



Government of India
Ministry of Power
Central Electricity Authority
System Planning & Project Appraisal Division
Sewa Bhawan, R. K. Puram, New Delhi-110066
Website: www.cea.nic.in



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No. 66/5/SP&PA-2013/1367-1379

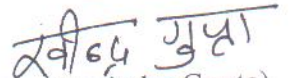
-As per List Enclosed-

Sub: Summary record of discussions of the 17th meeting of the Standing Committee on Power System Planning of Eastern Region on 25.05.2015 at NRPC, New Delhi.

Sir,

Minutes of the meeting for the 17th Standing Committee Meeting on Power System Planning in Eastern Region held on 25.05.2015 at NRPC, Katwaria Sarai, New Delhi is uploaded on the CEA website: www.cea.nic.in. (path to access: Wings of CEA/Power Systems/Standing Committee on Power System Planning/EASTERN REGION).

Yours faithfully,


(Ravinder Gupta)
Director (SP&PA)

Copy for kind information to:

- 1) PPS to Chairperson, CEA
- 2) PPS to Member PS, CEA

List of addressee:

1. Managing Director, Bihar State Power Transmission Company, Vidyut Bhavan, Baily Road, Patna-800021. Tel. 0612-2504442 Fax No. 0612-2504557	2. Executive Director (System), Damodar Valley Corporation DVC Towers, VIP Road, Kolkata-700054. Tel. 033-23557939 Fax No. 033-23554841
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Minutes of the 17th Standing Committee Meeting on Power System Planning of Eastern Region

List of participants is enclosed at **Annexure-I**

1.0 Chairperson / Member (PS), CEA welcomed the participants to the 17th meeting of the Standing Committee on the Power System Planning of Eastern Region and mentioned that the previous meeting was held in May 2014. He said that as per the time line specified by Ministry of Power, the Standing Committee meetings are to be held every quarter and henceforth we will be meeting regularly. He requested Director, SP&PA, CEA to take up the agenda items.

2.0 Renumbering of the Standing Committee Meeting on Power System Planning (SCMPSP) of Eastern Region

2.1 Director, CEA stated that till now sixteen meetings of the Standing Committee Meeting on Power System Planning (SCMPSP) of Eastern Region (ER) and one joint SCMPSP of ER and NER has been held. These meetings are not numbered in a sequential manner. Now, it is proposed to number these meeting sequentially in chronological order, as given below:

S. No.	SCM held on	Location	Meeting Number
1	8 th Feb., 2000	-	1 st (First)
2	26 th Sep., 2000	CEA, New Delhi	2 nd (Second)
3	16 th Dec., 2002	Bhubaneshwar, Odisha	3 rd (Third)
4	25 th Aug., 2003	Gangtok, Sikkim	4 th (Fourth)
5	24 th Dec., 2004	Puri, Odisha	5 th (Fifth)
6	22 nd June, 2006	Mirik, Darjeeling	6 th (Sixth)
7	5 th May, 2007	Puri, Odisha	7 th (Seventh)
8	5 th Nov., 2007	Ranchi, Jharkhand	8 th (Eighth)
9	8 th Nov., 2008	Bhubaneshwar, Odisha	9 th (Ninth)
10	14 th Sep., 2009	Bhubaneshwar, Odisha	10 th (Tenth)
11	20 th Sep., 2010	NRPC, New Delhi	11 th (Eleventh)
12	28 th Dec., 2010	POWERGRID, Gurgaon	12 th (Twelfth)
13	8 th Feb., 2012	NRPC, New Delhi	13 th (Thirteenth)
14	5 th Jan., 2013	POWERGRID, Gurgaon	14 th (Fourteenth)
15	27 th Aug., 2013	NRPC, New Delhi	15 th (Fifteenth)
16	2 nd May, 2014	NRPC, New Delhi	16 th (Sixteenth)

2.2 In addition to above, first joint Standing Committee Meeting on Power System Planning of Eastern Region and North Eastern Region was also held on 3rd January, 2014 at Guwahati, Assam.

2.3 Members noted the same.

2.4 Representative from POSOCO stated that the minutes of the some of the meetings of the SCM of ER prior to 2007 are not available on the web site of CEA and requested that the same may be uploaded on the CEA web site.

2.5 It was decided that the same would be uploaded on the CEA web site.

3.0 Confirmation of the minutes of 16th Standing Committee Meeting on Power System planning of Eastern Region

3.1 Director, CEA stated that the minutes of the 16th meeting of the Standing Committee on Power System Planning held on 2nd May, 2014 at NRPC, New Delhi were circulated vