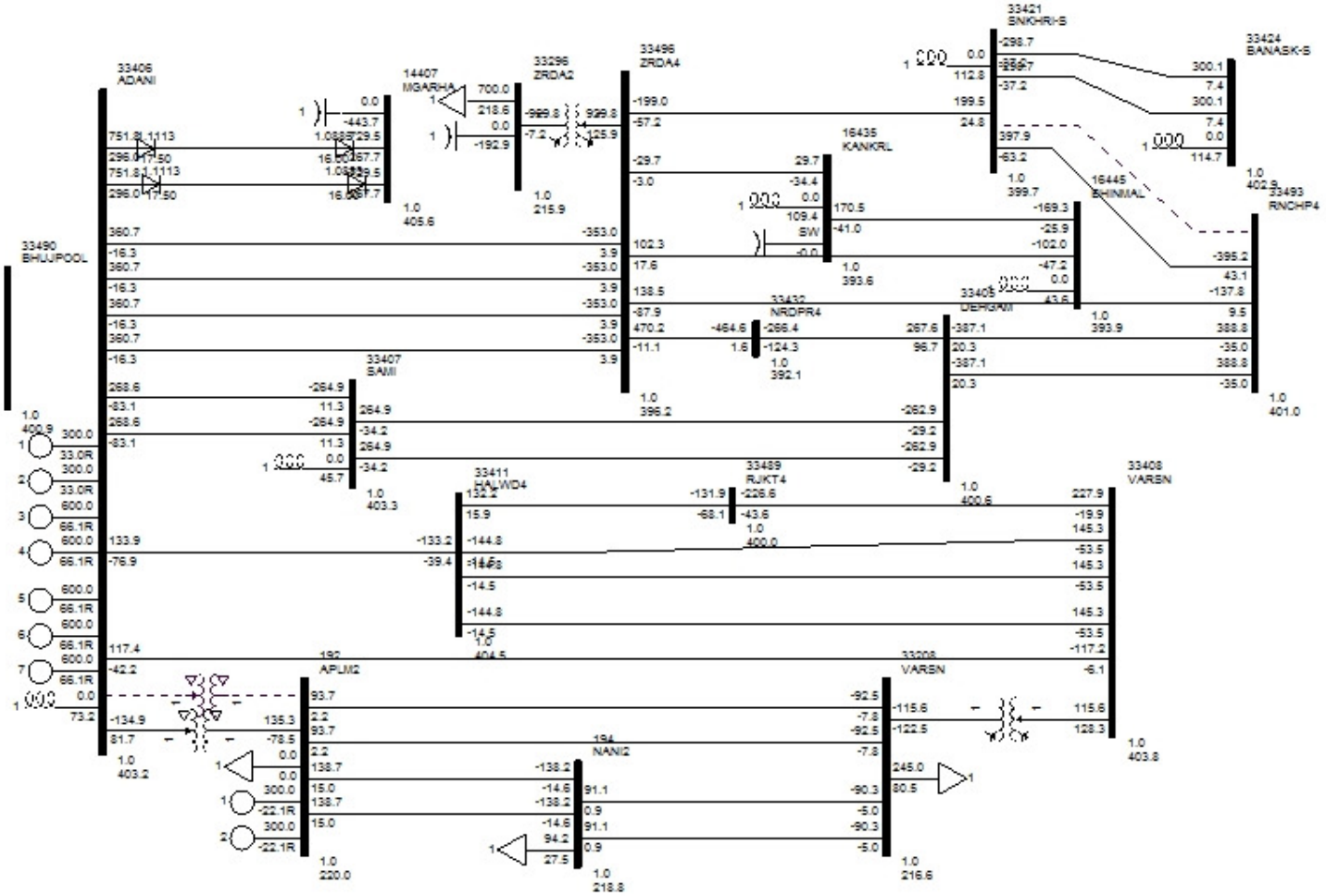
Base Case (2016-17) +40% FSC Adani Zerda 400 kV D/C line-2 : **Exhibit-XI**



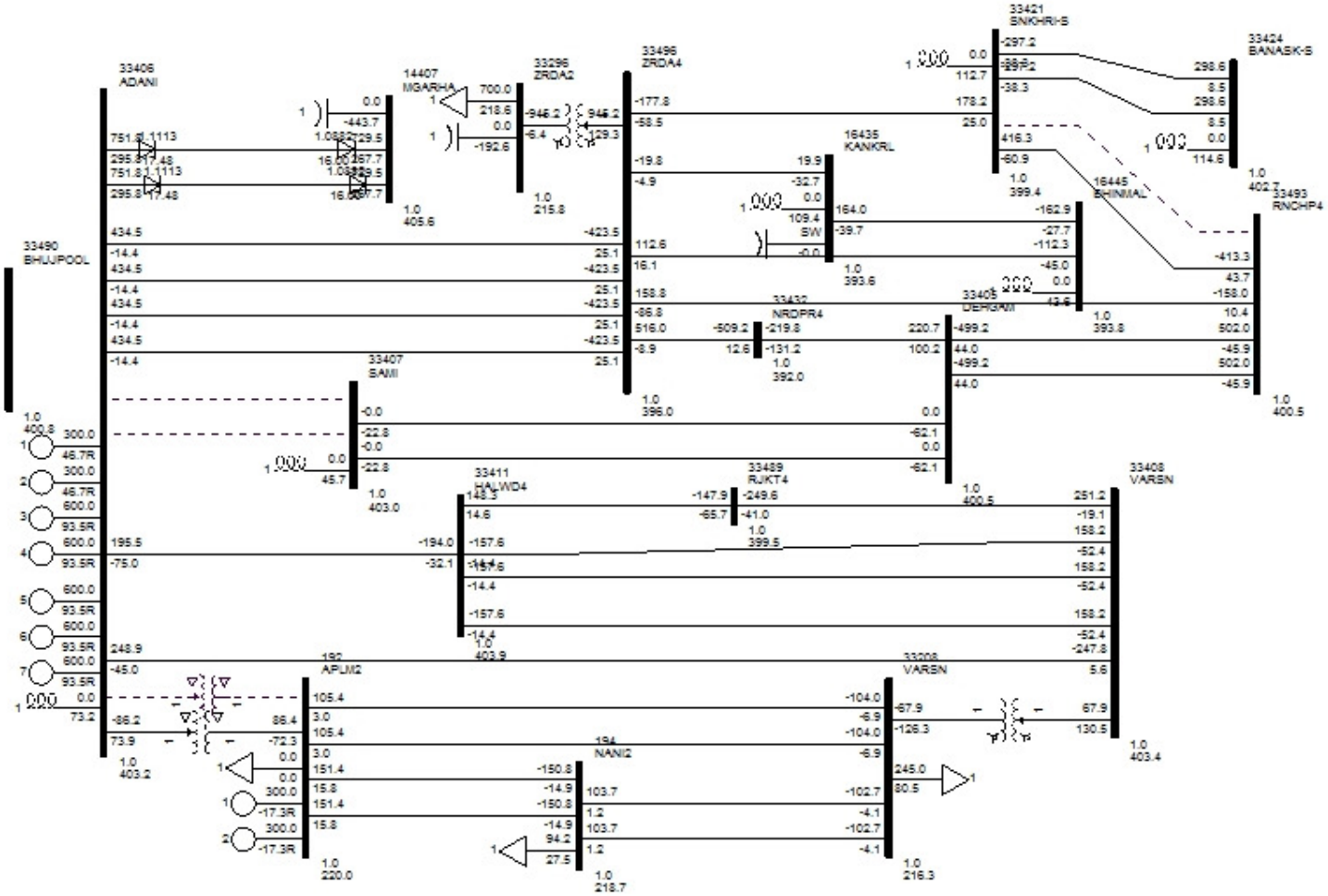
Base Case (2016-17) +40% FSC Adani Zerda 400 kV D/C line-2 + outage of Adani- Dehgam 400 kV D/C line: **Exhibit-XII**



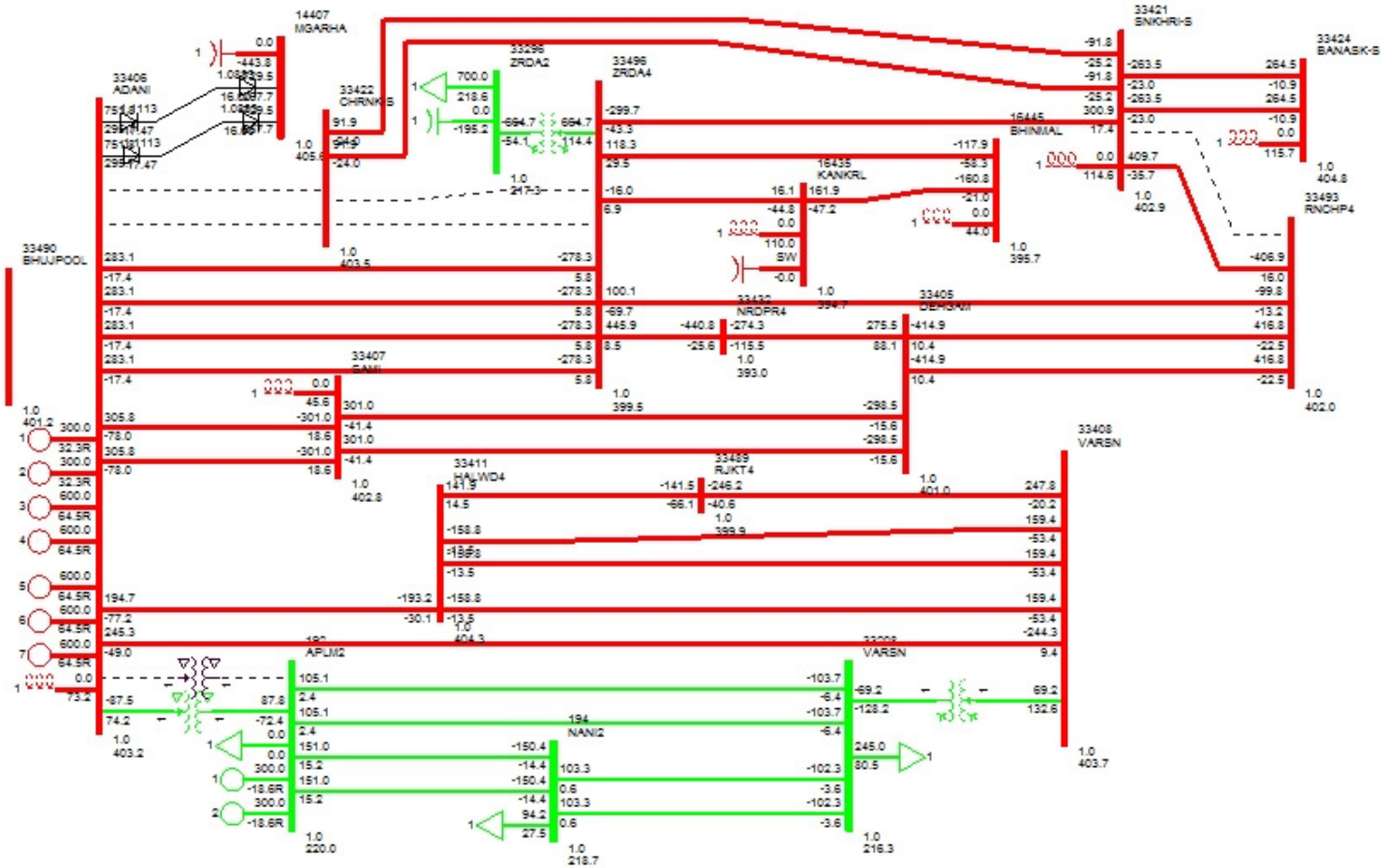
Base Case (2016-17) +40% FSC Adani Zerda 400 kV D/C line-1 and line-2: **Exhibit-XIII**



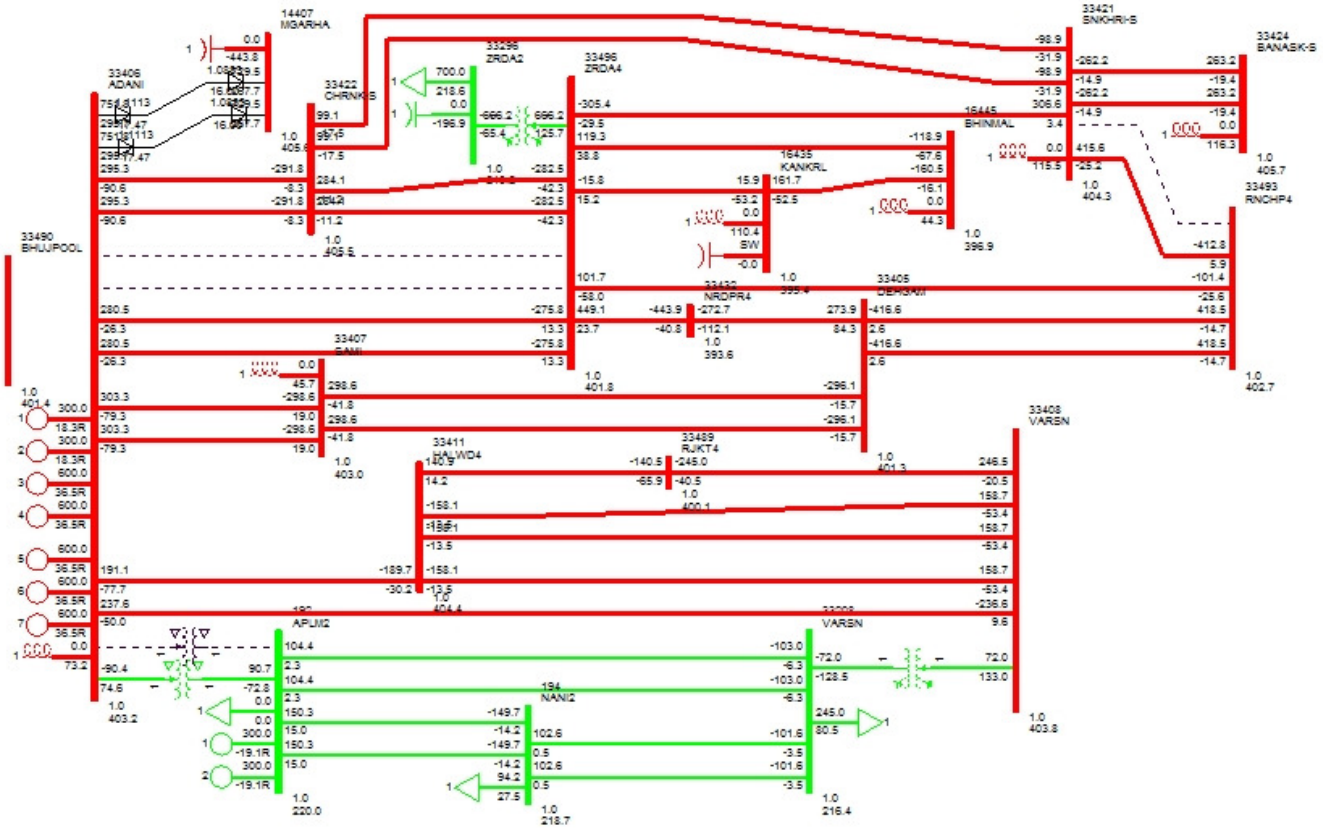
Base Case (2016-17) +40% FSC Adani Zerda 400 kV D/C line-1 and line-2 + outage of Adani-Dehgam line: **Exhibit-XIV**



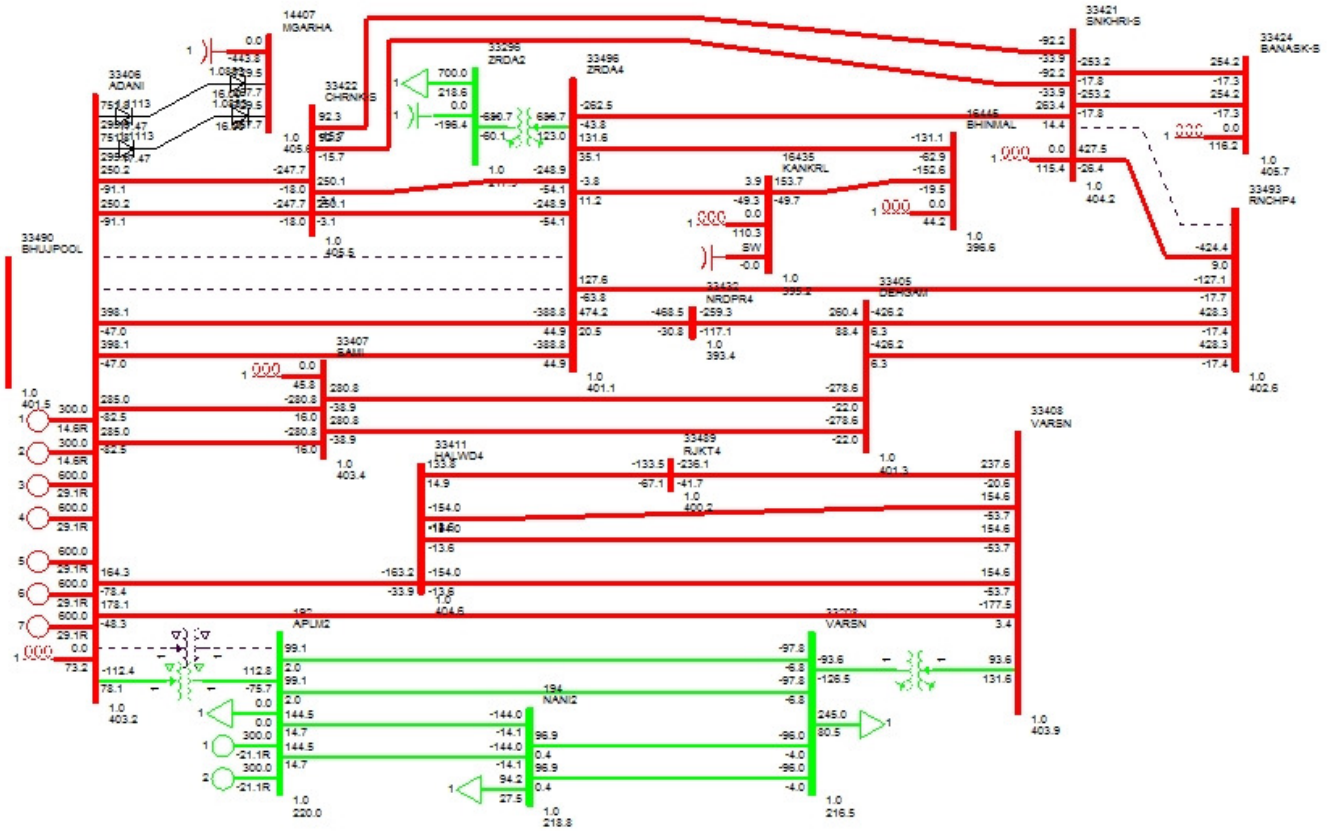
Base Case (2016-17) + Adani Zerda 400 kV D/C line-1 and line-2 + 500 MW injection at solar park Charanka: **Exhibit-XV**



Base Case (2016-17) + LILO of Adani Zerda 400 kV D/C line-1 at Charanka+ Adani Zerda 400 KV D/C line-2 + 500 MW injection at solar park Charanka: **Exhibit-XVI**



Base Case (2016-17) + LILO of Adani Zerda 400 kV D/C line-1 at Charanka+ 40 % FSC on Adani Zerda 400 KV D/C line-2 + 500 MW injection at solar park Charanka: **Exhibit-XVII**



ANNEXURE-5

ANNEXURE- 5

Report on Simulation Studies carried out for installation of additional transformers at Itarsi(PGCIL) 400kV S/s and Indore(PGCIL) 765kV S/s

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MP state has executed Power Purchase Agreement (PPA) with various Independent Power Producers (IPPs) as well as Central sector power project and power shall be made available to MP state at 400kV and 765kV voltage level. In order to draw this power at 220kV and 132kV level, adequate transformation capacity shall be required at 400/220kV level in MP state. The in-house studies have been carried out by MPPTCL considering the various 765kV S/s and 400kV S/s proposed by PGCIL and 400kV S/s Proposed by MPPTCL in the MP state which are expected to be commissioned upto year 2016-17 condition. After detailed study it is observed that as per the requirement of the system, following works shall be required in addition to the works already proposed by MPPTCL and PGCIL:-

(I) Installation of additional 2x500MVA, 400/220kV Transformer at Indore (PGCIL) 765kV Substation.

(II) Installation of additional 1x315MVA, 400/220kV Transformer at Itarsi(PGCIL) 400kV Substation.

2. To carry out the simulation studies the following is considered:
   - All 400kV, 220kV and 132 lines in circuit.
   - All 400kV and 220kV Transformers in circuit.
   - All 220kV, 132kV and 33kV capacitor banks are in circuit.

3. Load Generation Balance considered for study:

MP Generation (Thermal + Hydel)	6695 MW
MP Share (Central Sector + JV + Others)	6905 MW
Total Availability	13600 MW
Total MP Demand	13600 MW

4. Plant-Wise Generation considered in study:

Sl.No.	Name of the Plant	Generation (MW)
1	Birsinghpur TPS	1340
2	Satpura TPS	1330
3	Shree Singaji(Malwa) TPS	1200
4	Amarkanatak TPS	450
5	Pench HEP	80

Sl.No.	Name of the Plant	Generation (MW)
6	Bargi HEP	90
7	Bansagar-1(Tons) HEP	315
8	Bansagar-2(Silpara) HEP	30
9	Bansagar-3(Deolond) HEP	60
10	Bansagar-4(Zinna) HEP	40
11	Rajghat HEP	45
12	Madikheda HEP	60
13	Gandhisagar HEP	115
14	Birsinghpur HEP	20
15	Indirasagar HEP	1000
16	Omkareshwar HEP	520

5. 400/220kV ICT's Considered in the study**:**

Sl. No.	Substation	Utility	400/220 kV ICT's
1	Gwalior	PGCIL	3*315 MVA
2	Bina (PG)	PGCIL	1*315 MVA
3	Satna	PGCIL	2*315 MVA
4	Jabalpur	PGCIL	2*315 MVA
5	Seoni	PGCIL	2*315 MVA
6	Khandwa	PGCIL	2*315 MVA
7	Itarsi	PGCIL	1*315 MVA
8	Damoh	PGCIL	2*315 MVA
9	Shujalpur	PGCIL	2*315 MVA
10	Rajgarh	PGCIL	2*315 MVA
11	Satpura	MPPGCL	1*500 MVA
12	Birsinghpur	MPPGCL	1*500 MVA
13	Malwa TPS	MPPGCL	2*315 MVA
14	Indore	MPPTCL	4*315 MVA
15	Bhopal	MPPTCL	4*315 MVA
16	Bina (MP)	MPPTCL	3*315 MVA

Sl. No.	Substation	Utility	400/220 kV ICT's
17	Nagda	MPPTCL	4*315 MVA
18	Ashta	MPPTCL	2*315 MVA
19	Pithampur	MPPTCL	2*315 MVA
20	Katni	MPPTCL	2*315 MVA
21	Julwaniya	MPPTCL	2*315 MVA
22	Chhegaon	MPPTCL	2*315 MVA

6. Import/Export of Madhya Pradesh from Grid (ISTS/ Chattisgarh / Gujarat/ Maharasthra) have been considered matching with the flows on the interstate line.

7. Proposal for installation of additional 2x500MVA, 400/220kV Transformer at Indore (PGCIL) 765kV Substation.

In year 2013-14, the demand of West Discom of MP has touched 4100MW and demand is expected to increase this year. At present 4x315MVA, 400/220kV ICTs installed at 400kV S/s Indore(MPPTCL) are loaded to their full capacity even considering additional support of 175MW from Barwaha 220kV S/s. This is an alarming situation, therefore it is required to review the supply condition of Indore area for present and for future planning purpose.

Out of the 4 nos. 315MVA transformers, two sets of 400/220/33kV, 105MVA transformers installed at Indore(MPPTCL) 400kV S/s are very old and have competed 30 years of useful service. Therefore, alternative arrangement to maintain reliability of the system is an essential requirement for 400kV S/s Indore(MPPTCL). The studies carried out by NLDC for management of loads during Rabi Season of 2013-14 also indicates that there would be over loading of 400/220kV transformers at Indore in case of contingency conditions.

Considering above, it is essential to provide an additional source on 400kV level at the earliest in the vicinity of Indore area to provide the relief to ICTs installed at 400kV S/s Indore(MPPTCL).

Possibilities may be explored by PGCIL to install 2x500MVA, 400/220kV transformers at 765kV S/s Indore(PGCIL). This will facilitate fulfilment of demand of the area by importing power on 400kV level without depending upon 220kV inputs from other regions and also provide relief for undesired run of Hydel power stations installed at Western part of MP.

Observations:

7.1 System constraints without 2x500MVA, 400/220KV ICTs at Indore(PGCIL)

- **<u>Case-1A</u>**
  Under the Normal Condition(Base Case), no constraints/overloading have been observed.

- **Case-2A**
  Under N-1 Contingency at Indore(MP) (Outage of one ICT), no constraints/overloading have been observed.
- **Case-3A**
  Under N-1 Contingency at Nagda (Outage of one ICT), no constraints/overloading have been observed.
- **Case-4A**
  Under N-1 Contingency at Pithampur (Outage of one ICT), overloading of the order of 108.44% have been observed on the other ICT at Pithampur.
- **Case-5A**
  Under N-1 Contingency at Ashta (Outage of one ICT), overloading of the order of 114.38% have been observed on the other ICT at Ashta.

The power flow under different conditions is given hereunder:

Case-1A

Power flow on ICTs under normal condition (Base Case)
Without Considering 2x500MVA,400/220kV ICT at Indore(PGCIL) 765kV

Name of 400kV Substations	400kV Bus Voltage	220kV Bus Voltage	ICT rated Capacity	ICT Loading		% Loading
	KV	KV	(MVA)	MW	MVAR	
Indore(MP)	401.52	220.11	4*315	909.13	64.02	72.15%
Pithampur	405.34	220.52	2*315	507.68	11.10	80.58%
Nagda	399.14	219.61	4*315	658.55	274.10	52.27%
Ashta	403.33	218.97	2*315	463.00	81.18	73.49%

Case-2A

(N-1) contingency of 400/220kV,1x315 MVA ICT at Indore(MP)
Without Considering 2x500MVA,400/220kV ICT at Indore(PGCIL) 765kV

Name of 400kV Substations	400kV Bus Voltage	220kV Bus Voltage	ICT rated Capacity	ICT Loading		% Loading
	KV	KV	(MVA)	MW	MVAR	
Indore(MP)	401.45	219.69	4*315	0+805.02	71.97	85.19%
Pithampur	405.16	220.33	2*315	529.1	15.2	83.98%

Nagda	398.88	219.47	4*315	678.55	274.46	53.85%
Ashta	402.82	218.63	2*315	470.92	83	74.75%

Case-3A

(N-1) contingency of 400/220kV,1x315 MVA ICT at Nagda
Without Considering 2x500MVA,400/220kV ICT at Indore(PGCIL) 765kV

Name of 400kV Substations	400kV Bus Voltage	220kV Bus Voltage	ICT rated Capacity	ICT Loading		% Loading
	KV	KV	(MVA)	MW	MVAR	
Indore(MP)	401.32	219.79	4*315	925.86	75.29	73.48%
Pithampur	405.12	220.27	2*315	511.98	14.54	81.27%
Nagda	399.35	218.33	4*315	0+596.97	261.86	63.17%
Ashta	402.74	218.48	2*315	465.96	85.12	73.96%

Case-4A

(N-1) contingency of 400/220kV,1x315 MVA ICT at Pithampur
Without Considering 2x500MVA,400/220kV ICT at Indore(PGCIL) 765kV

Name of 400kV Substations	400kV Bus Voltage	220kV Bus Voltage	ICT rated Capacity	ICT Loading		% Loading
	KV	KV	(MVA)	MW	MVAR	
Indore(MP)	401.87	220	4*315	970.14	82.87	77.00%
Pithampur	405.89	220.61	2*315	0+341.59	48.74	**108.44%**
Nagda	399.91	218.09	4*315	664.01	229.67	52.70%
Ashta	402.84	218.58	2*315	467.6	84.82	74.22%

Case-5A

(N-1) contingency of 400/220kV,1x315 MVA ICT at Ashta
Without Considering 2x500MVA,400/220kV ICT at Indore(PGCIL) 765kV

Name of 400kV Substations	400kV Bus Voltage	220kV Bus Voltage	ICT rated Capacity	ICT Loading		% Loading
	KV	KV	(MVA)	MW	MVAR	
Indore(MP)	401.93	220.2	4*315	933.22	72.41	74.07%
Pithampur	405.28	221.42	2*315	519.56	53.84	82.47%
Nagda	400.16	218.28	4*315	660.04	227.66	52.38%
Ashta	401.99	218.72	2*315	0+360.31	115.17	**114.38%**

7.2 System improvement with 2x500MVA,400/220kV ICTs at Indore(PGCIL)

- **Case-1B**
  Under the Normal Condition(Base Case), no constraints/overloading have been observed.
- **Case-2B**
  Under N-1 Contingency at Indore(MP) (Outage of one ICT), no constraints/overloading have been observed.
- **Case-3B**
  Under N-1 Contingency at Nagda (Outage of one ICT), no constraints/overloading have been observed.
- **Case-4B**
  Under N-1 Contingency at Pithampur (Outage of one ICT), no constraints/overloading have been observed..
- **Case-5B**
  Under N-1 Contingency at Ashta (Outage of one ICT), no constraints/overloading have been observed.

The power flow under different conditions is given hereunder:

Case-1B

Power flow on ICTs under normal condition (Base Case)
With 2x500MVA,400/220kV ICT at Indore(PGCIL) 765kV

Name of 400kV Substations	400kV Bus Voltage	220kV Bus Voltage	ICT rated Capacity	ICT Loading		% Loading
	KV	KV	(MVA)	MW	MVAR	
Indore(PG)	403.3	220.5	2*500	546.54	60.96	54.65%
Indore(MP)	403.83	220.27	4*315	695.91	74.49	55.23%
Pithampur	406.09	220.32	2*315	420.14	18.14	66.69%

Nagda	401.82	218.96	4*315	576.16	235.6	45.73%
Ashta	404.68	219.58	2*315	430.74	81.86	68.37%

Case-2B

(N-1) contingency of 400/220kV,1x315 MVA ICT at Indore(MP)
With 2x500MVA,400/220kV ICT at Indore(PGCIL) 765kV

Name of 400kV Substations	400kV Bus Voltage	220kV Bus Voltage	ICT rated Capacity	ICT Loading		% Loading
	KV	KV	(MVA)	MW	MVAR	
Indore(PG)	403.15	220.85	2*500	569.5	46.8	56.95%
Indore(MP)	403.11	221.01	4*315	0+616.82	42.49	65.27%
Pithampur	406.2	220.85	2*315	431.36	28.7	68.47%
Nagda	401.91	219.18	4*315	584.82	228	46.41%
Ashta	405.21	220.16	2*315	435.04	75.5	69.05%

Case-3B

(N-1) contingency of 400/220kV,1x315 MVA ICT at Nagda
With 2x500MVA,400/220kV ICT at Indore(PGCIL) 765kV

Name of 400kV Substations	400kV Bus Voltage	220kV Bus Voltage	ICT rated Capacity	ICT Loading		% Loading
	KV	KV	(MVA)	MW	MVAR	
Indore(PG)	403.2	220.91	2*500	554.34	44.34	55.43%
Indore(MP)	403.01	221.3	4*315	714.94	32.86	56.74%
Pithampur	406.33	221.11	2*315	420	31.84	66.67%
Nagda	401.07	219.44	4*315	0+524.09	253.5	55.46%
Ashta	405.39	220.28	2*315	432.82	74.78	68.70%

Case-4B

(N-1) contingency of 400/220kV,1x315 MVA ICT at Pithampur
With 2x500MVA,400/220kV ICT at Indore(PGCIL) 765kV

Name of 400kV Substations	400kV Bus Voltage	220kV Bus Voltage	ICT rated Capacity	ICT Loading		% Loading
	KV	KV	(MVA)	MW	MVAR	
Indore(PG)	403.18	220.91	2*500	576.6	44.54	57.66%
Indore(MP)	402.95	221.25	4*315	742.12	35.57	58.90%
Pithampur	406.43	220.62	2*315	0+275.11	16.87	87.34%
Nagda	401.57	219.05	4*315	578.96	224.94	45.95%
Ashta	405.24	220.18	2*315	432.24	75.14	68.61%

Case-5B

(N-1) contingency of 400/220kV,1x315 MVA ICT at Ashta
With 2x500MVA,400/220kV ICT at Indore(PGCIL) 765kV

Name of 400kV Substations	400kV Bus Voltage	220kV Bus Voltage	ICT rated Capacity	ICT Loading		% Loading
	KV	KV	(MVA)	MW	MVAR	
Indore(PG)	403.35	220.81	2*500	558.04	51.44	55.80%
Indore(MP)	402.74	220.82	4*315	726.9	50.69	57.69%
Pithampur	406.42	221.11	2*315	423.46	30.94	67.22%
Nagda	400.57	218.58	4*315	581.9	220.35	46.18%
Ashta	409.66	221.41	2*315	0+311.61	60.3	98.92%

8 Proposal for installation of additional 1x315MVA, 400/220kV Transformer at Itarsi(PGCIL) 400kV Substation.

At present there are a number of 220kV substations of MPPTCL around Itarsi and Betul area viz.Sarni, Betul, Handia, Hoshangabad, Itarsi & Pipariya 220kV S/s. All these

220kV substations are dependent on 220kV supply available from Satpura TPS and Itarsi400/220kV S/s(PGCIL). At present one no. 315MVA, 400/220kV ICT is installed at Itarsi (PGCIL) 400kV S/s. Day by day loading & dependency on this ICT is increasing as the old units of 62.5MW at Satpura TPS of MPPGCL supplying power on 220kV are being abandoned in a phased manner.

The 500MVA,400/220kV ICT at Satpura TPS is the only other source of power at 220kV, in which frequent problems is experienced as these single phase units have rendered useful life of 35 years and there is no spare transformer available. Therefore reliability of the 500MVA, 400kV ICT at Satpura is uncertain. It is also observed that during system distress conditions, on outage of partial generation on 220kV supply from Satpura TPS, about 300MW load is recorded on the single transformer at Itarsi (PGCIL) 400kV S/s. It is quite alarming condition to maintain stability of so many 220kV substations dependent on these sources as mentioned above.

It is therefore very essential to install an additional 1x315MVA,400/220kV transformer at Itarsi (PGCIL) 400kVS/s to ensure the reliability of supply and stability of 220kV substations around Itarsi and Betul area during normal as well as system distress conditions.

Observations:

8.1 System Constraints without considering additional 1x315MVA ICT at Itarsi-PGCIL

- **Case-1C**
  Under the Normal Condition(Base Case), overloading of the order of 107.65% have been observed on Single ICT at Itarsi(PGCIL).

- **Case-2C**
  Under N-1 Contingency at Satpura TPS (Outage of 1x500MVA ICT), overloading of the order of 132.96% have been observed on Single ICT at Itarsi(PGCIL).

- **Case-3C**
  Under N-1 Contingency at Bhopal (Outage of one ICT), overloading of the order of 111.50% and 111.60% have been observed on ICTs at Itarsi(PGCIL) and Bhopal respectively.

The power flow under different conditions is given hereunder :

CASE-1C

Power flow on ICTs under normal condition (Base Case)
Without Additional 1x315MVA,400/220kV ICT at Itarsi (PGCIL) 400kV

Name of 400kV Substations	400kV Bus Voltage	220kV Bus Voltage	ICT rated Capacity	ICT Loading		% Loading
	KV	KV	(MVA)	MW	MVAR	

Itarsi(PG)	401.72	218.99	1*315	339.11	93.07	**107.65%**
Satpura TPS	405.42	219.53	1*500	294.83	75.05	58.97%
Bhopal	400.42	219.15	4*315	1162.48	102.48	92.26%

CASE-2C

(N-1) contingency of 400/220kV,1x500 MVA ICT at Satpura TPS
Without Additional 1x315MVA,400/220kV ICT at Itarsi(PGCIL) 400kV

Name of 400kV Substations	400kV Bus Voltage	220kV Bus Voltage	ICT rated Capacity	ICT Loading		% Loading
	KV	KV	(MVA)	MW	MVAR	
Itarsi(PG)	400.69	218.61	1*315	418.82	112.06	**132.96%**
Satpura TPS	406.75	216.62	1*500	0	0	0.00%
Bhopal	399.19	220.14	4*315	925.62	124.53	73.46%

CASE-3C

(N-1) contingency of 400/220kV,1x315 MVA ICT at Bhopal
Without Additional 1x315MVA,400/220kV ICT at Itarsi(PGCIL) 400kV

Name of 400kV Substations	400kV Bus Voltage	220kV Bus Voltage	ICT rated Capacity	ICT Loading		% Loading
	KV	KV	(MVA)	MW	MVAR	
Itarsi(PG)	401.19	219.12	1*315	351.22	86.39	**111.50%**
Satpura TPS	405.3	219.59	1*500	299.6	72.85	59.92%
Bhopal	399.61	219.48	4*315	0+1054.69	134.38	**111.60%**

8.2 System improvement with additional 1x315MVA ICT at Itarsi-PGCIL i.e. 2x315MVA, 400/220kV ICT at Itarsi(PGCIL)

- **Case-1D**
  Under the Normal Condition(Base Case), no overloading have been observed on the ICTs at Itarsi(PGCIL), Bhopal and Satpura TPS.

- **Case-2D**
  Under N-1 Contingency at Satpura TPS (Outage of 1x500MVA ICT), no overloading have been observed on the ICTs at Itarsi(PGCIL), Bhopal and Satpura TPS.

- **Case-3D**
  Under N-1 Contingency at Bhopal (Outage of one ICT), no overloading have been observed on the ICTs at Itarsi(PGCIL), Bhopal and Satpura TPS.

The power flow under different conditions is given hereunder :

CASE-1D

Power flow on ICTs under normal condition (Base Case)
With Additional 1x315MVA,400/220kV ICT at Itarsi(PGCIL) 400kV

Name of 400kV Substations	400kV Bus Voltage	220kV Bus Voltage	ICT rated Capacity	ICT Loading		% Loading
	KV	KV	(MVA)	MW	MVAR	
Itarsi(PG)	401.46	219.15	2*315	503.06	121.37	79.85%
Satpura TPS	405.44	219.46	1*500	248.92	74.15	49.78%
Bhopal	399.57	218.57	4*315	1125.78	103.9	89.35%

CASE-2D

(N-1) contingency of 400/220kV,1x500 MVA ICT at Satpura TPS
With Additional 1x315MVA,400/220kV ICT at Itarsi(PGCIL) 400kV

Name of 400kV Substations	400kV Bus Voltage	220kV Bus Voltage	ICT rated Capacity	ICT Loading		% Loading
	KV	KV	(MVA)	MW	MVAR	
Itarsi(PG)	401	219.79	2*315	600.91	103.52	95.38%
Satpura TPS	406.95	217.28	1*500	0	0	0.00%
Bhopal	399.5	220.1	4*315	1148.86	129.23	91.18%

CASE-3D

(N-1) contingency of 400/220kV,1x315 MVA ICT at Bhopal
With Additional 1x315MVA,400/220kV ICT at Itarsi(PGCIL) 400kV

Name of 400kV Substations	400kV Bus Voltage	220kV Bus Voltage	ICT rated Capacity	ICT Loading		% Loading
	KV	KV	(MVA)	MW	MVAR	
Itarsi(PG)	401.13	219.4	2*315	511.91	112.26	81.26%
Satpura TPS	405.25	219.58	1*500	240.97	69.36	48.19%
Bhopal	399.26	219.95	4*315	0+929.43	162.81	98.35%

ANNEXURE-6

Reactive Compensation Studies

for

Inter State Transmission System

as part of

Green Energy Corridors

Reactive Compensation Studies for Inter State Transmission System As a part of Green Energy Corridors

Suitable reactive power compensation needs to be provided in the EHV system so as maintain system parameters namely voltages within permissible limits under various network operating conditions including off-peak periods. As per the Transmission planning criteria of CEA (Jan'13), following normal voltage limits for 765kV & 400kV systems are provided for steady state as well as during sudden load rejection phenomenon (Temporary over voltage):

- **Steady state voltage limits**

Voltage (kVrms)		
	Normal rating	
Normal	**Maximum**	**Minimum**
765	800	728
400	420	380

- **Temporary over voltage limits due to sudden voltage rejection (Peak phase to neutral)**

Voltage (kVrms)	**TOV**
800	1.4 p.u. (653kV = 1 p.u.)
420	1.5 p.u. (343kV = 1 p.u.)

Present report covers the studies and analysis carried out to evolve requirement of reactive compensation in the form of reactors of suitable size at appropriate location so as to maintain the voltage and other parameters within limits for the identified Inter State transmission system (ISTS) as part of Green Energy Corridors. As part of Green Energy Corridors, entire transmission scheme is phased out according to the KFW funding availability in three tranches i.e. tranche-I, II & III. Details of the transmission scheme in each KFW loan tranche are as under:

(a) Green Energy Corridors-ISTS-Part-A (Tranche-I)

Rajasthan (Northern region)

- Ajmer (New)- Ajmer (RVPN) 400kV D/c (Quad) – 57km
- Chittorgarh (New)- Chittorgarh (RVPN) 400kV D/c (Quad)-25km
- Establishment of 2x1500 MVA, 765/400kV S/s at Chittorgarh
- Establishment of 2x1500 MVA, 765/400kV S/s at Ajmer (New)

Tamil Nadu (Southern region)

- Tirunelveli Pooling Station - Tuticorin Pooling Station 400 kV 2xD/c (Quad) -1st ckt 57km/2nd ckt – 55km
- Establishment of 2x500 MVA, 400/230kV S/s at Tirunelveli Pooling Station

(b) Green Energy Corridors-ISTS-Part-B (Tranche-II)

Gujarat (Western Region)

- Establishment of 765/400/220 kV (765/400 kV - 2x1500 MVA & 400/220 kV-2x500MVA) sub-station at Banaskantha
- Banaskantha – Chittorgarh 765kV D/C -285 km
- Banaskantha-Sankhari 400 kV D/C-26 km

Rajasthan (Northern region)

- Chittorgarh – Ajmer(New) 765kV D/C -200km

(c) Green Energy Corridors-ISTS-Part-C (Tranche-III)

Gujarat (Western Region)

- Establishment of 765/400/220 kV (765/400 kV-2x1500 MVA & 400/220 kV- 2x500 MVA) sub-station at Bhuj Pool
- Bhuj Pool – Banaskanta 765kV D/c -315km

Accordingly, reactive compensation studies have been carried out for above transmission scheme(s) to identify suitable line reactors for charging the lines. It is also assumed that to keep flexibility in line charging from either ends, adequate line reactors to be provided at either end satisfying the Transmission planning criteria steady state voltage limits.

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Further, to control bus voltage during off-peak conditions or while charging of lines from various substations, necessary bus reactors each at 765kV/400kV voltage levels have

been considered. While carrying out line charging studies, above bus reactors have been taken into consideration. Details of bus reactors proposed at various substations are as under:

Green Energy Corridors-ISTS-Part-A (Tranche-I)

- 1x240 MVAR,765kV Bus reactor each at Chittorgarh & Ajmer Substation
- 1x125 MVAR,420kV Bus reactor each at Chittorgarh & Ajmer Substation
- 2x125 MVAR,420kV Bus reactors at Tirunelvelli Substation

Green Energy Corridors-ISTS-Part-B (Tranche-II)

- 1x330 MVAR,765kV Bus reactor at Banaskantha Substation
- 1x125 MVAR,420kV Bus reactor at Banaskantha Substation

Green Energy Corridors-ISTS-Part-C (Tranche-III)

- 1x330 MVAR,765kV Bus reactor at Bhuj Pool Substation
- 1x125 MVAR,420kV Bus reactor at Bhuj Pool Substation

Considering above reactive compensation at bus level, requirement of line reactive compensation has been studied for various transmission lines and results are as under:

(a) Studies for provision of Line reactors in **Chittorgarh-Ajmer 765kV D/c** line

(i) Line Charging Studies

Line Length : approx. 200 km

Charging from Ajmer end without Line reactors at either end

Source Rise : 63 kV
Line Rise : 19 kV
Total Rise : 82 kV

Charging from Chittorgarh end without Line reactors at either end

Source Rise : 42kV
Line Rise : 19kV
Total Rise : 61kV

Study results in this regard are enclosed at ***Annexure-A1***.

From above, it may be observed that charging of above line from either end without any line reactors shall lead to very high voltages at the open end thus making it not feasible to charge the line.

Accordingly, to facilitate charging of the line from either end, 1x240 MVAR line reactor at each end of 765kV Chittorgarh-Ajmer line is considered in view of the availability of standard size (minimum) of 240 MVAR for Line reactor. Results of the charging studies considering above line reactor combination is as under:

Charging from Ajmer end with 1x240 MVAR Line reactor at either ends

Source Rise : 6 kV
Line Rise : 1.5 kV
Total Rise : 7.5 kV

Charging from Chittorgarh end with 1x240 MVAR Line reactor at either ends

Source Rise : 4 kV
Line Rise : 1.5 kV
Total Rise : 5.5 kV

Study results in this regard are enclosed at ***Annexure-A2***.

From above line charging study results, Chittorgarh – Ajmer 765 kV D/c line is proposed to be provided with 240 MVAR line reactor on both ends of each circuit.

(ii) Transient Over voltage Study on sudden load rejection

The line reactors are provided on long lines to facilitate charging of the line to control Ferranti rise (voltages) at the open end while charging from either ends. Further, the receiving end line reactor also facilitates in controlling power frequency temporary over voltages due to sudden load rejection. As per the Transmission Planning Criteria, the temporary over voltage should remain within 1.4 P.U (for 765kV system).

The surge impedance loading (SIL) of the line is reduced by the line reactors by a factor “k = SQRT(1-degree of compensation)”. Therefore, it is desirable that the line reactors if not required, under high loading conditions, should be taken out of service. In order to achieve that flexibility, there is generally a practice to equip line reactor with additional breaker thereby making them switchable line reactor. The switchable line reactor offers additional flexibility for controlling over voltages in real time basis in such conditions. However, the major concern while selecting fixed or switchable line reactor is power frequency temporary over voltages due to sudden load rejection.

Detailed EMTP studies have been carried out for sudden load rejection at receiving end(s) on single line to ground fault followed by opening of the three phases after 100ms to simulate worst case TOV condition. For this, pre-fault flow of about 1200

MW/ckt and 400 MVAR/ckt is kept. The results of the EMTP studies are given at ***Exhibit - I*** and results are summarized in the table as under:

Sno	Case	TOV (p.u.) [653kV = 1 p.u.]
1	With 1x240 MVAR Line reactor at either end	Opening at Chittorgarh end – 1.01p.u. Opening at Ajmer end – 1.05 p.u.
2	Without Line reactors at either end	Opening at Chittorgarh end – 1.09 p.u. Opening at Ajmer end – 1.14 p.u.

As the TOV in the case of without line reactors at either end doesn't violate the stipulated limits (1.4 pu) even in case of sudden load rejection at either ends, it is proposed to make the line reactor at either end as switchable so that line loadability can be improved. .

(b) Studies for provision of Line reactors in **Banaskantha -Chittorgarh 765kV D/c** line

(i) Line Charging Studies

Line Length : approx. 285 km

Charging from Chittorgarh end without Line reactors at either end

Source Rise : 43 kV
Line Rise : 40 kV
Total Rise : 83 kV

Charging from Banaskantha end without Line reactors at either end

Source Rise : 86 kV
Line Rise : 41 kV
Total Rise : 127 kV

Study results in this regard are enclosed at ***Annexure-A3***.

From above, it may be observed that charging of above line from either end without any line reactors shall lead to very high voltages at the open end thus making it not feasible to charge the line.

Accordingly, in order to facilitate charging of the line from either end, 1x240 MVAR line reactor at each end of 765kV Banaskantha - Chittorgarh line is proposed. Results of the charging studies considering above line reactor combination is as under:

Charging from Chittorgarh end with 1x240 MVAR Line reactor at each end

Source Rise : 15 kV
Line Rise : 14 kV
Total Rise : 29 kV

Charging from Banaskantha end with 1x240 MVAR Line reactor at each end

Source Rise : 29 kV
Line Rise : 14 kV
Total Rise : 43 kV

Study results in this regard are enclosed at ***Annexure-A4***.

As there is difficulty in charging above line from Banaskantha end due to source rise issues, it is proposed to study charging with 1x330 MVAR line reactor alternative at Banaskantha end. Accordingly, in order to facilitate charging of the line from either end, 1x240 MVAR line reactor at Chittorgarh end and 1x330 MVAR line reactor at Banaskantha end of 765kV Banaskantha - Chittorgarh line is considered. Results of the charging studies considering above line reactor combination is as under:

Charging from Chittorgarh end with 1x330 MVAR Line reactor at Banaskantha & 1x240 MVAR at Chittorgarh

Source Rise : 10 kV
Line Rise : 5 kV
Total Rise : 15 kV

Charging from Banaskantha end with 1x330 MVAR Line reactor at Banaskantha & 1x240 MVAR at Chittorgarh

Source Rise : 19 kV
Line Rise : 13 kV
Total Rise : 32 kV

Study results in this regard are enclosed at ***Annexure-A5***.

From above line charging study results, Banaskantha – Chittorgarh 765 kV D/c line is proposed to be provided with 330 MVAR line reactor at Banaskantha end and 240 MVAR line reactor at Chittorgarh end for its both circuits.

(ii) Transient Over voltage Study on sudden load rejection

Detailed EMTP studies have been carried out for sudden load rejection at receiving end(s) on single line to ground fault followed by opening of the three phases after 100ms to simulate TOV condition. For this, pre-fault flow of about 1300 MW/ckt and 450 MVAR/ckt is kept. The results of the EMTP studies are given at ***Exhibit – II*** and results are summarized in the table as under.

Sno	Case	TOV (p.u.) [653kV = 1 p.u.]
1	With 1x240 MVAR Line reactor at Chittorgarh & 1x330 MVAR line reactor at Banaskantha end	Opening at Chittorgarh end – 1.09 p.u. Opening at Banaskantha end – 1.07 p.u.
2	Without Line reactors at either end	Opening at Chittorgarh end – 1.19 p.u. Opening at Banaskantha end – 1.19 p.u.

As the TOV in the case of without line reactors at either end doesn't violate the stipulated limits (1.4 pu) even in case of sudden load rejection at either ends, it is proposed to make the line reactor at either end as switchable so that line loadability can be improved. .

(c) Studies for provision of Line reactors in **Bhuj Pool - Banaskantha 765kV D/c** line

(i) Line Charging Studies

Line Length : approx. 315 km

Charging from Bhuj Pool end without Line reactors at either end

Source Rise : 50 kV
Line Rise : 49 kV
Total Rise : 99 kV

Charging from Banaskantha end without Line reactors at either end

Source Rise : 47 kV
Line Rise : 49 kV
Total Rise : 96 kV

Study results in this regard are enclosed at ***Annexure-A6***.

From above, it may be observed that charging of above line from either end without any line reactors shall lead to very high voltages at the open end thus making it not feasible to charge the line.

In order to facilitate charging of the line from either end, 1x240 MVAR line reactor at Bhuj Pool end and 1x330 MVAR line reactor at Banaskantha end of 765kV Bhuj Pool - Banaskantha line is proposed. Results of the charging studies considering above line reactor combination is as under:

Alternative-I

Charging from Bhuj Pool end with 1x330 MVAR Line reactor at Banaskantha & 1x240 MVAR at Bhuj Pool

Source Rise : 15 kV
Line Rise : 9.5 kV
Total Rise : 24.5 kV

Charging from Banaskantha end with 1x330 MVAR Line reactor at Banaskantha & 1x240 MVAR at Bhuj Pool

Source Rise : 14.5 kV
Line Rise : 19.5 kV
Total Rise : 34 kV

Study results in this regard are enclosed at ***Annexure-A7***.

As there is difficulty in charging above line from Banaskantha end in Alternative-I , it is proposed to study charging with 1x330 MVAR line reactor each at Banaskantha end and Bhuj Pool end as ***Alternative-II*** as under.

Alternative-II

Charging from Bhuj Pool end with 1x330 MVAR Line reactor at Banaskantha & 1x330 MVAR at Bhuj Pool

Source Rise : 10 kV
Line Rise : 9.5 kV
Total Rise : 19.5 kV

Charging from Banaskantha end with 1x330 MVAR Line reactor at Banaskantha & 1x330 MVAR at Bhuj Pool

Source Rise : 9.5 kV
Line Rise : 9.5 kV
Total Rise : 19 kV

Study results in this regard are enclosed at ***Annexure-A8***.

Accordingly, in order to facilitate charging of the line from either end, 1x330 MVAR line reactor at Banaskanta end and 1x330 MVAR line reactor at Bhuj Pool end of 765kV Banaskantha – Bhuj Pool line is proposed.

(i) Transient Over voltage Study on sudden load rejection

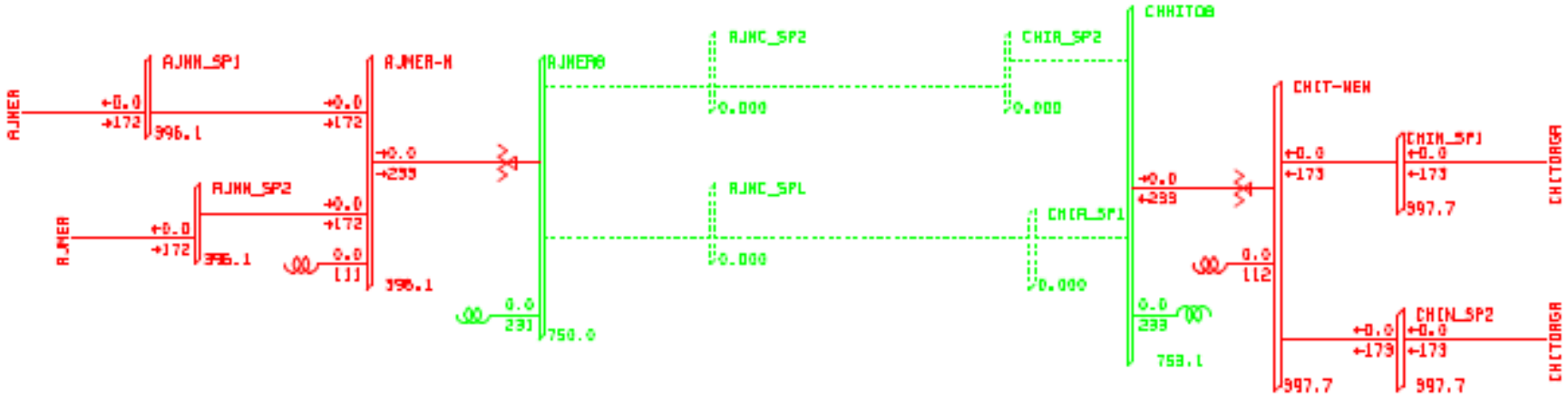
Detailed EMTP studies have been carried out for sudden load rejection at receiving end(s) on single line to ground fault followed by opening of the three phases after 100ms to simulate TOV condition. For this, pre-fault flow of about 1300 MW/ckt and 450 MVAR/ckt is kept. The results of the EMTP studies are given at ***Exhibit – III*** and results are summarized in the table as under.

Sno	Case	TOV (p.u.) [653kV = 1 p.u.]
1	With 1x330 MVAR Line reactor each at Bhuj Pool & Banaskantha end	Opening at Bhuj Pool end – 1.09 p.u. Opening at Banaskantha end – 1.05 p.u.
2	Without Line reactors at either end	Opening at Bhuj Pool end -1.24 p.u. Opening at Banaskantha end – 1.25 p.u.

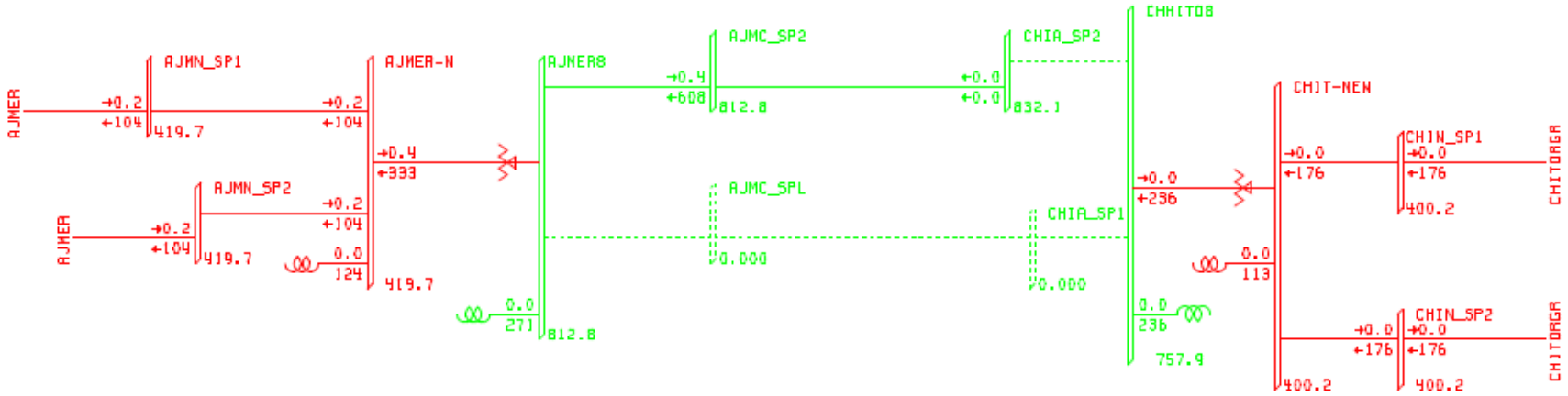
As the TOV in the case of without line reactors at either end doesn't violate the stipulated limits (1.4 pu) even in case of sudden load rejection at either ends, it is proposed to make the line reactor at either end as switchable so that line loadability can be improved. .

Ajmer -Chittorgarh 765kV D/c Line

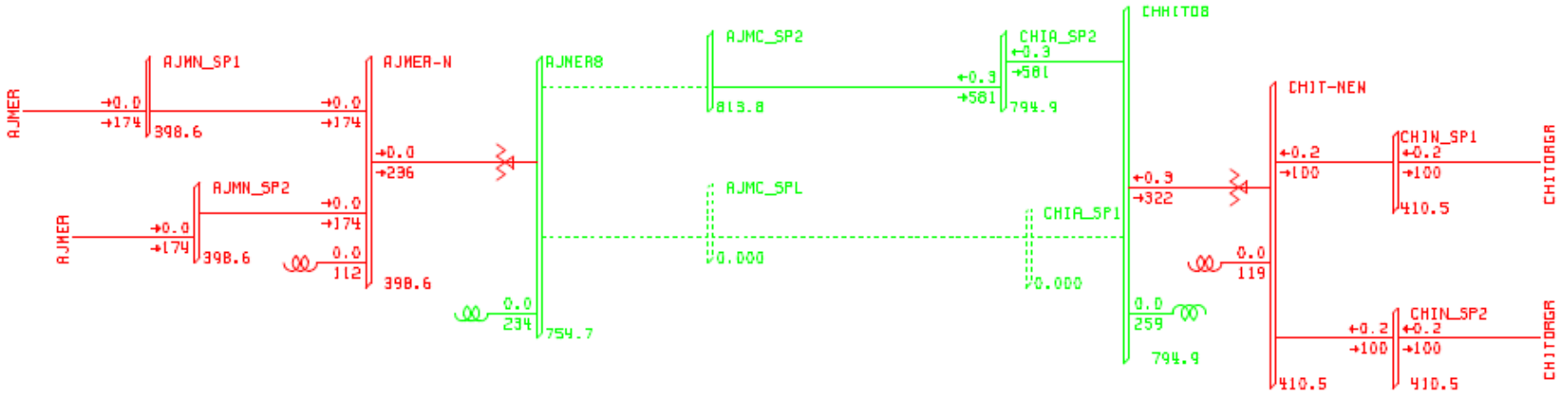
Pre Charging



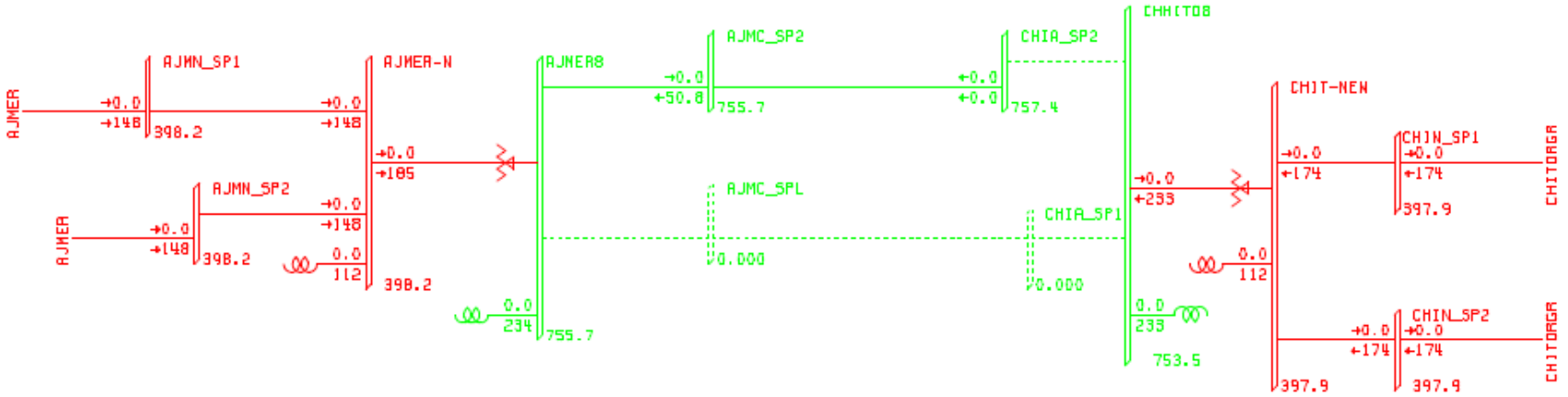
Charging from Ajmer end (Without line reactor)



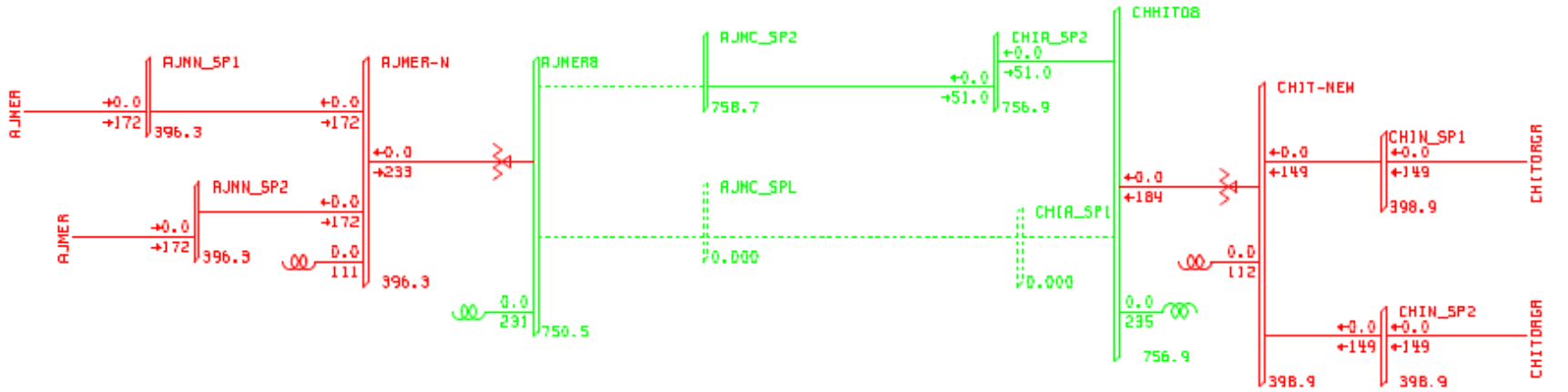
Charging from Chittorgarh end (Without line reactor)



Charging from Ajmer end (240MVAR line reactor at each end)



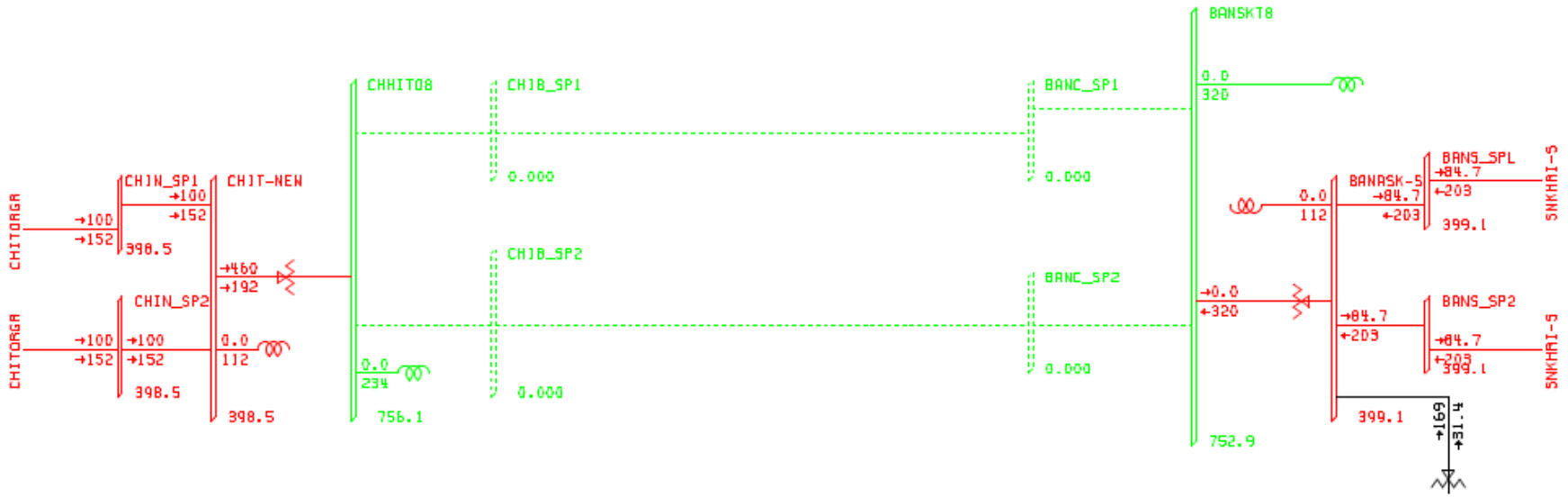
Charging from Chittorgarh end (240MVAR line reactor at each end)



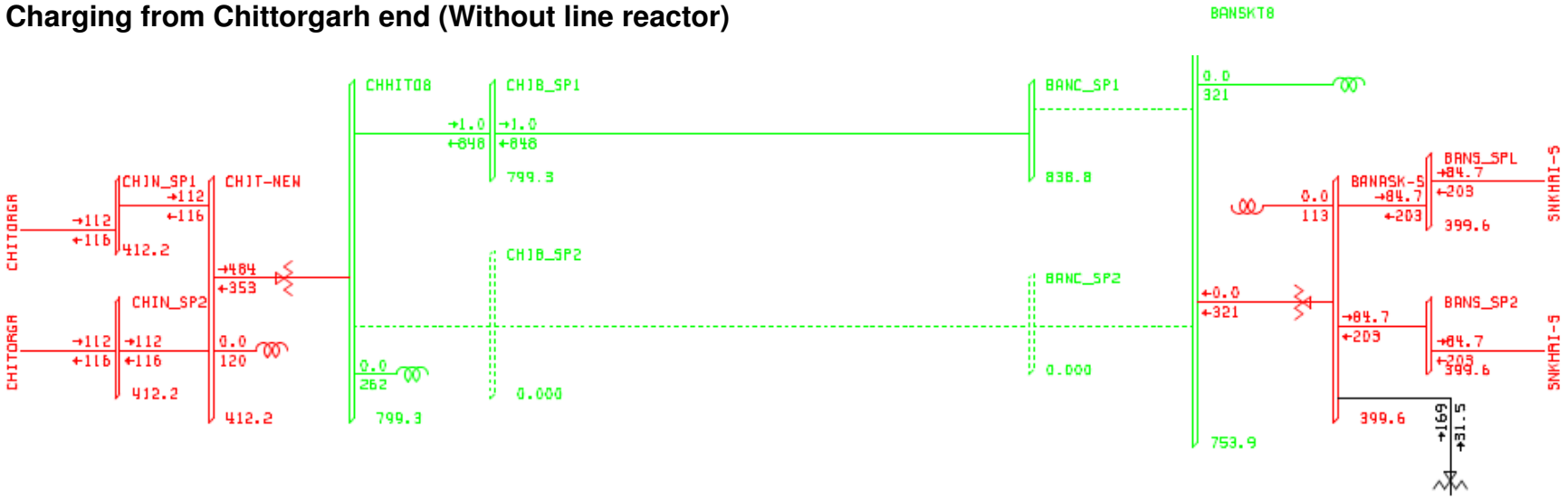
Annexure-A3

Chittorgarh - Banaskanta 765kV D/c Line

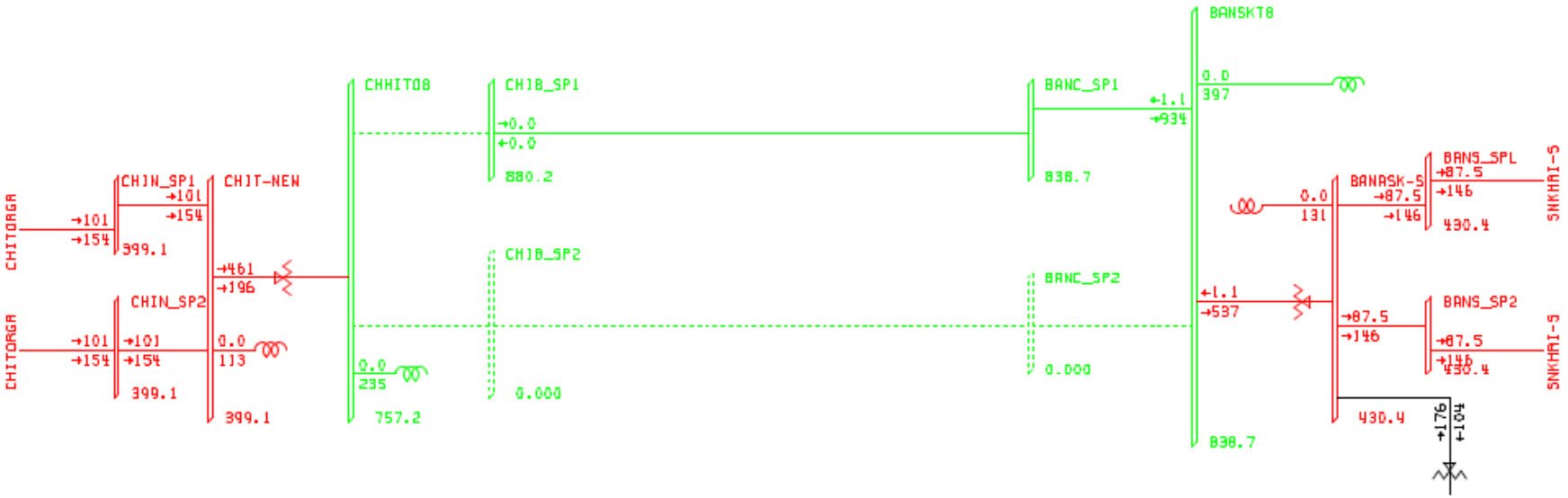
Pre Charging



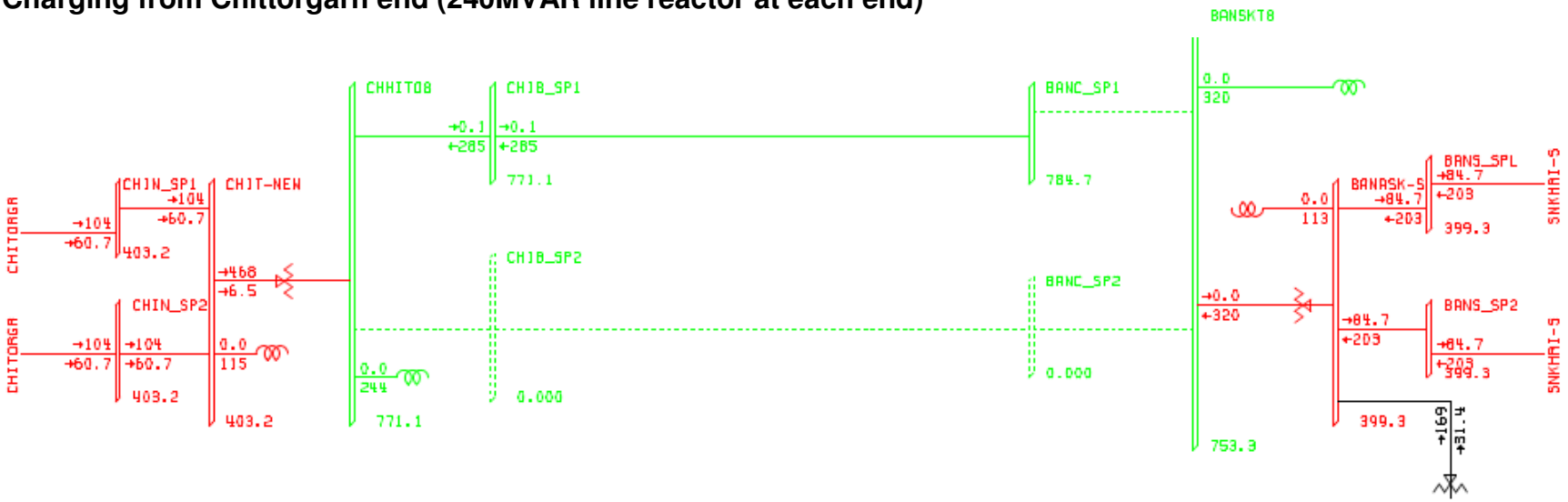
Charging from Chittorgarh end (Without line reactor)



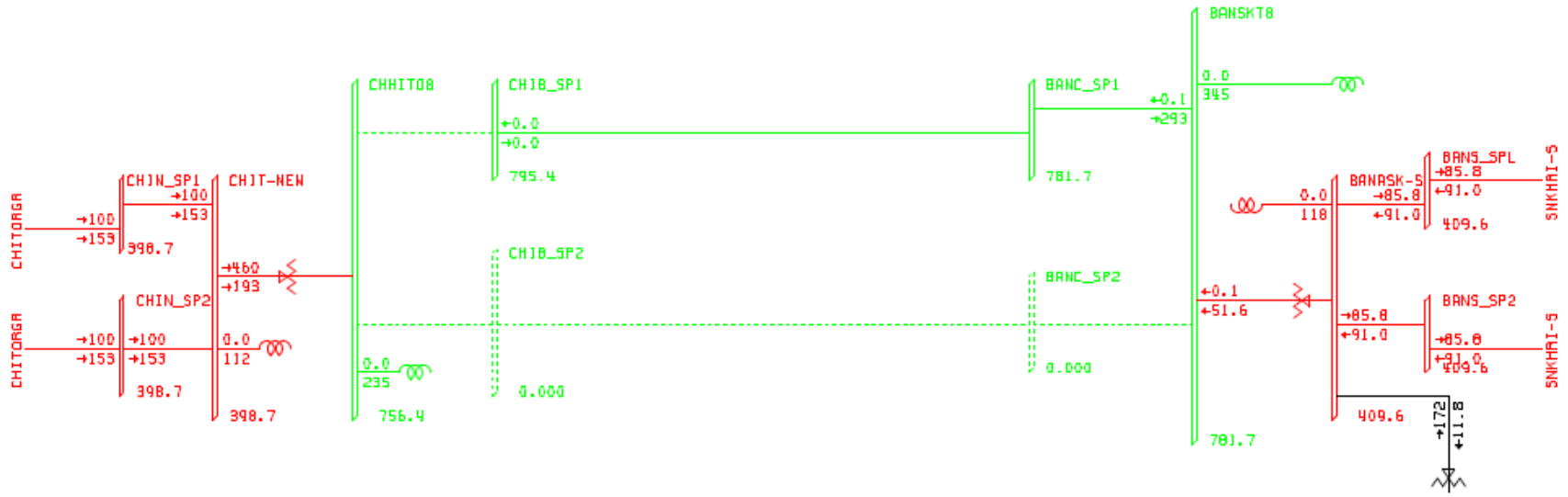
Charging from Banaskanta end (Without line reactor)



Charging from Chittorgarh end (240MVAR line reactor at each end)

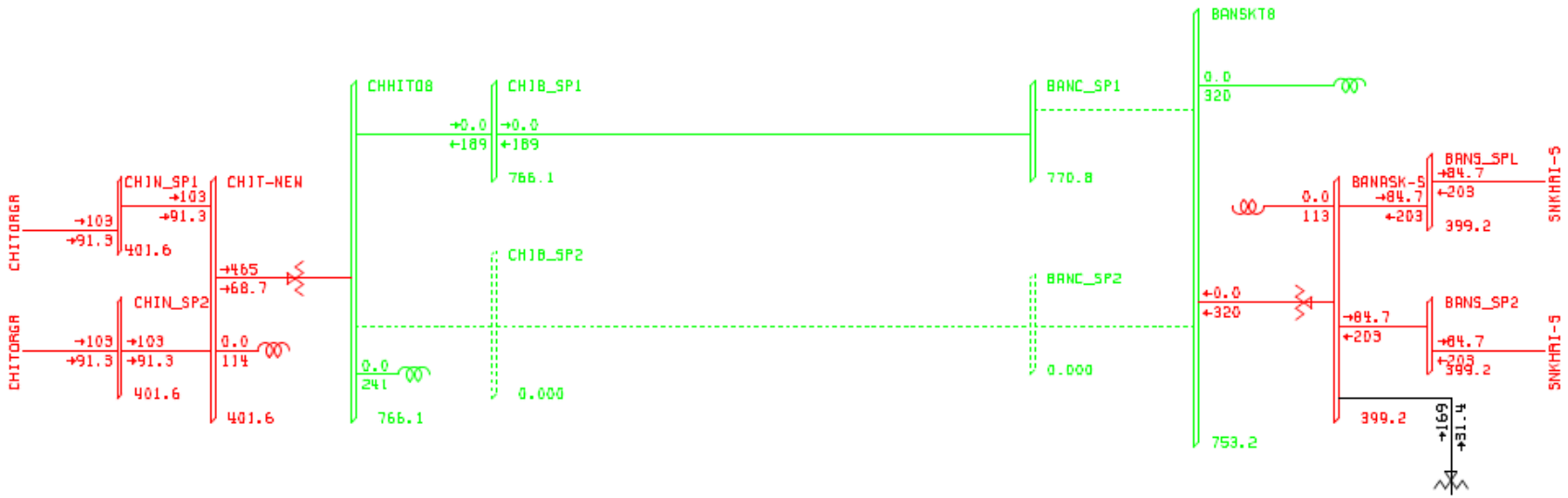


Charging from Banaskanta end (240MVAR line reactor at each end)

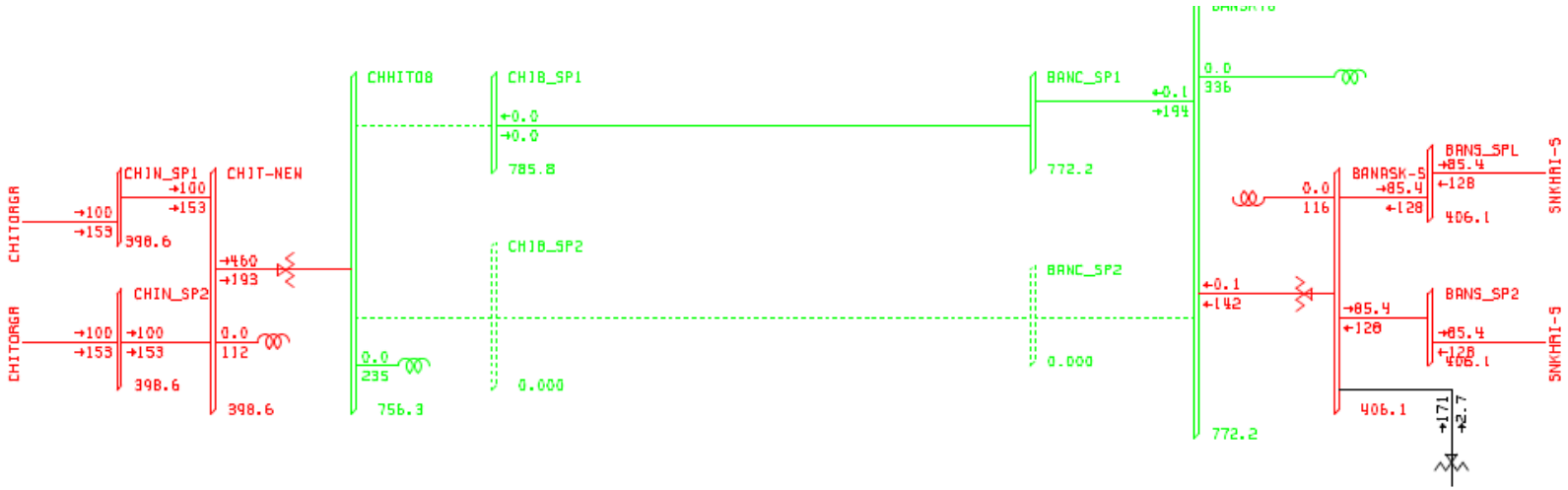


Annexure-A5

Charging from Chittorgarh end (240MVAR line reactor at Chittorgarh & 330MVAR line reactor at Banaskanta end)



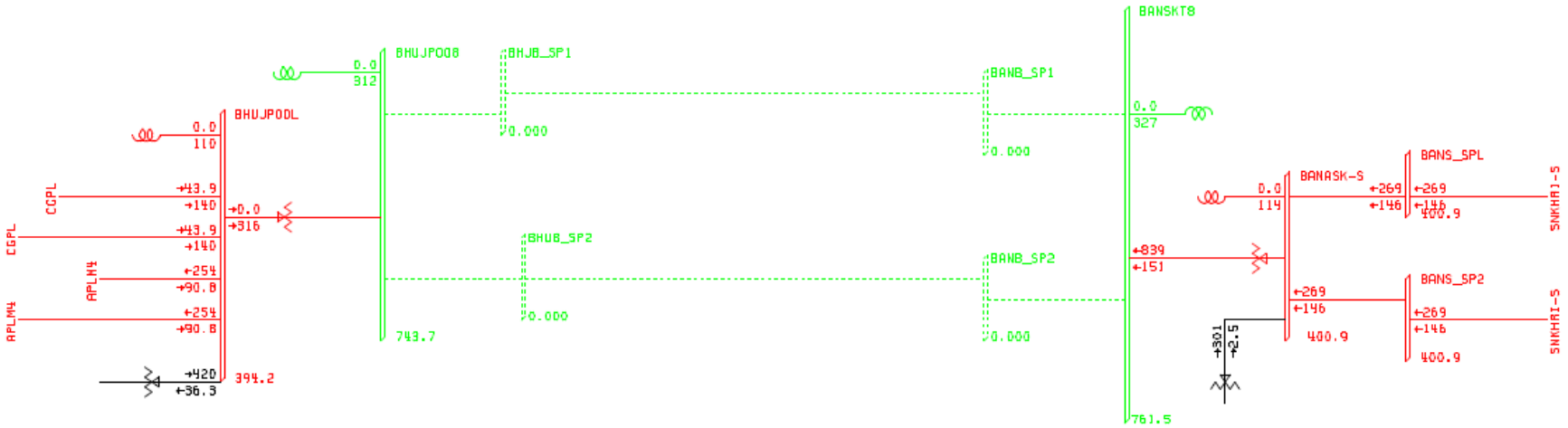
Charging from Banaskanta end (240MVAR line reactor at Chittorgarh & 330MVAR line reactor at Banaskanta end)



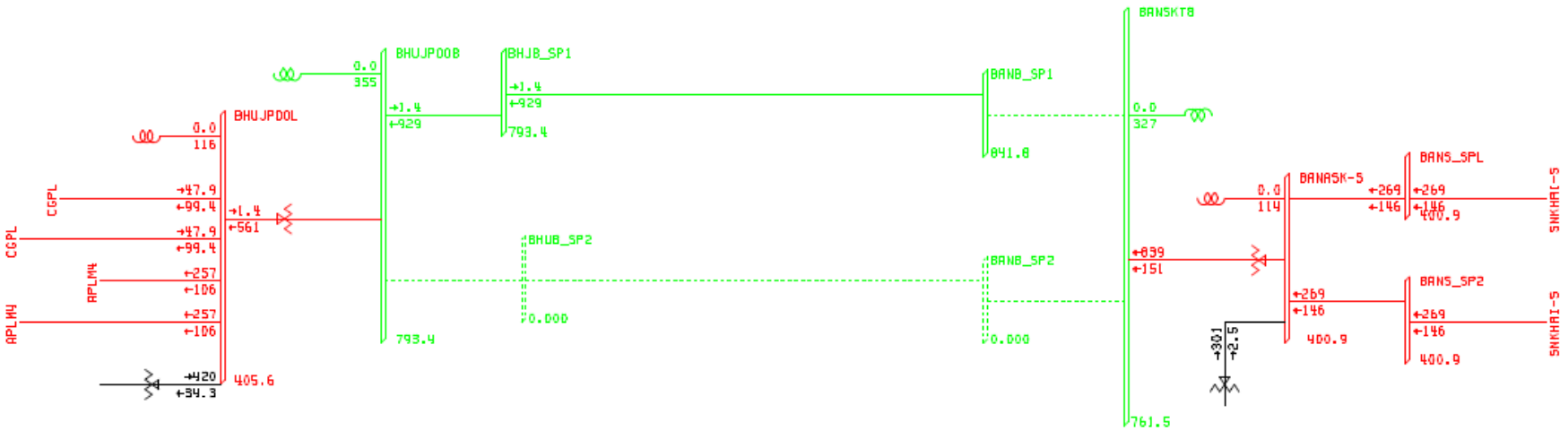
Annexure-A6

Bhuj Pool - Banaskanta 765kV D/c Line

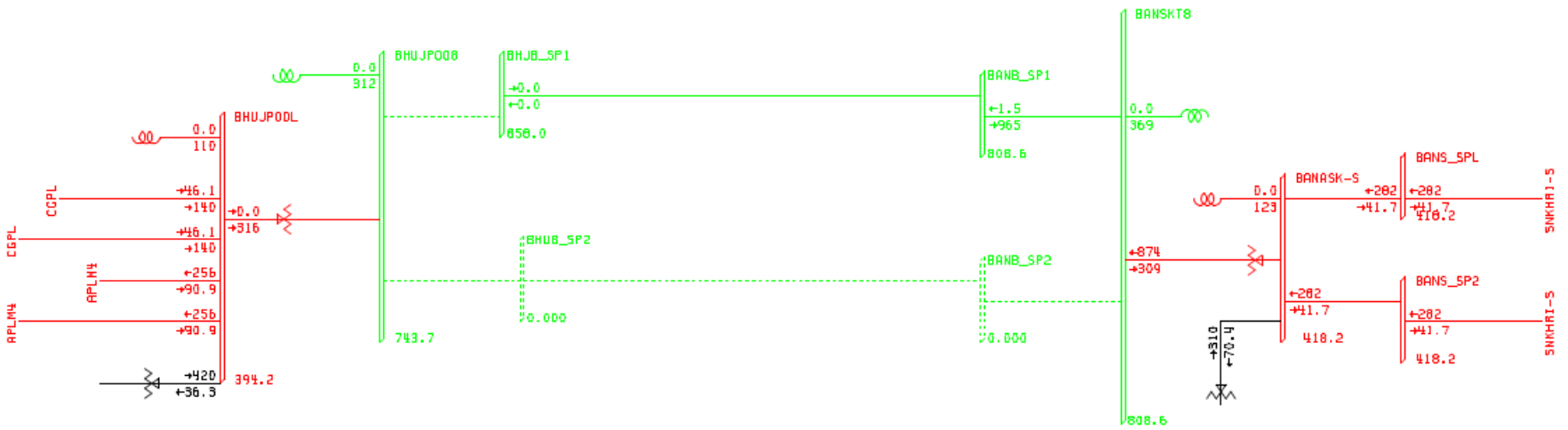
Pre Charging



Charging from Bhuj Pool end (Without line reactor)

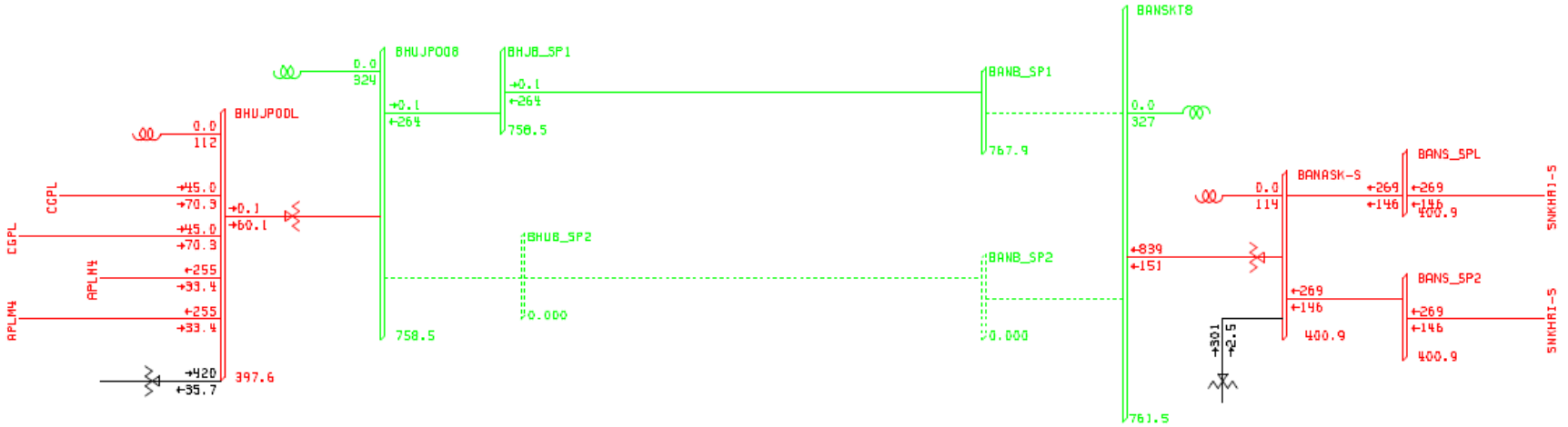


Charging from Banaskanta end (Without line reactor)

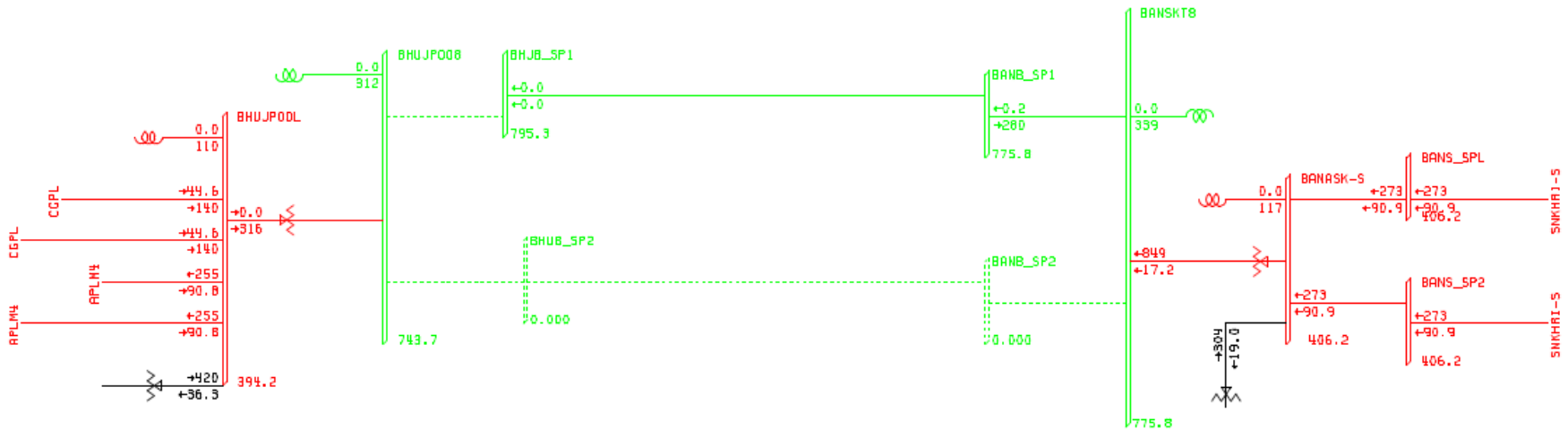


Annexure-A7

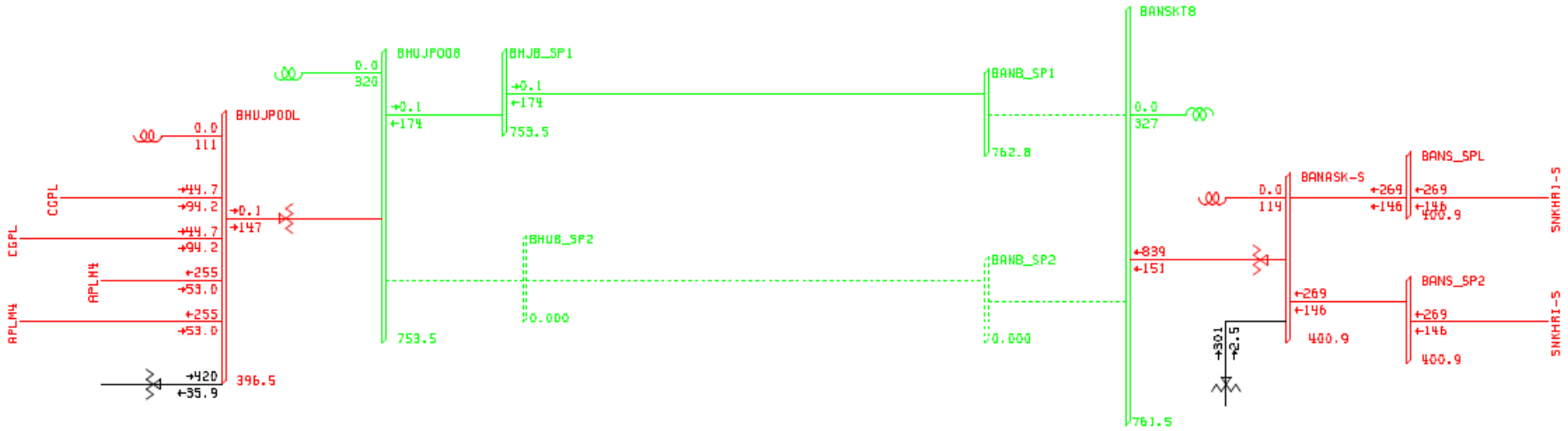
Charging from Bhuj Pool end (240MVAR line reactor at Bhuj Pool & 330MVAR line reactor at Banaskanta end)



Charging from Banaskanta end (240MVAR line reactor at Bhuj Pool & 330MVAR line reactor at Banaskanta end)



Charging from Bhuj Pool end (330MVAR line reactor at each end)



Charging from Banaskanta end (330MVAR line reactor at each end)

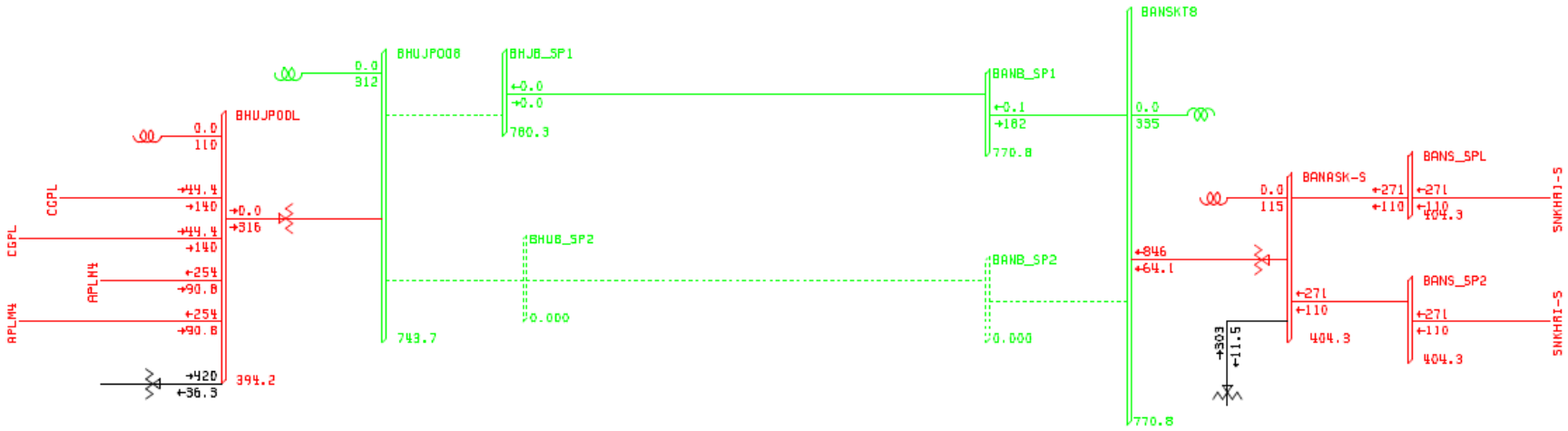
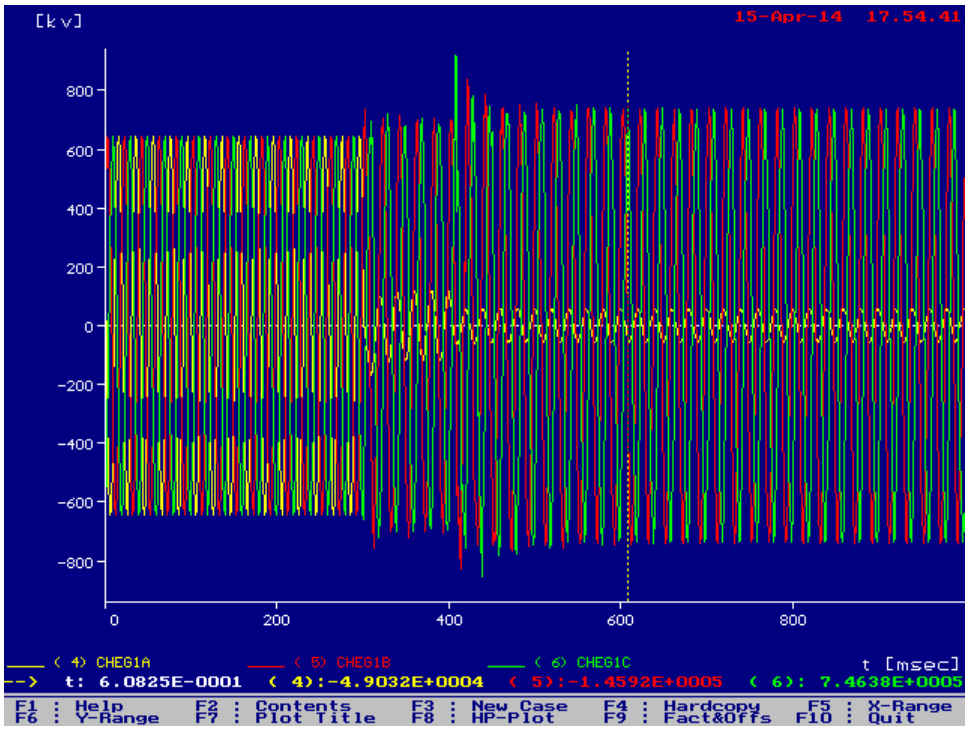


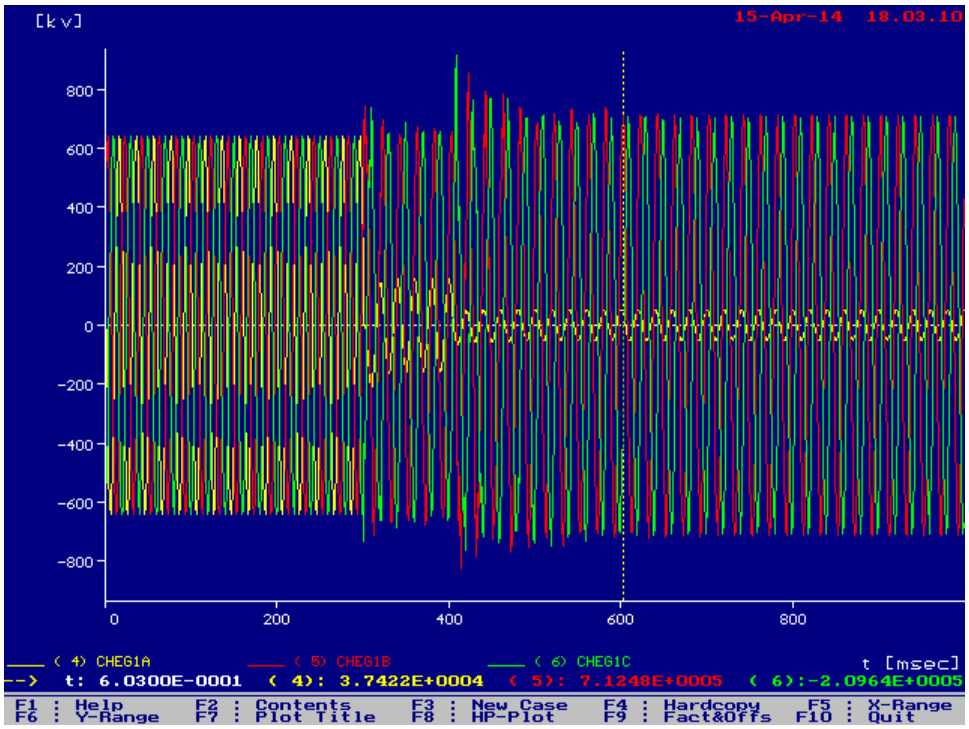
Exhibit -I

Temporary Over Voltage Study for 765kv Chittorgarh – Ajmer D/c line

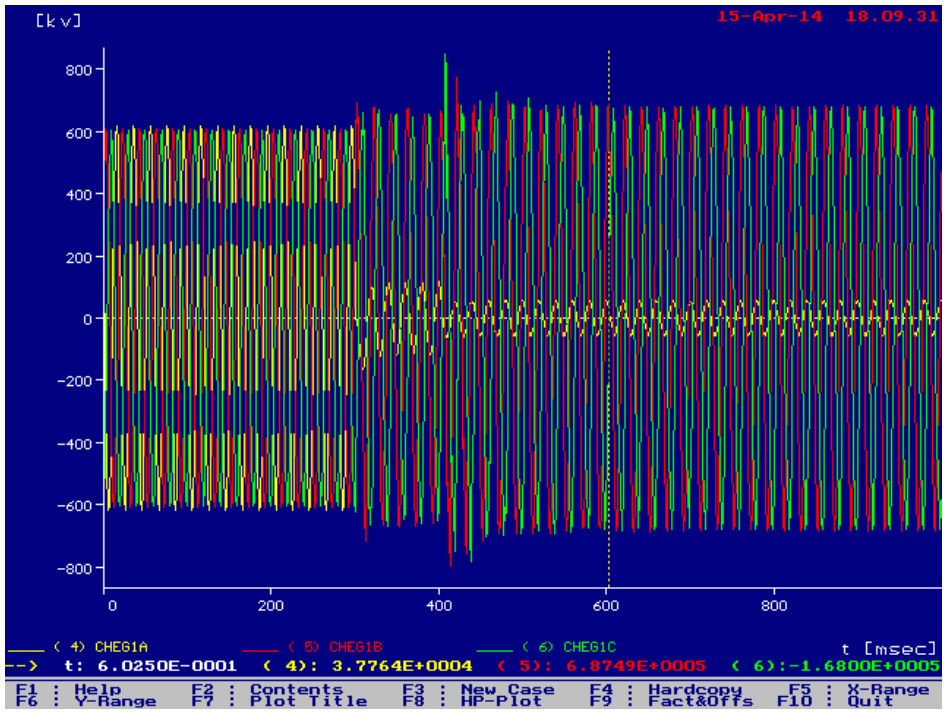
Case-1: Opening at Ajmer end (No line Reactor at either end)



Case-2: Opening at Chittorgarh end (No line Reactor at either end)



Case-3: Opening at Ajmer end (1x240 MVAR line Reactor at each end)



Case-4: Opening at Chittorgarh end (1x240 MVAR line Reactor at each end)

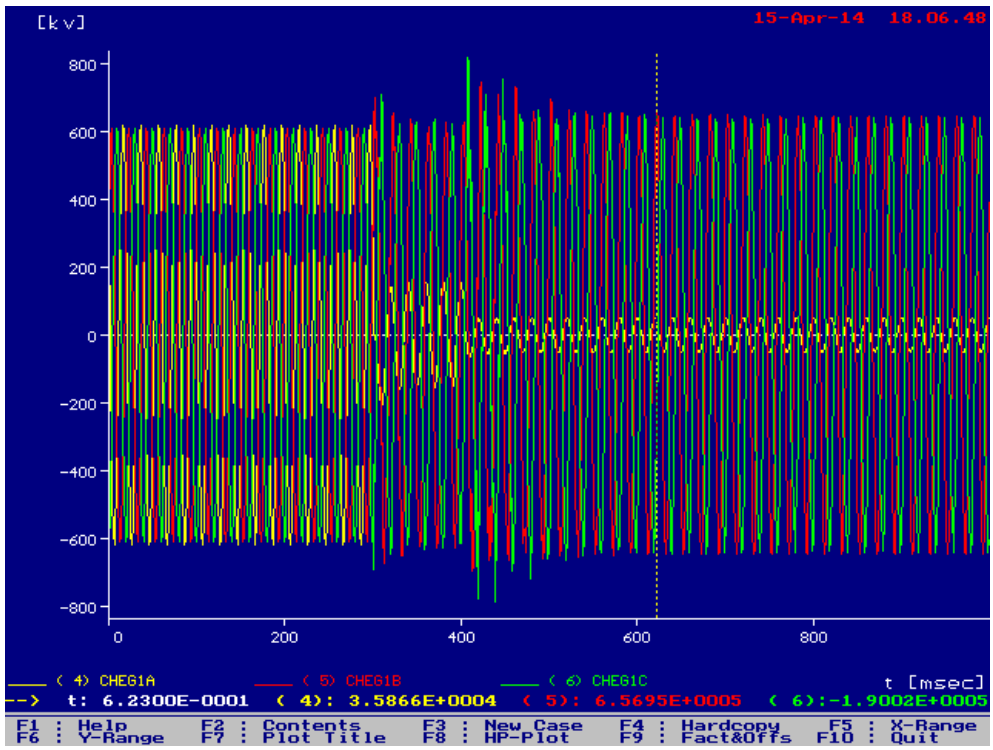
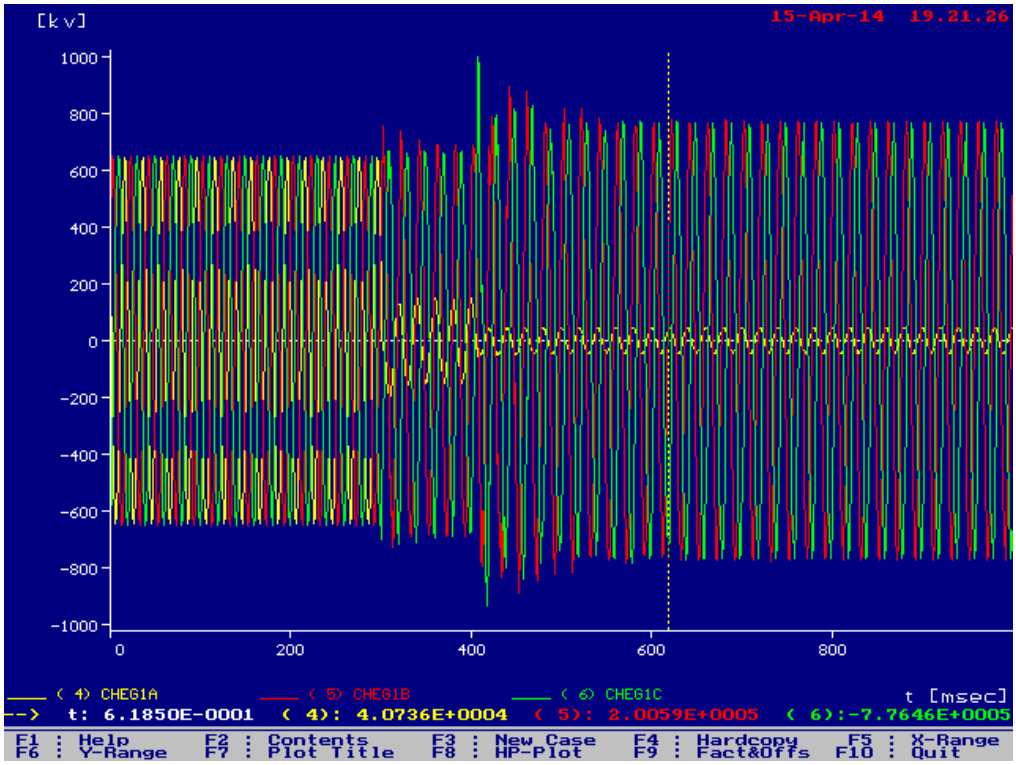


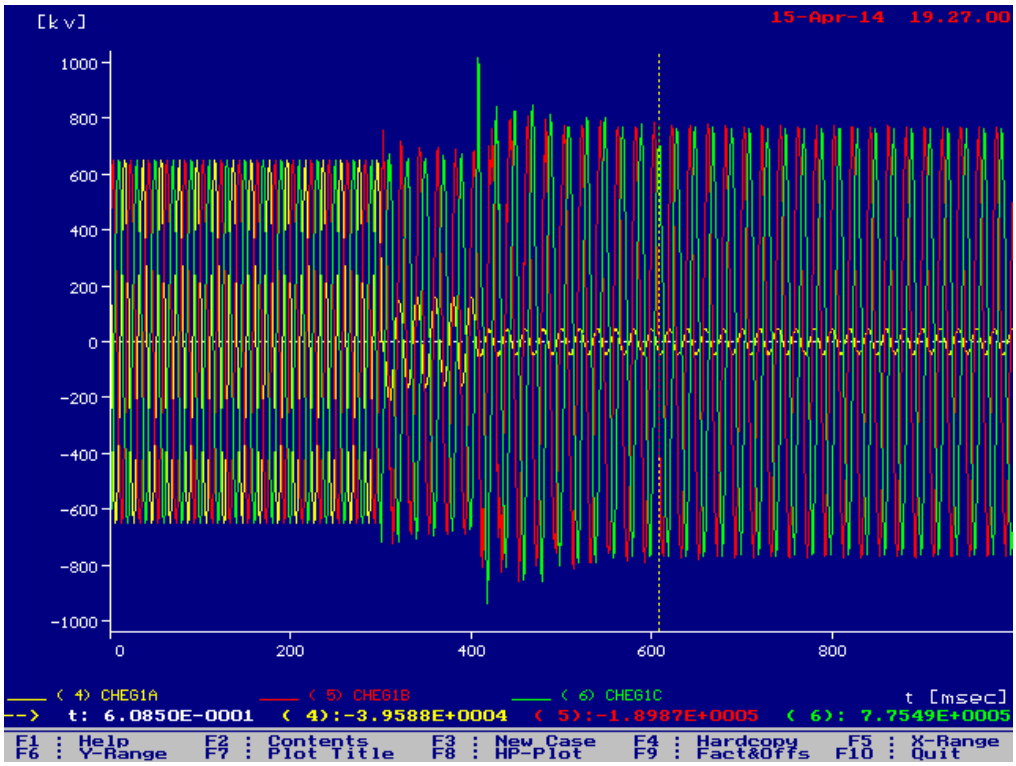
Exhibit -II

Temporary Over Voltage Study for 765kv Chittorgarh – Banaskanta D/c line

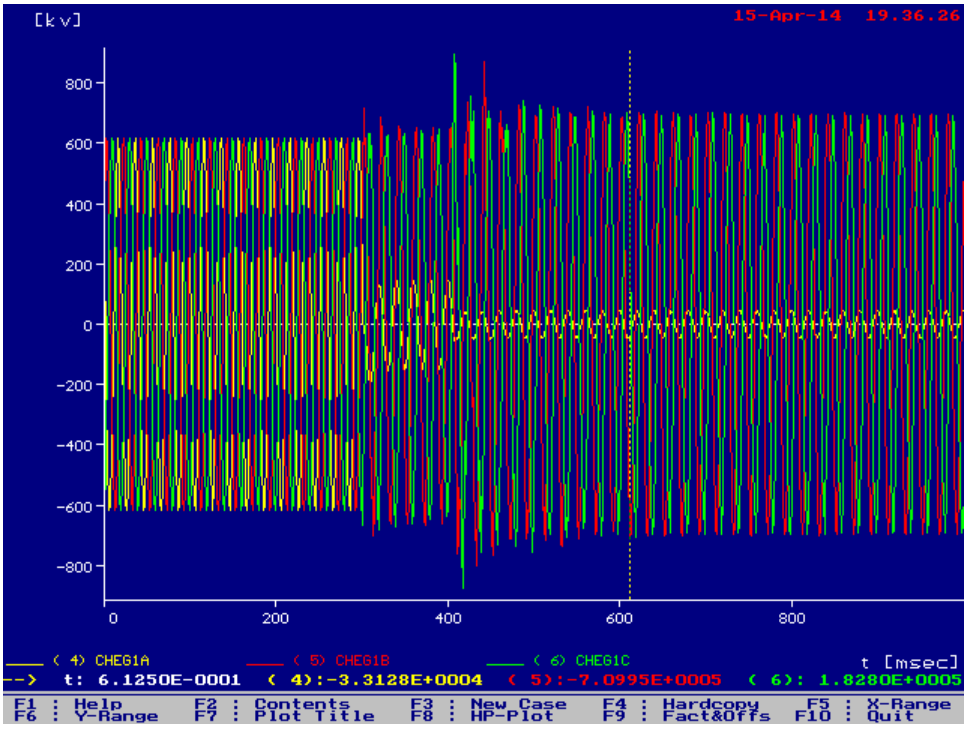
Case-1: Opening at Chittorgarh end (No line Reactor at either end)



Case-2: Opening at Banaskanta end (No line Reactor at either end)



Case-3: Opening at Chittorgarh end (1x330MVAR line reactor at Banaskanta end & 1x240MVAR line reactor at Chittorgarh end)



Case-3: Opening at Banaskanta end (1x330MVAR line reactor at Banaskanta end & 1x240MVAR line reactor at Chittorgarh end)

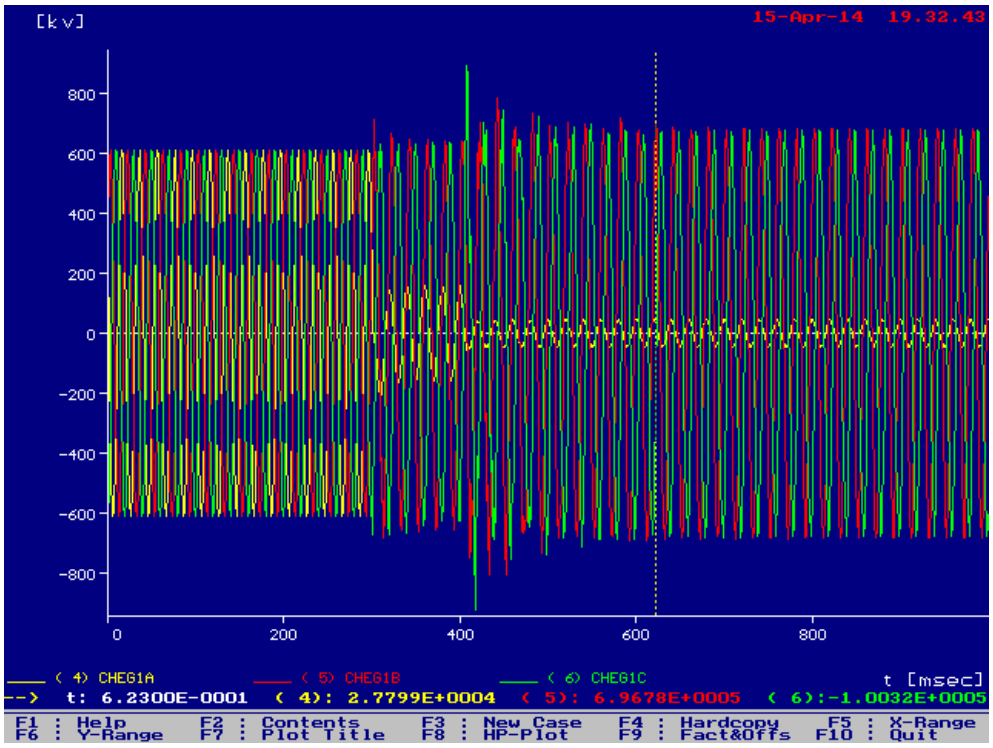
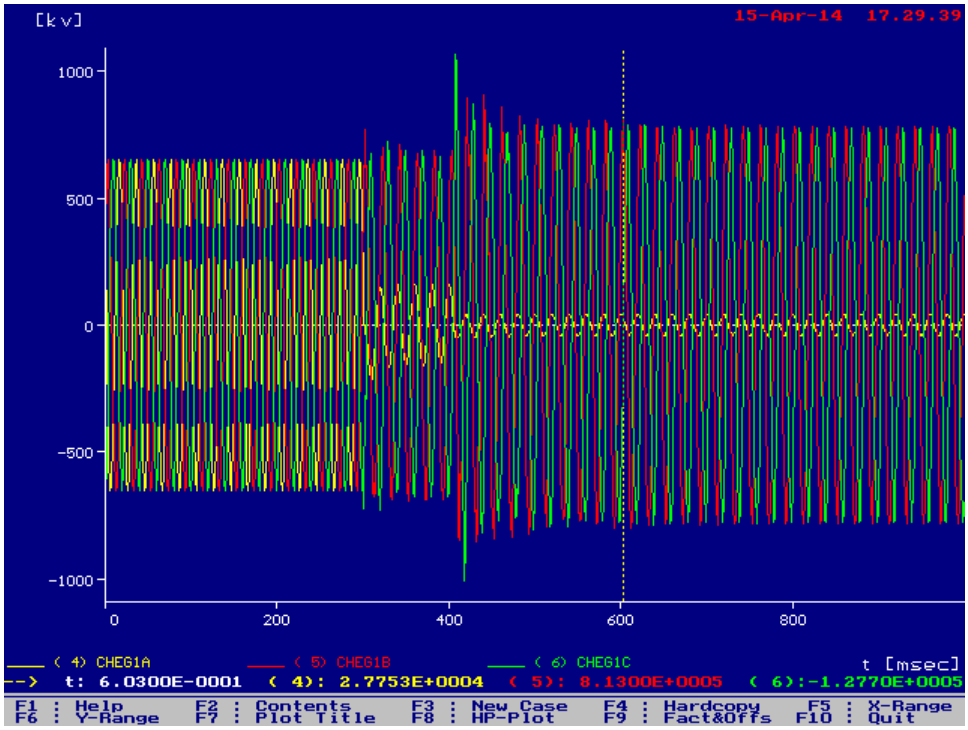


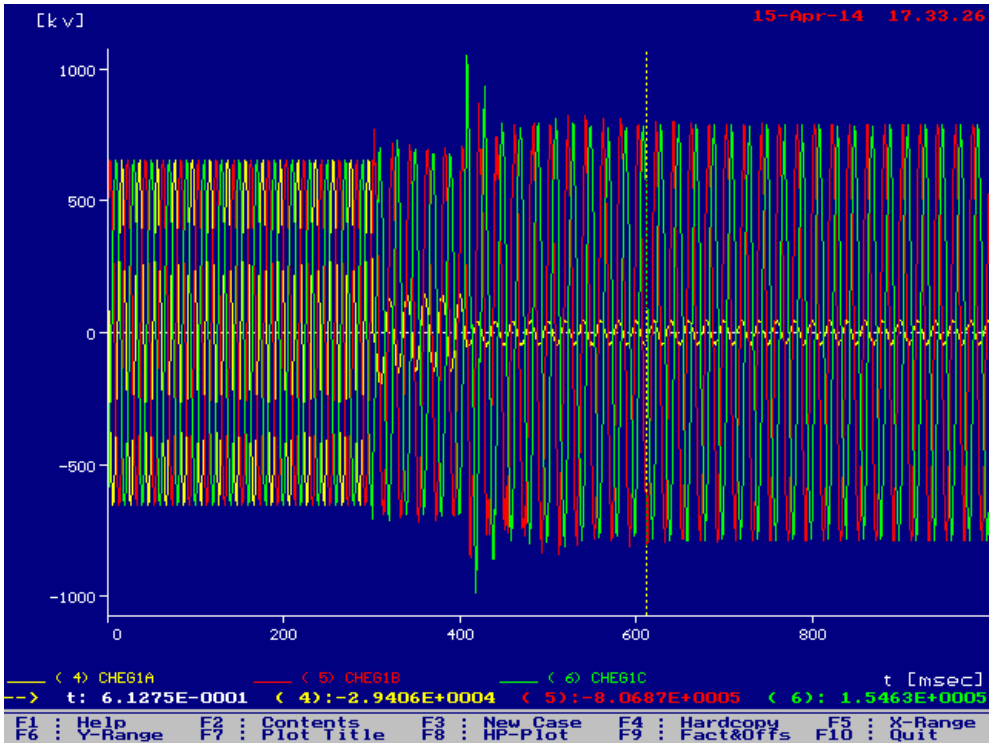
Exhibit -III

Temporary Over Voltage Study for 765kV Bhuj Pool – Banaskanta D/c line

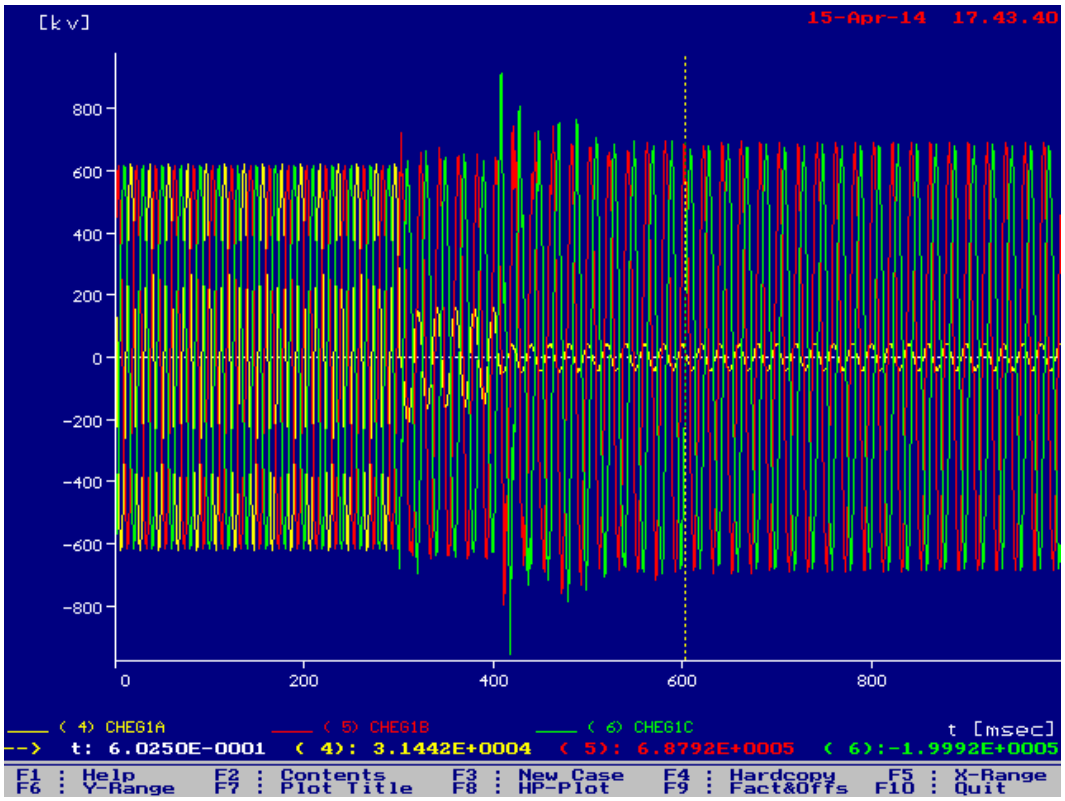
Case-1: Opening at Banaskanta end (No line Reactor at either end)



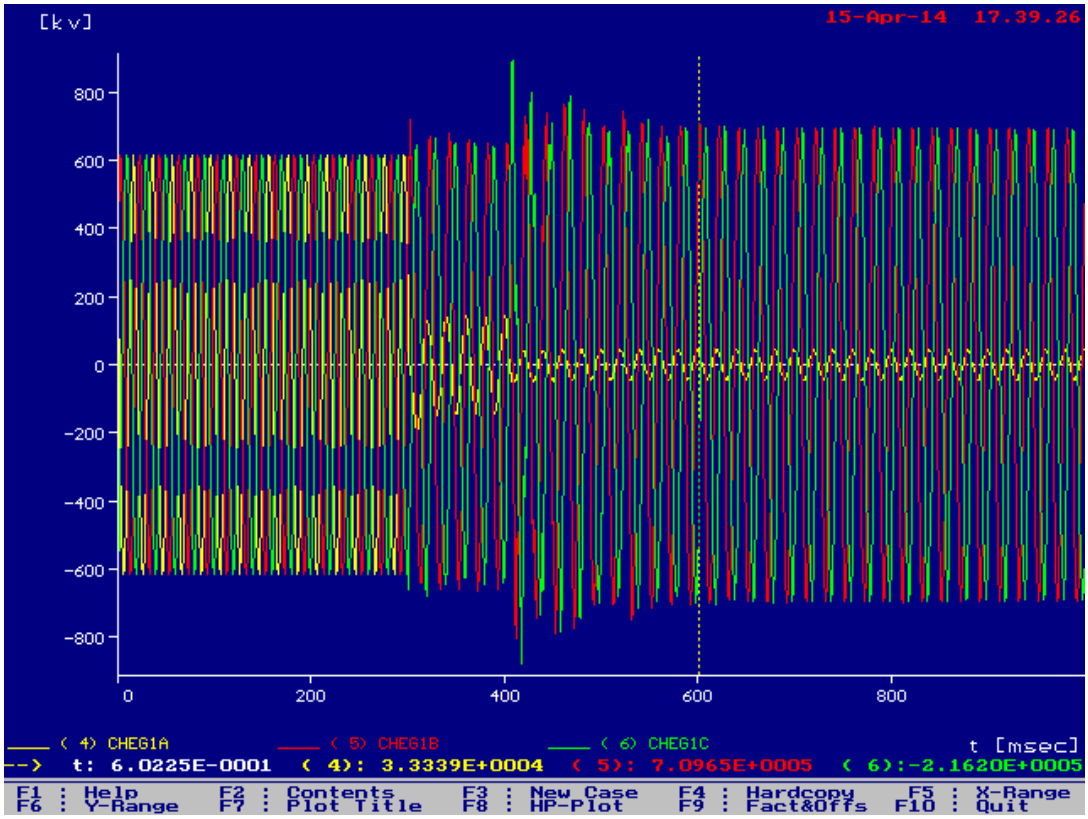
Case-2: Opening at Bhuj Pool end (No line Reactor at either end)



Case-3: Opening at Banaskanta end (1x330 MVAR line Reactor at each end)



Case-4 Opening at Bhuj Pool end (1x330 MVAR line Reactor at each end)



ANNEXURE-7

Exhibit - 1.0

SYSTEM STUDIES : Southern Region 2018-19

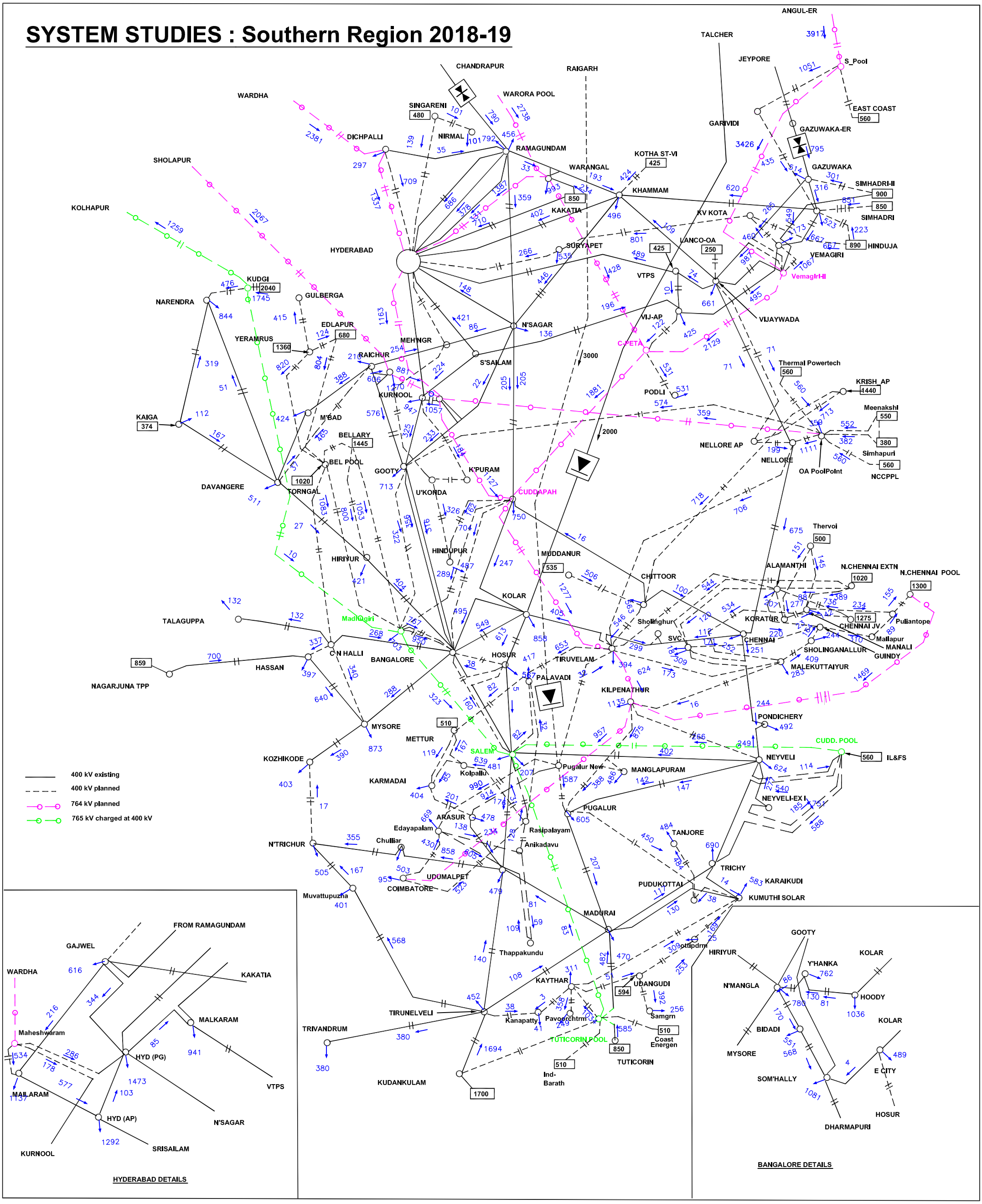


Exhibit - 2.1

SYSTEM STUDIES : Southern Region 2018-19

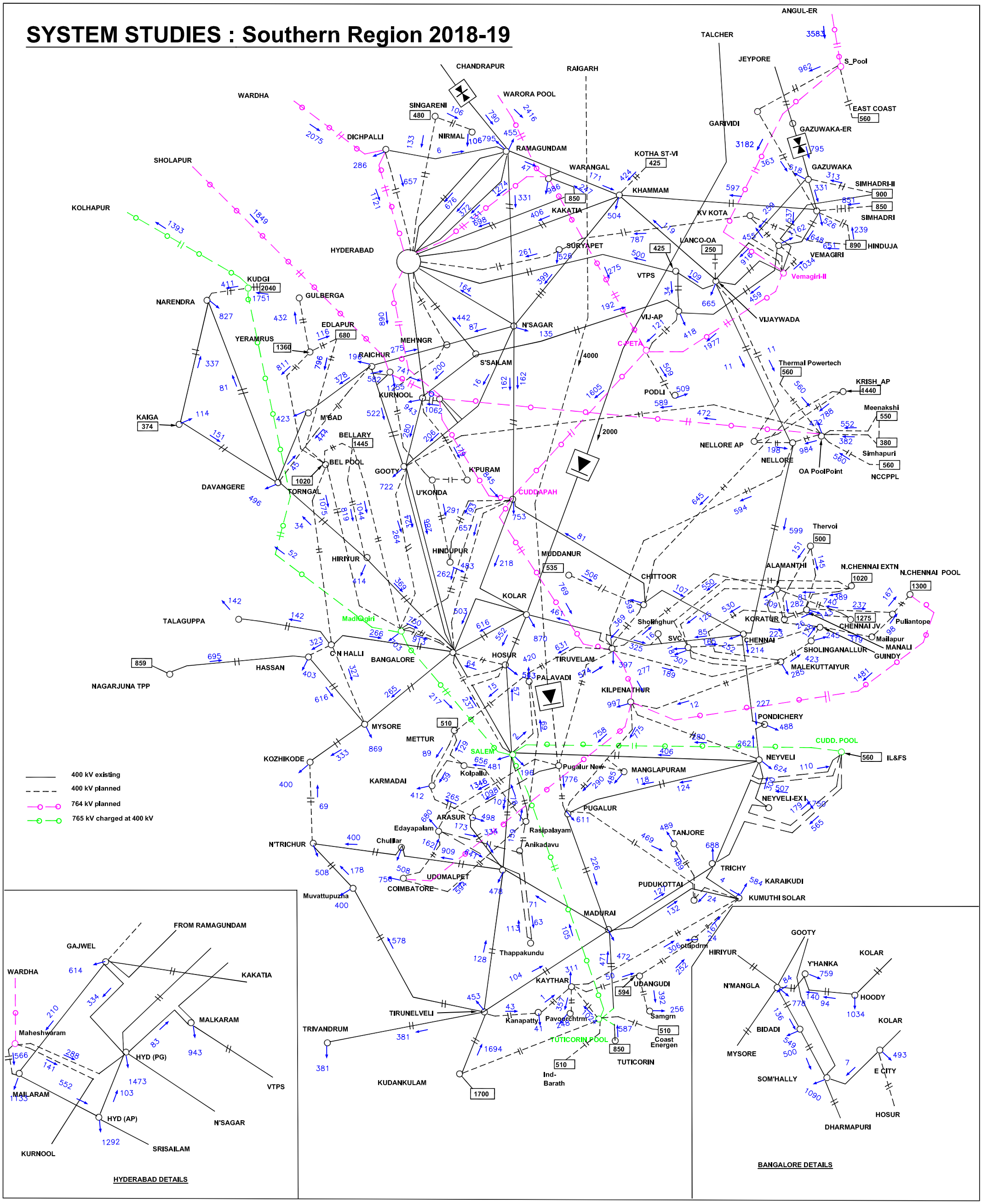
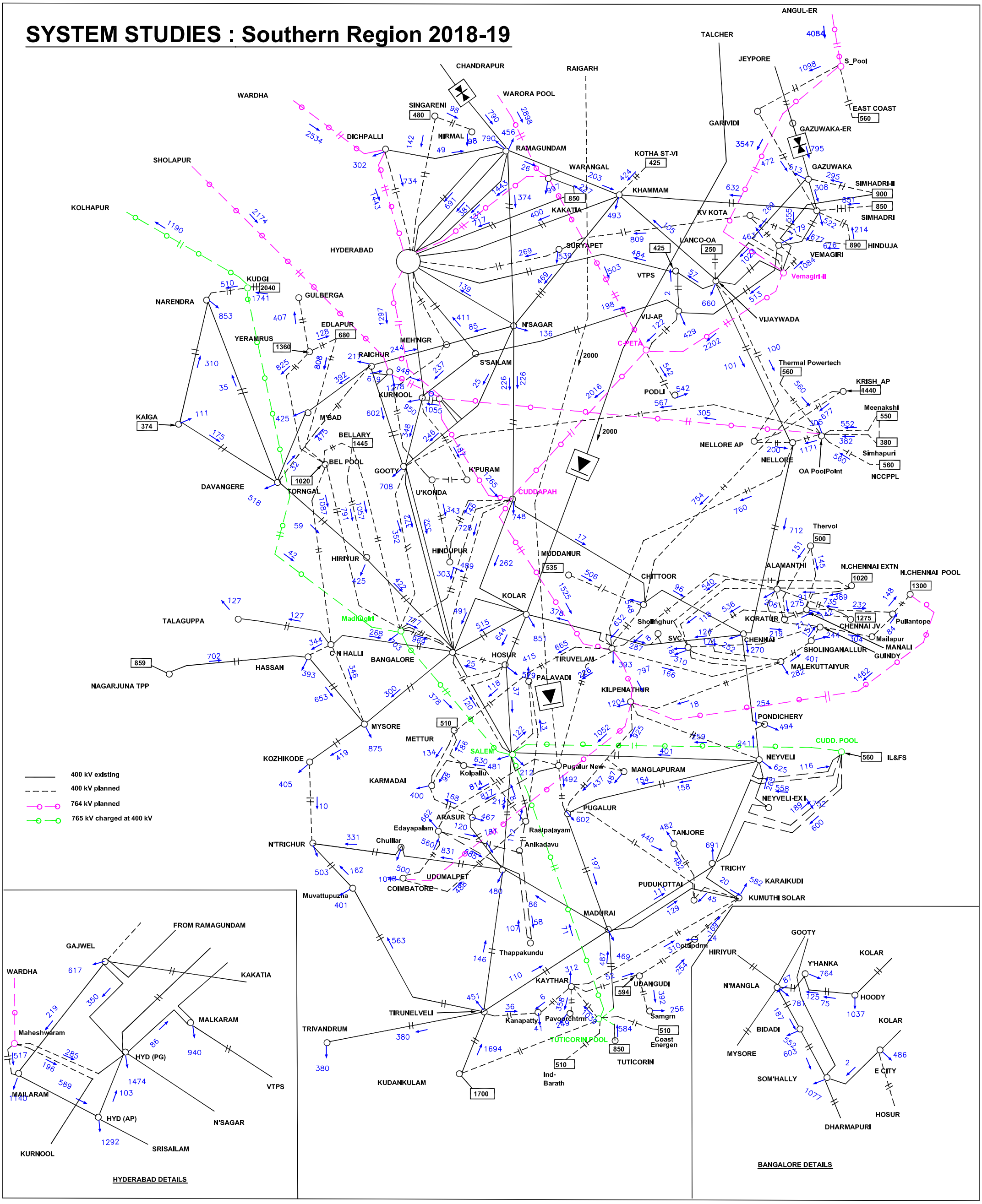


Exhibit - 2.2

SYSTEM STUDIES : Southern Region 2018-19



HYDERABAD DETAILS

BANGALORE DETAILS

Exhibit - 2.3

SYSTEM STUDIES : Southern Region 2018-19

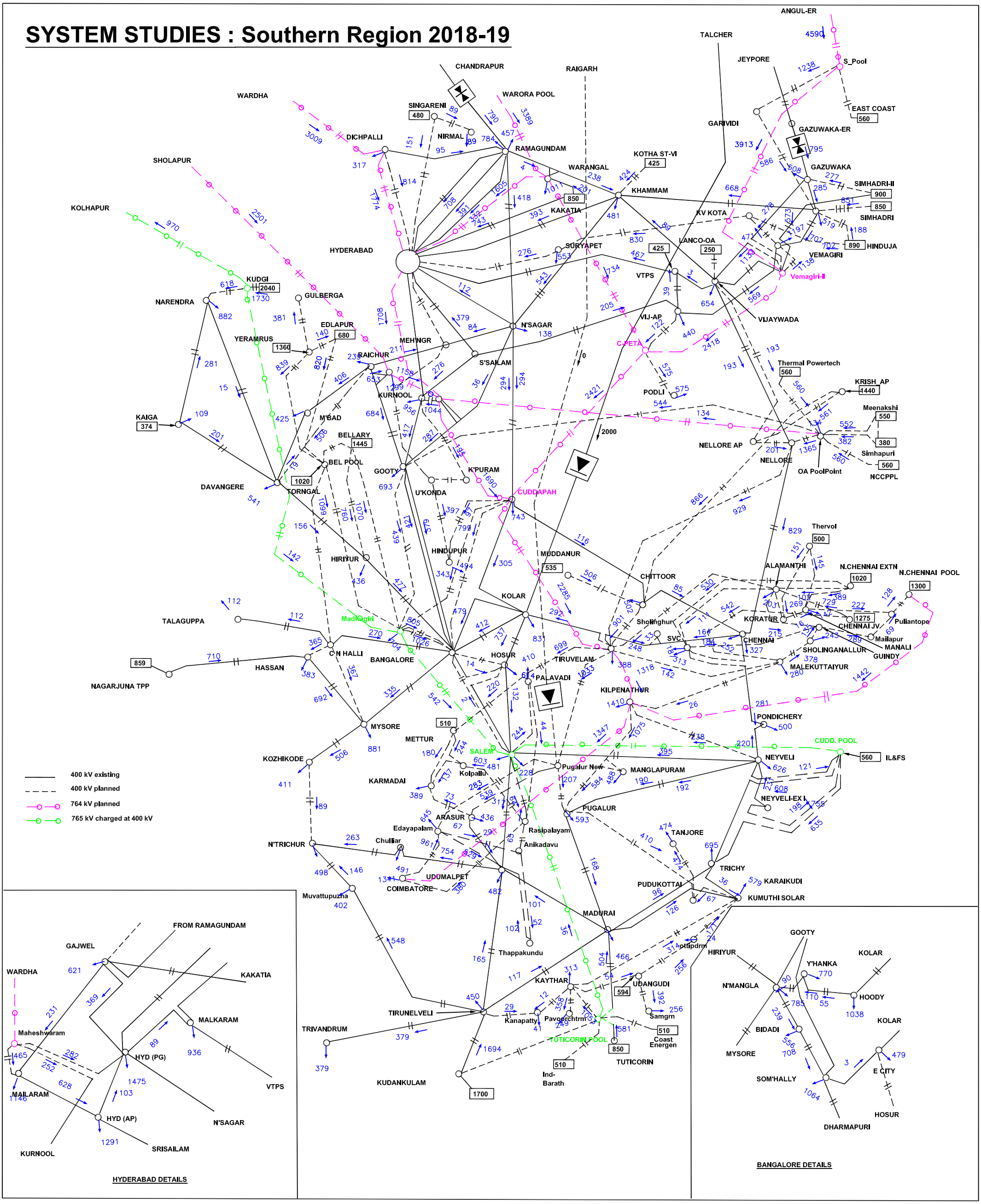


Exhibit - 2.4

SYSTEM STUDIES : Southern Region 2018-19

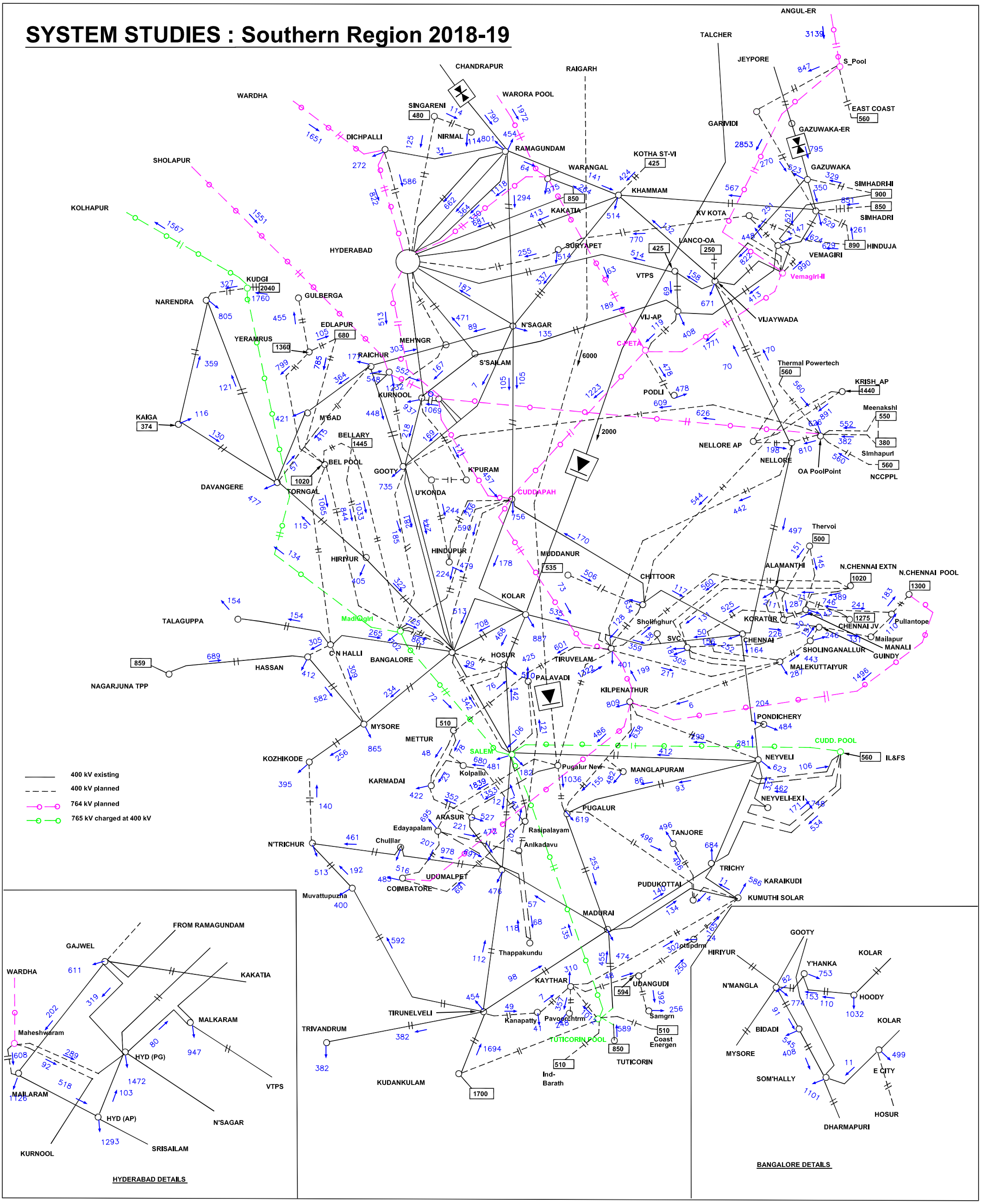


Exhibit - 3.1

SYSTEM STUDIES : Southern Region 2018-19

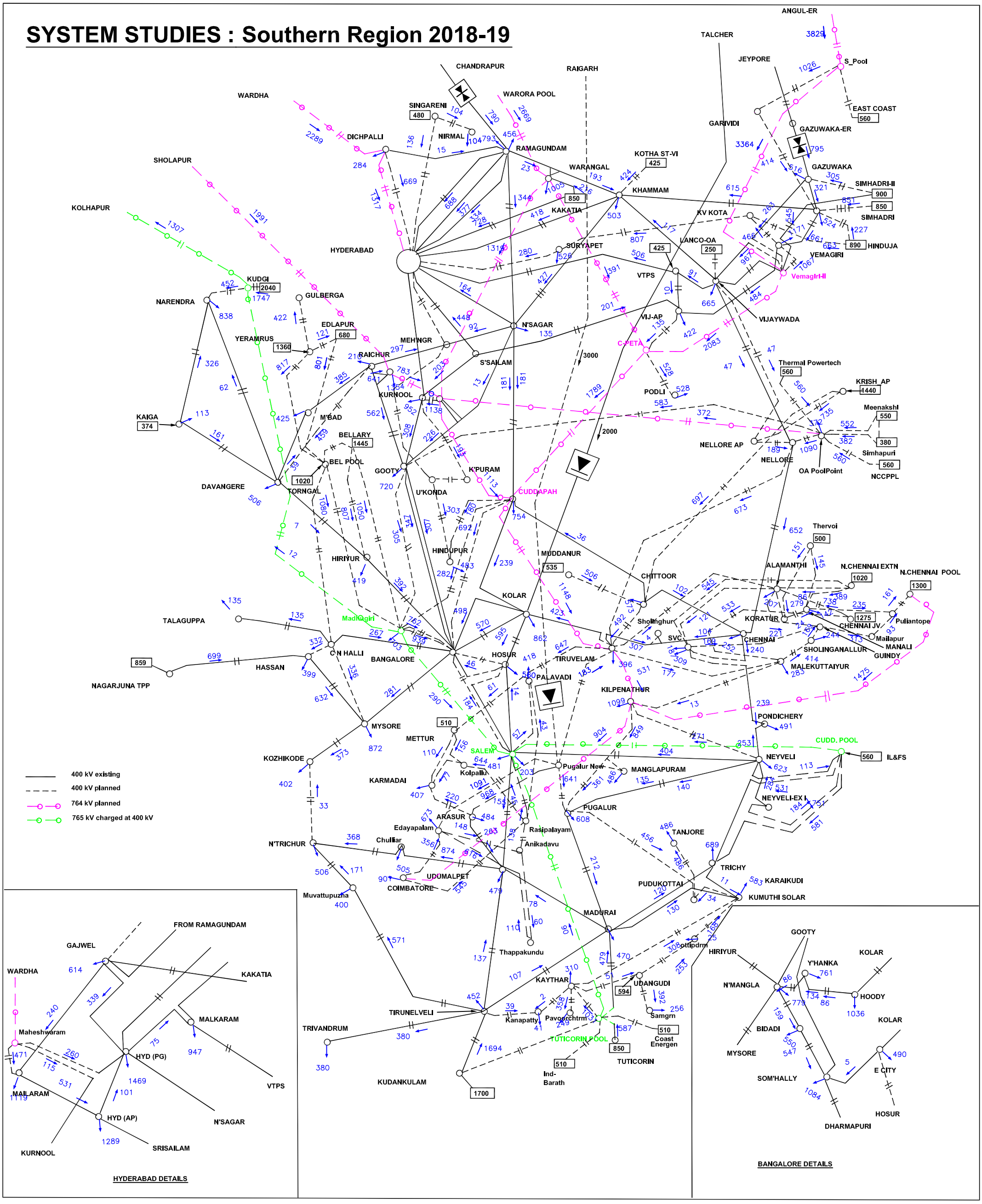


Exhibit - 3.2

SYSTEM STUDIES : Southern Region 2018-19

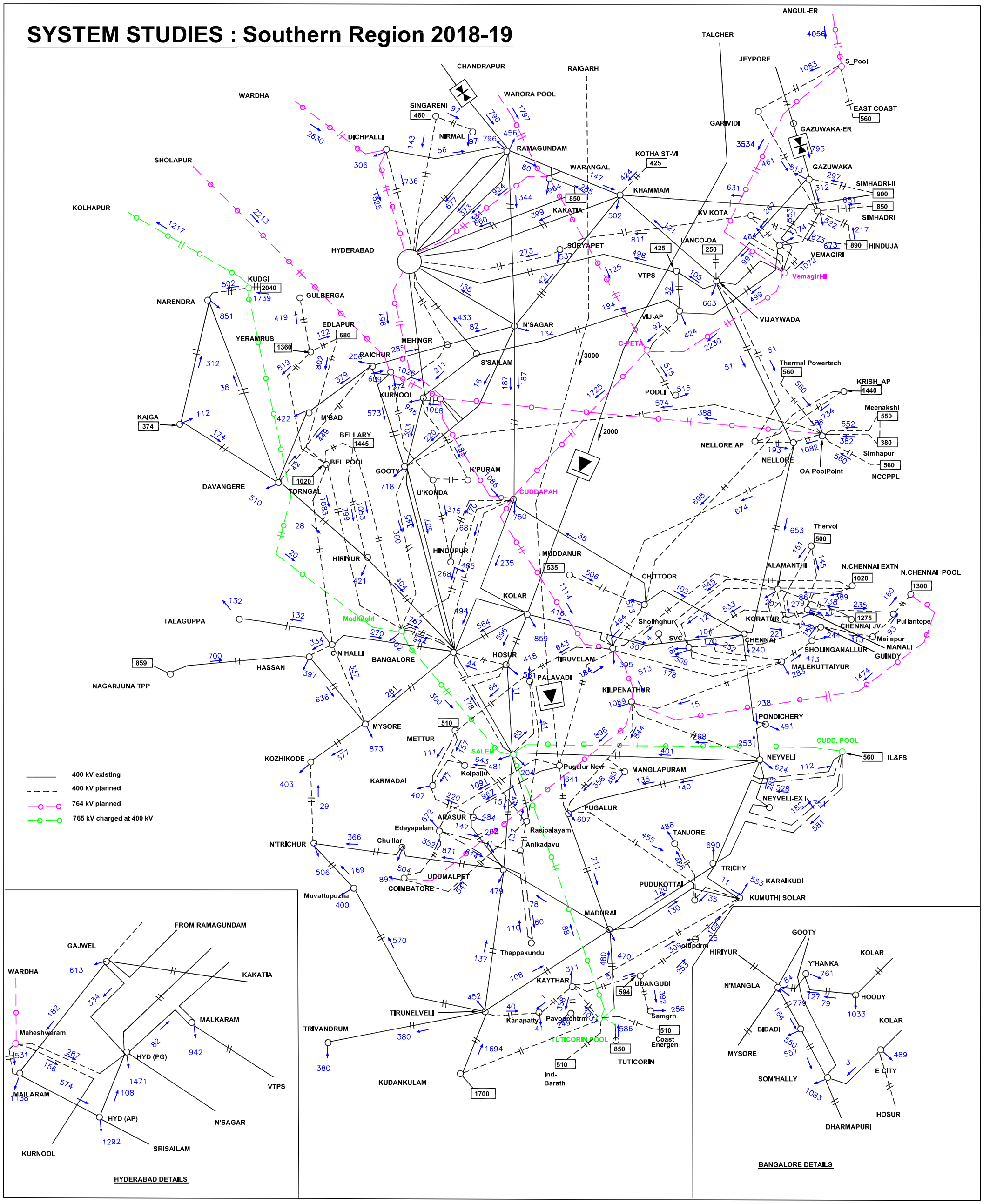
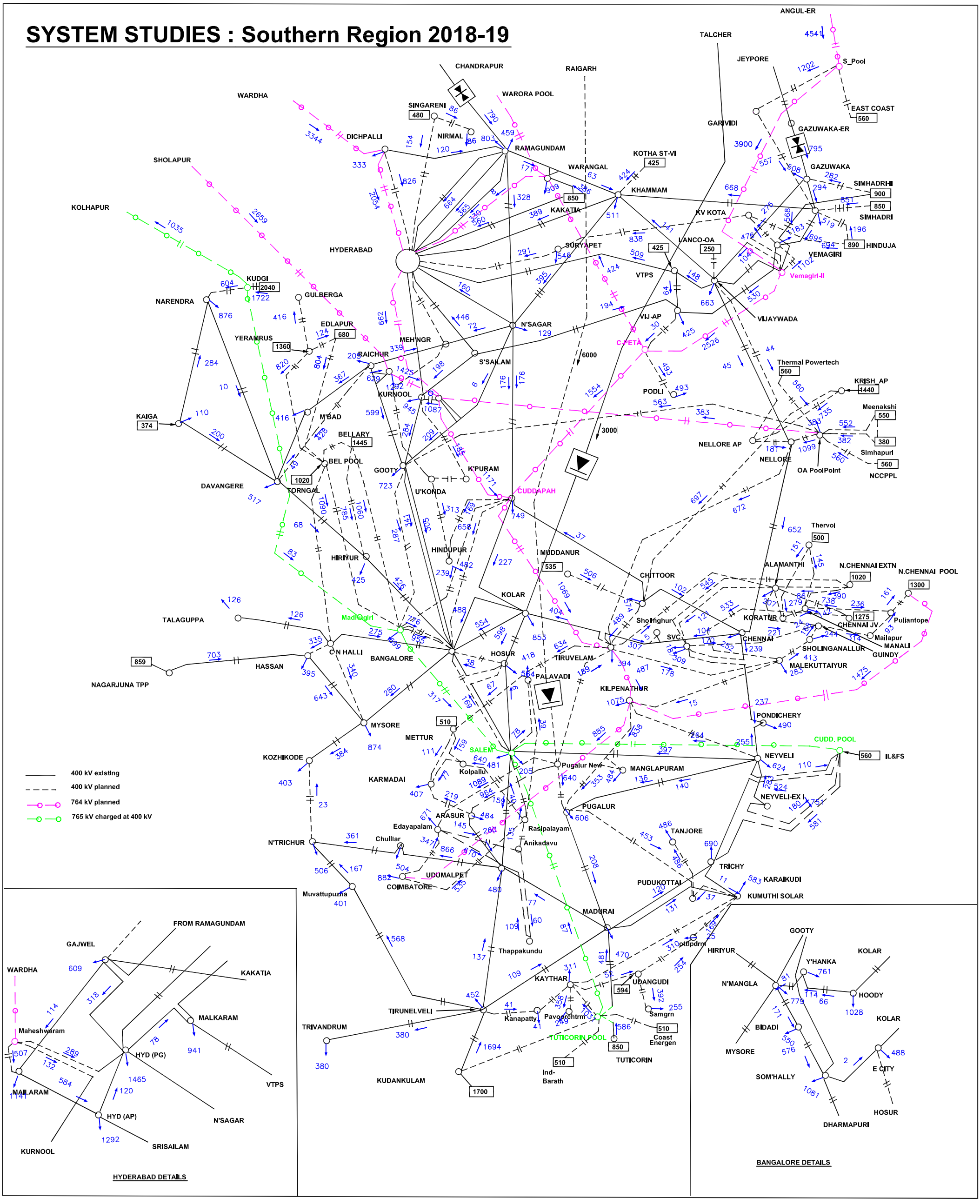


Exhibit - 3.3

SYSTEM STUDIES : Southern Region 2018-19



HYDERABAD DETAILS

BANGALORE DETAILS

Exhibit - 4.1

SYSTEM STUDIES : Southern Region 2018-19

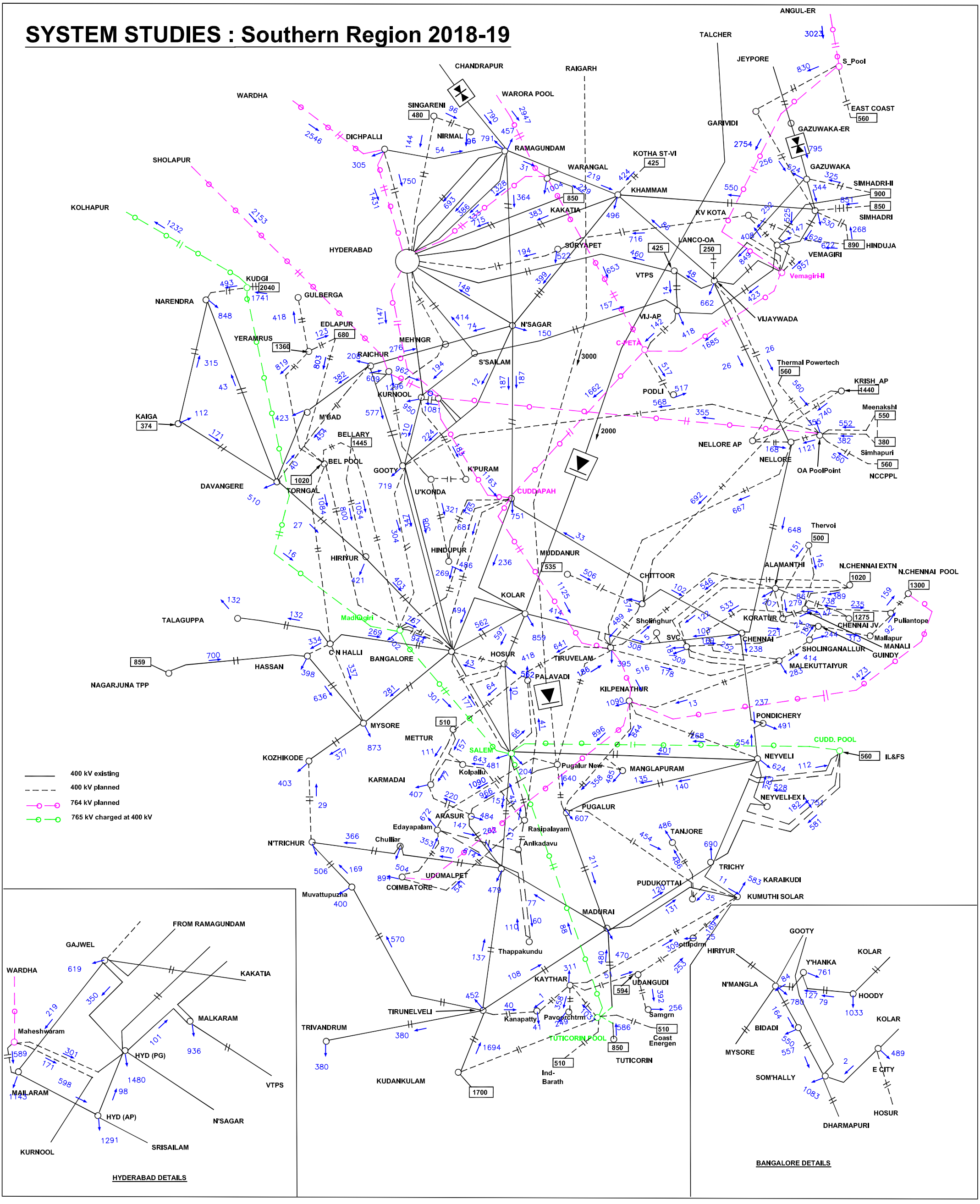
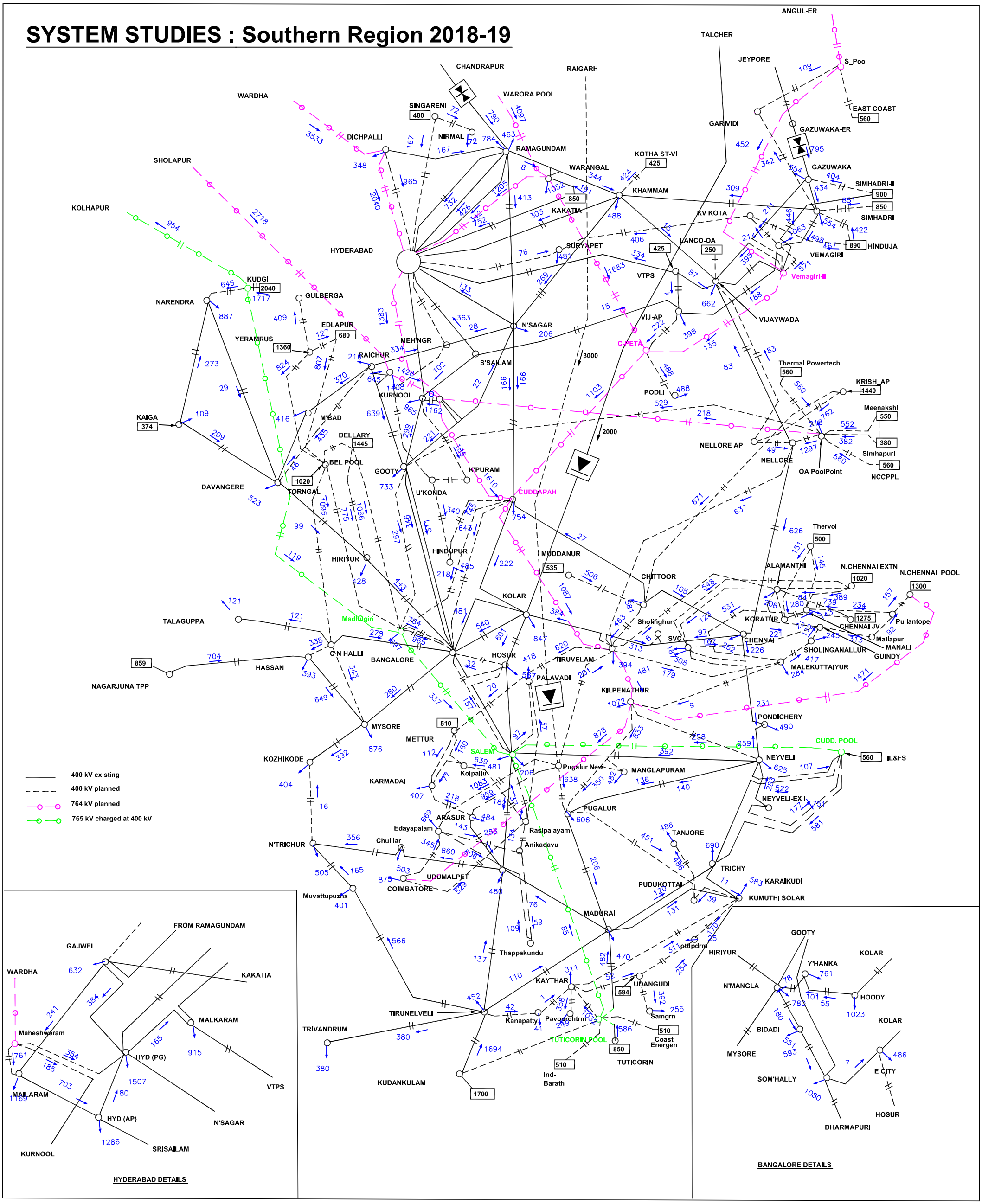


Exhibit - 4.2

SYSTEM STUDIES : Southern Region 2018-19



HYDERABAD DETAILS

BANGALORE DETAILS

Exhibit - 4.3

SYSTEM STUDIES : Southern Region 2018-19

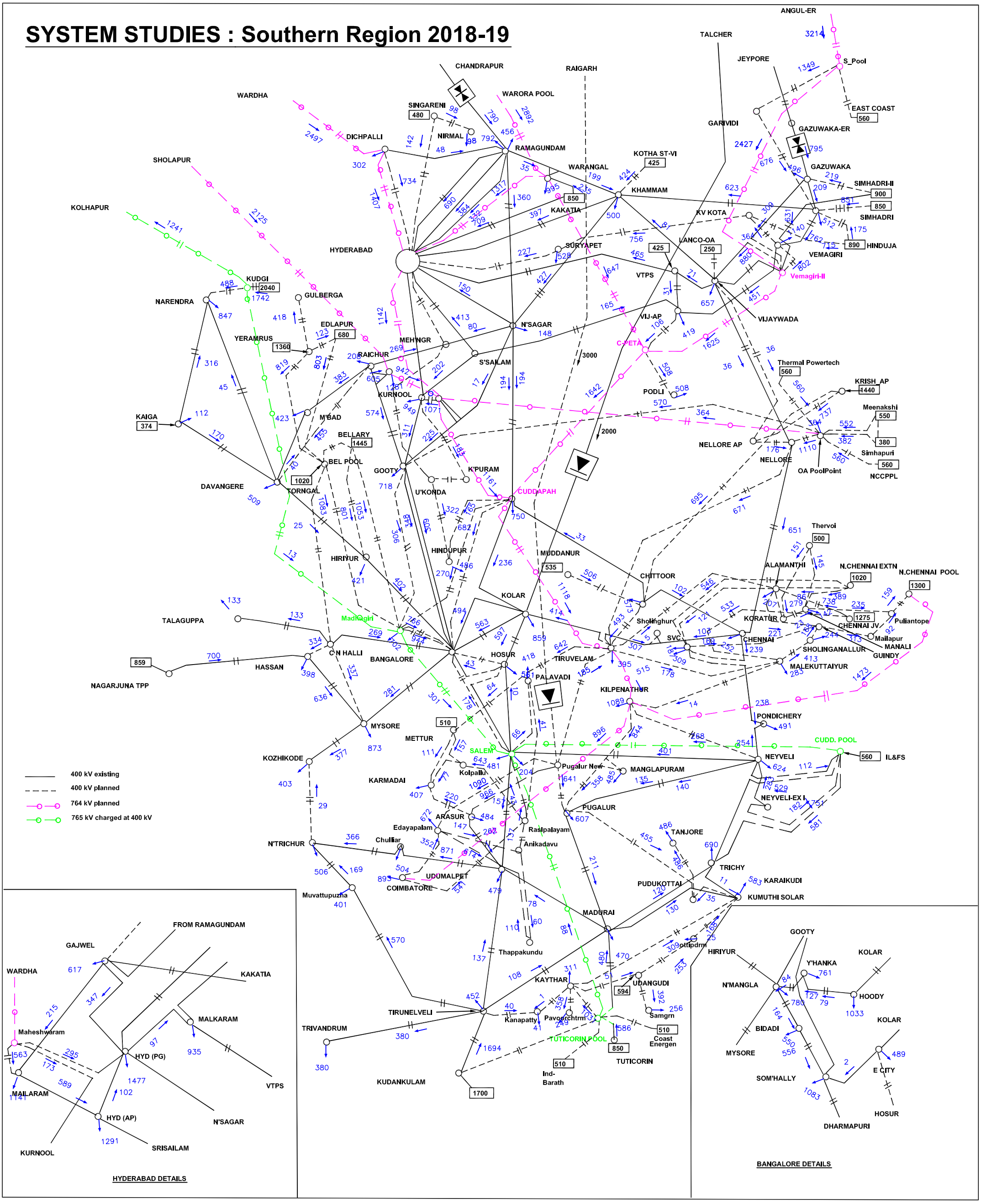


Exhibit - 4.4

SYSTEM STUDIES : Southern Region 2018-19

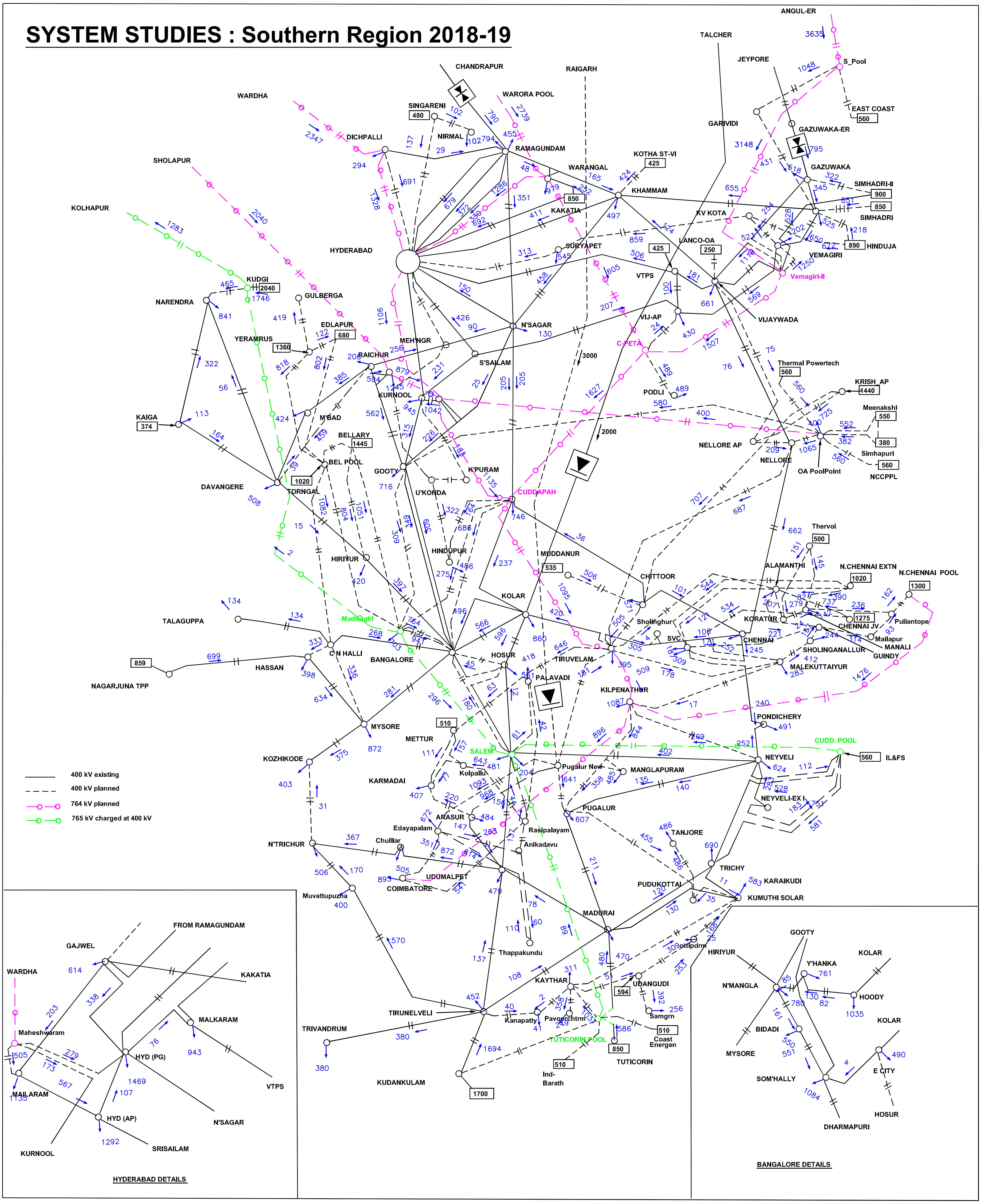
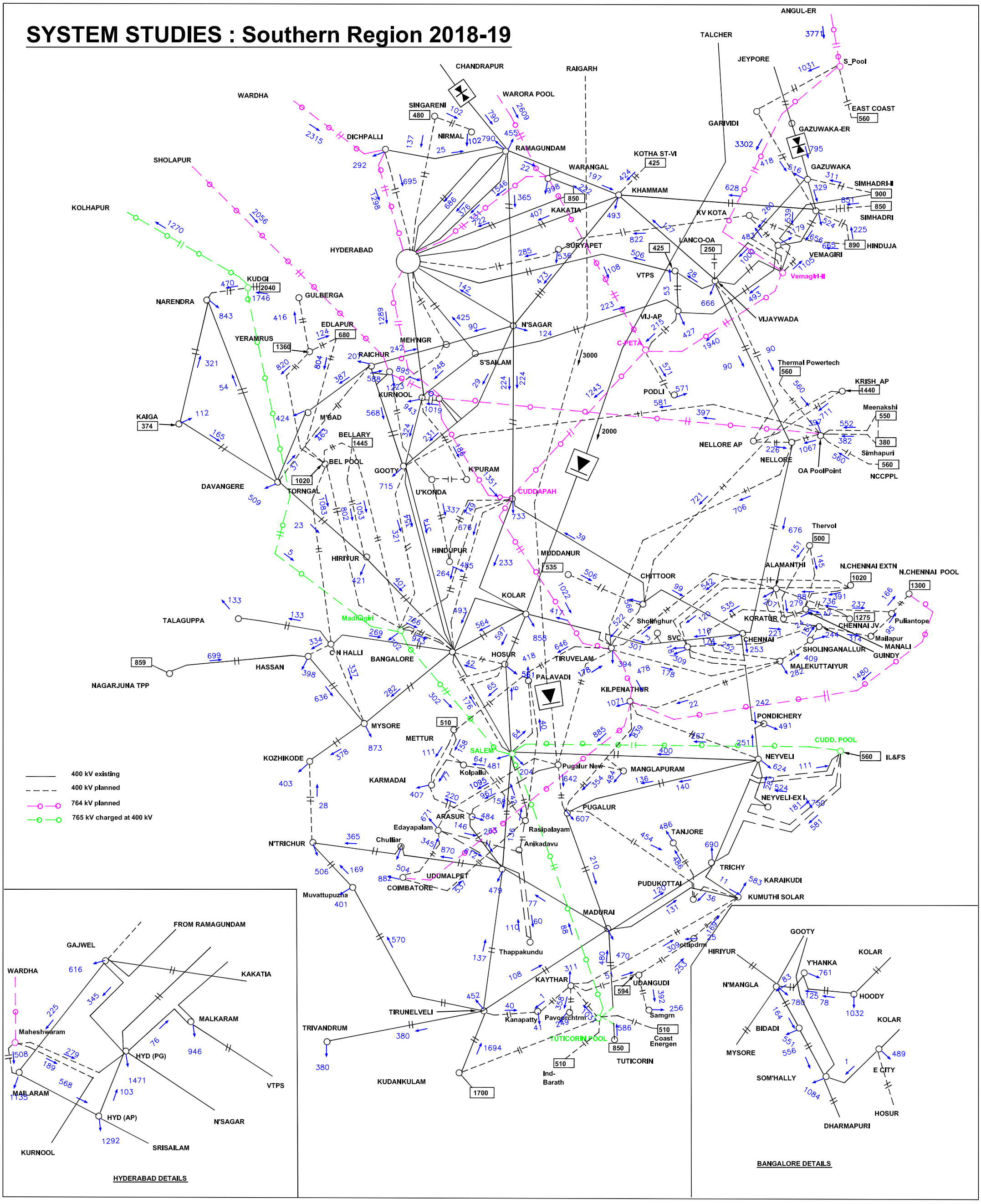


Exhibit - 4.5

SYSTEM STUDIES : Southern Region 2018-19

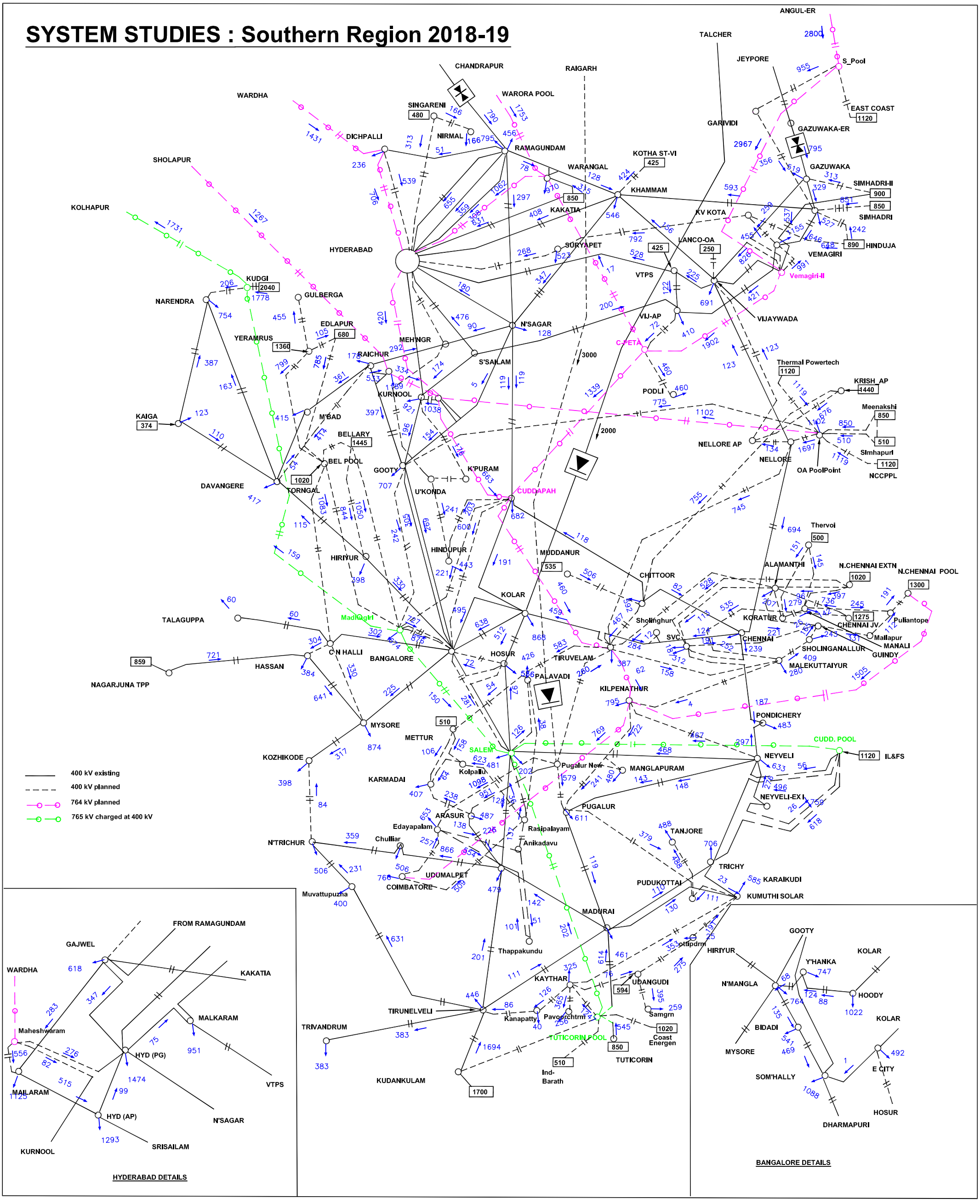


HYDERABAD DETAILS

BANGALORE DETAILS

Exhibit - 5.1

SYSTEM STUDIES : Southern Region 2018-19



HYDERABAD DETAILS

BANGALORE DETAILS

Exhibit - 5.2

SYSTEM STUDIES : Southern Region 2018-19

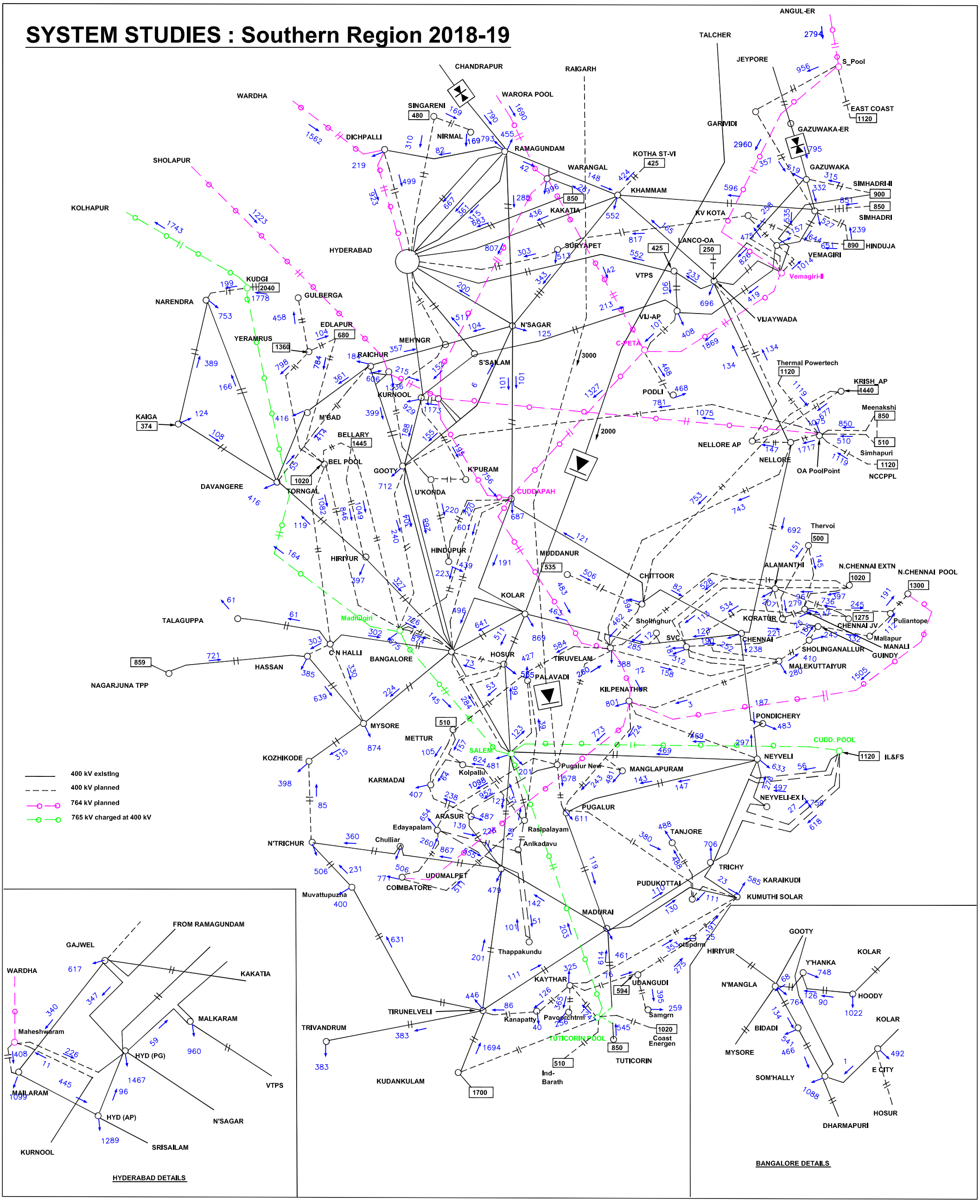
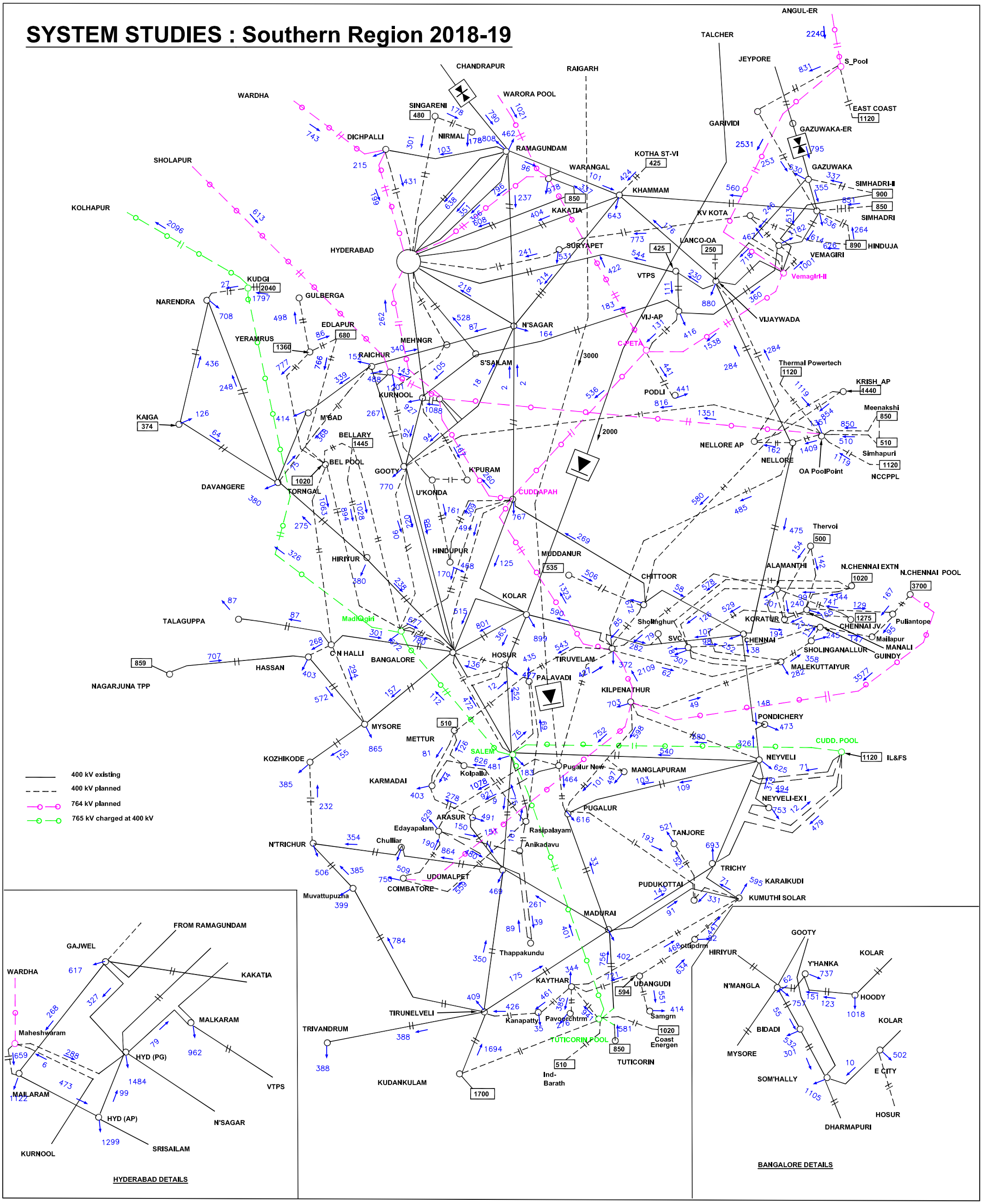


Exhibit - 6.1

SYSTEM STUDIES : Southern Region 2018-19



HYDERABAD DETAILS

BANGALORE DETAILS

Exhibit - 6.2

SYSTEM STUDIES : Southern Region 2018-19

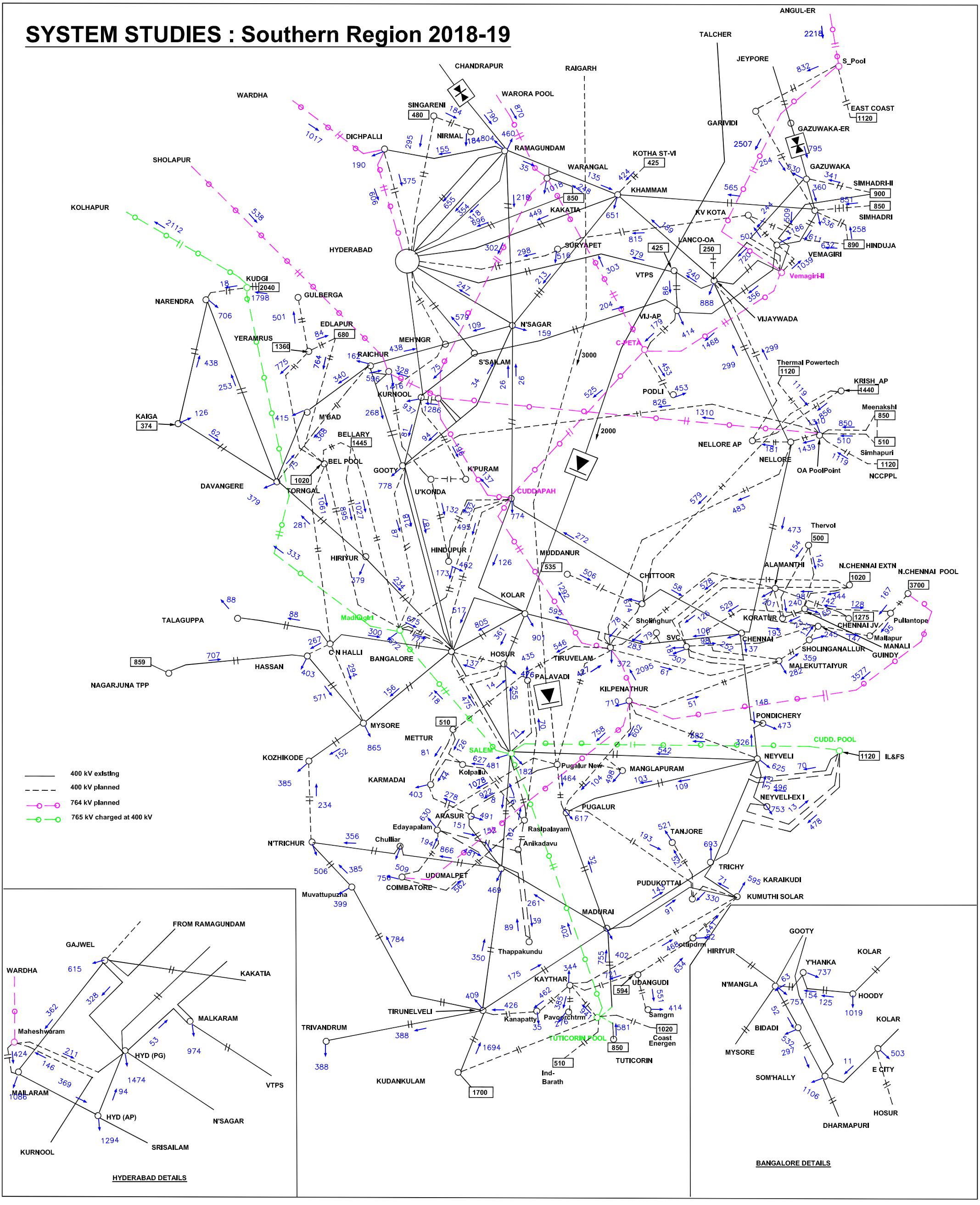


Exhibit - 6.3

SYSTEM STUDIES : Southern Region 2018-19

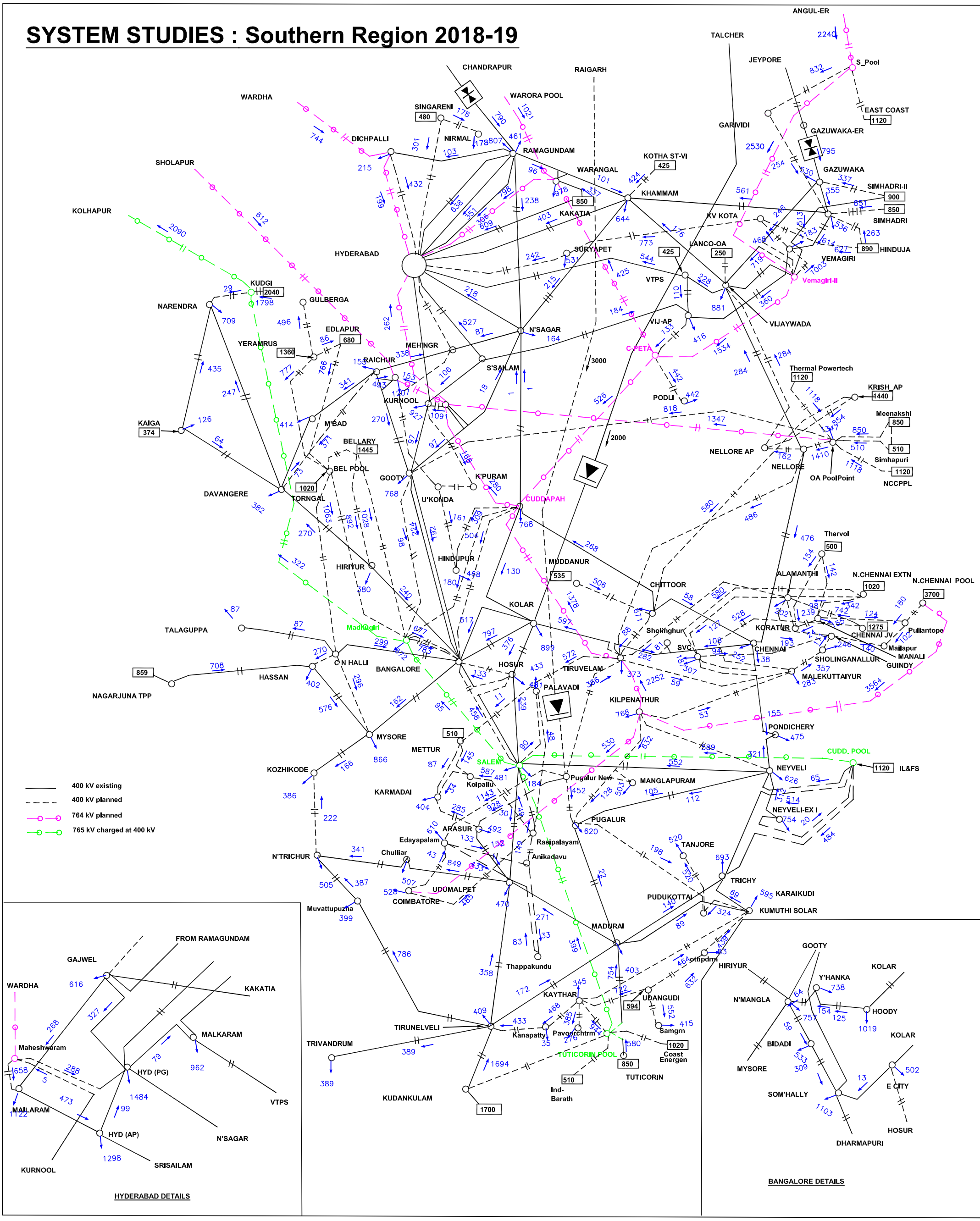


Exhibit - 6.4

SYSTEM STUDIES : Southern Region 2018-19

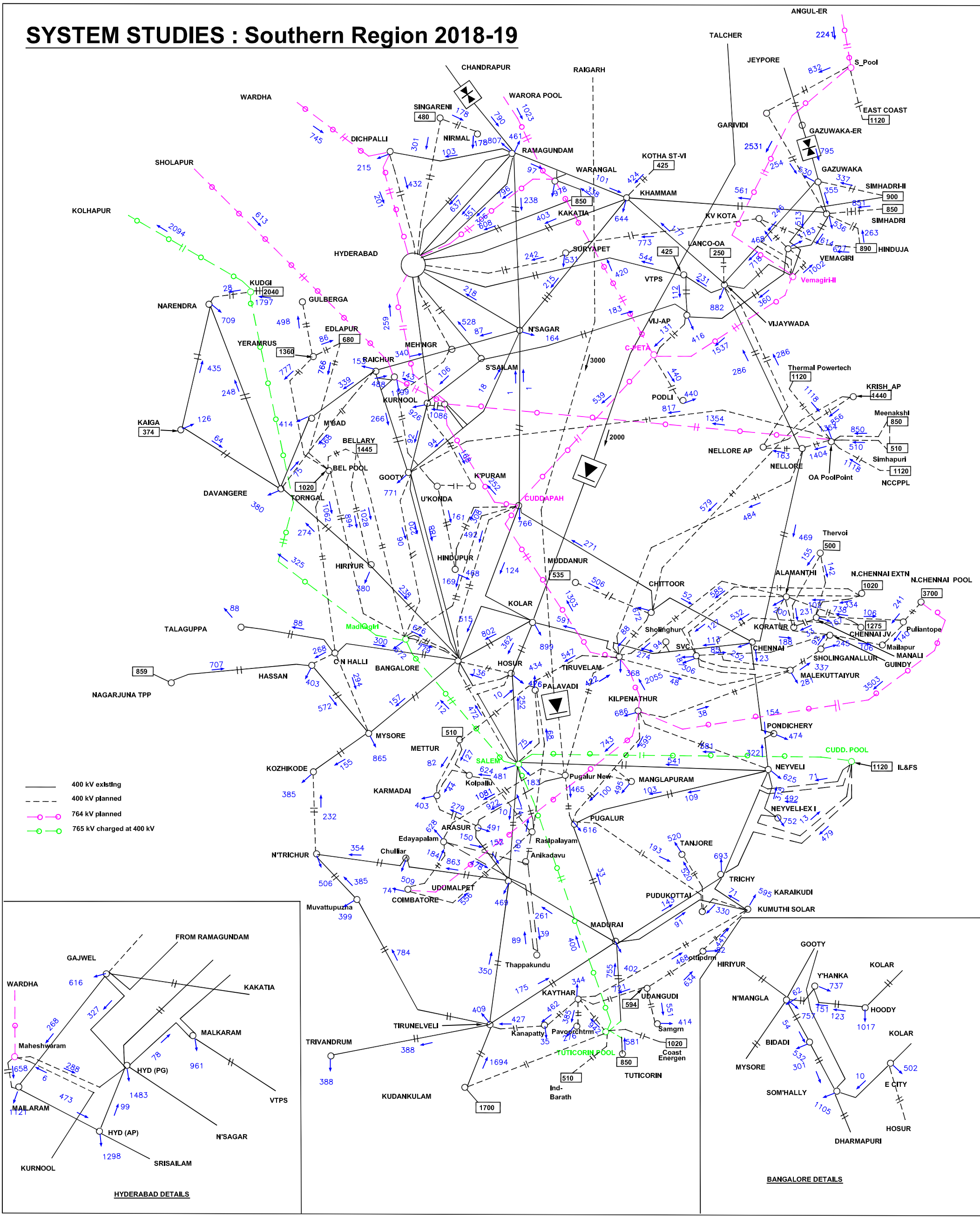


Exhibit - PST 20 deg

SYSTEM STUDIES : Southern Region 2018-19

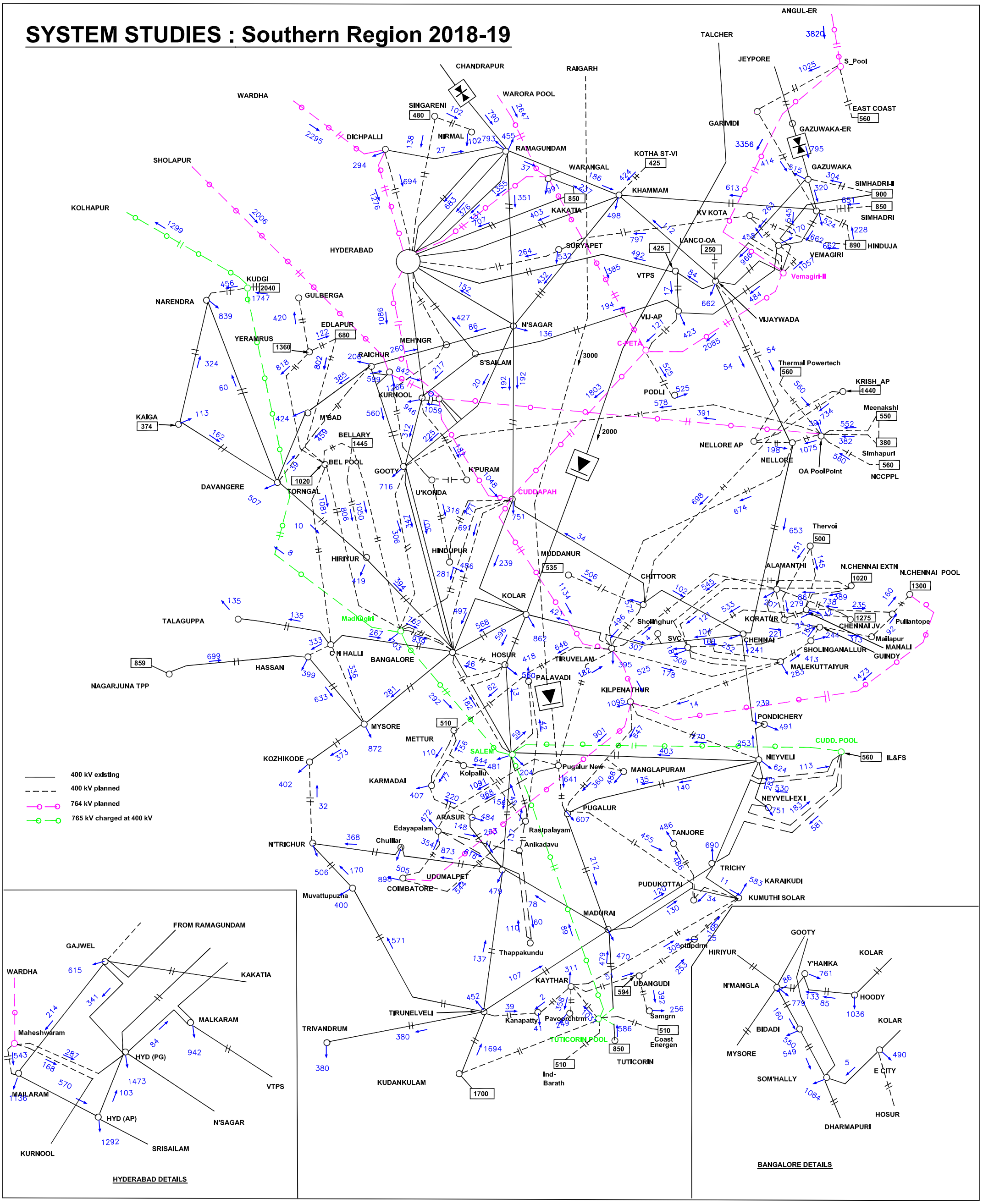


Exhibit - PST 15 deg

SYSTEM STUDIES : Southern Region 2018-19

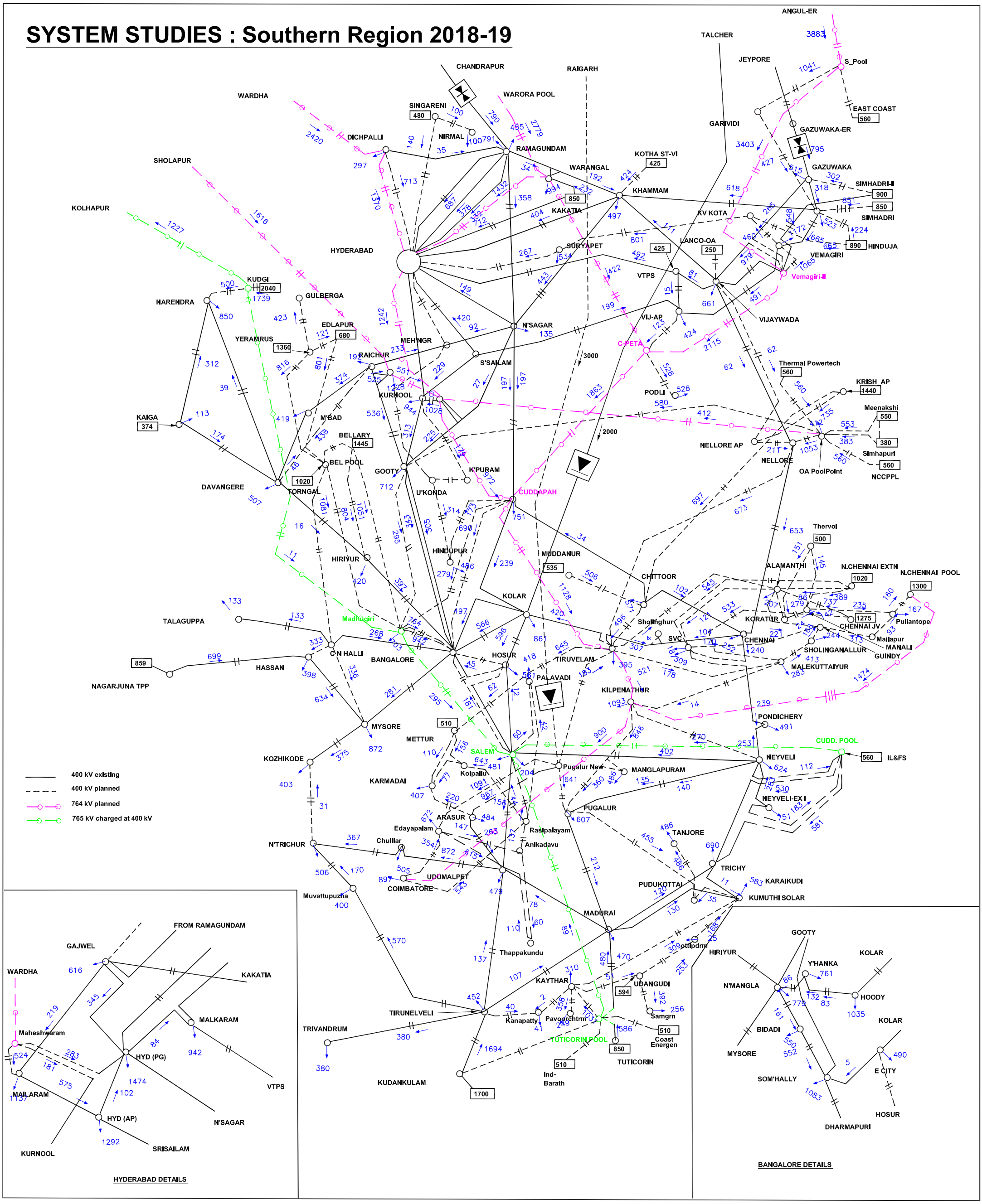


Exhibit - PST 10 deg

SYSTEM STUDIES : Southern Region 2018-19

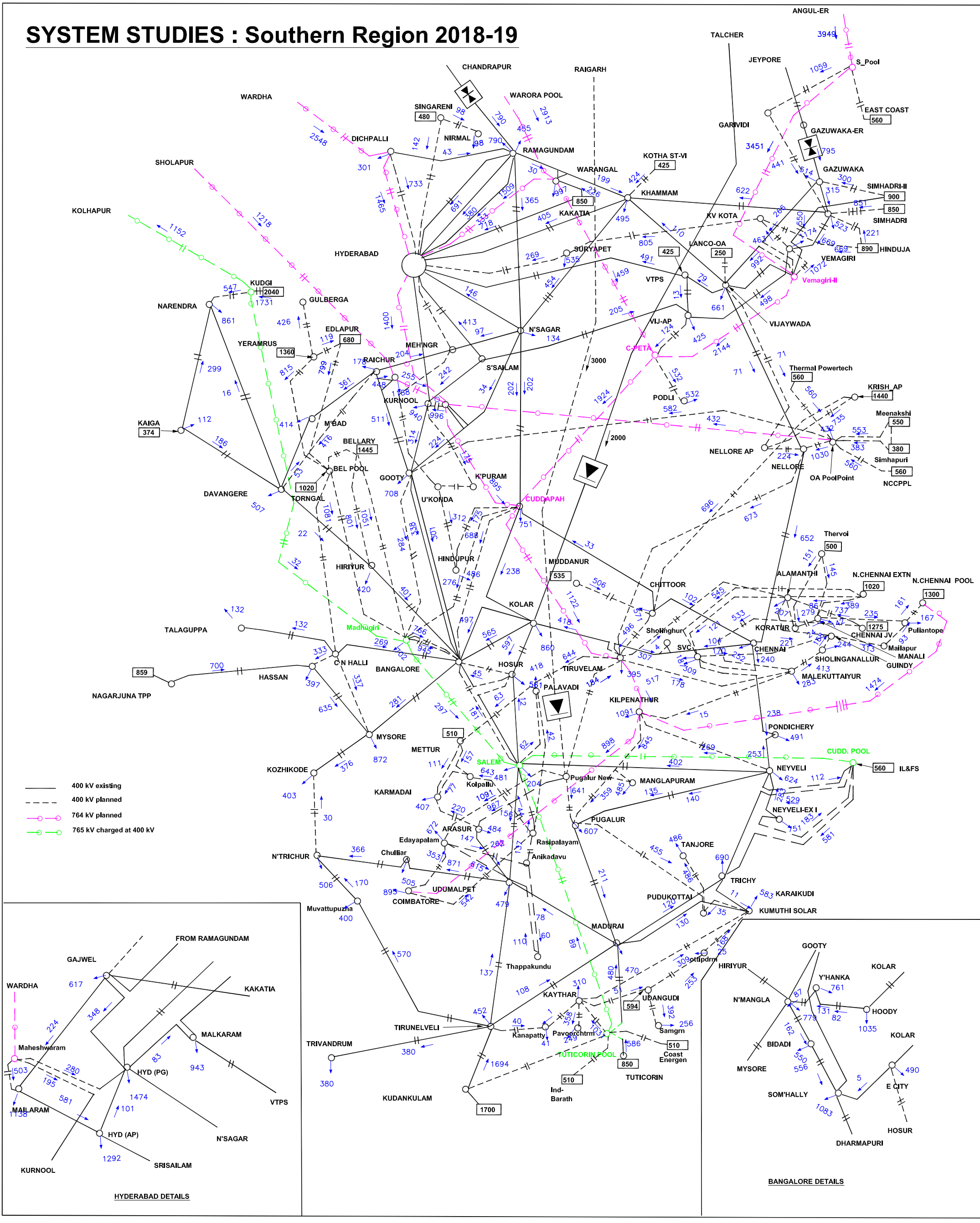
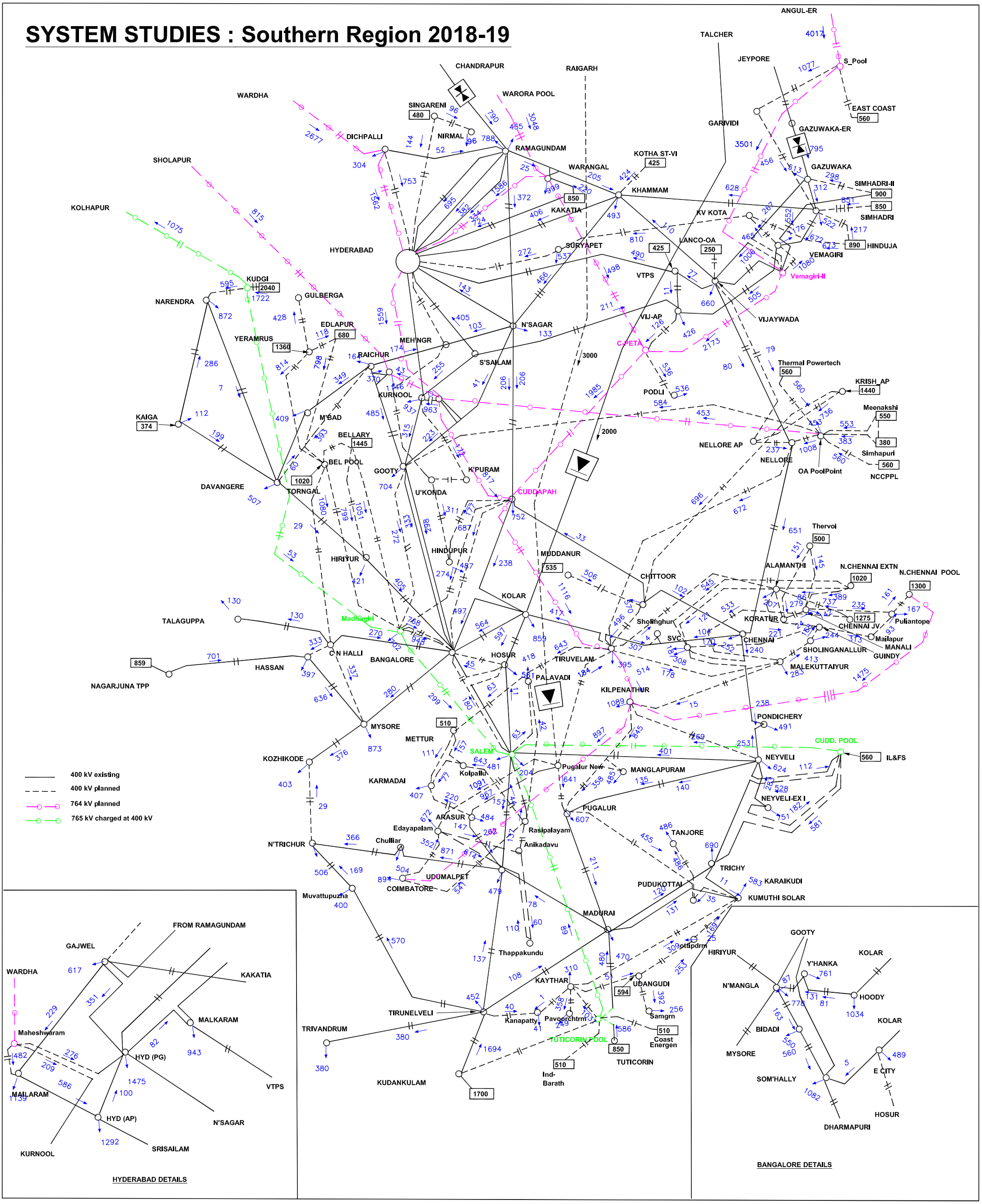


Exhibit - PST 5 deg

SYSTEM STUDIES : Southern Region 2018-19



HYDERABAD DETAILS

BANGALORE DETAILS

Exhibit - Without PST

SYSTEM STUDIES : Southern Region 2018-19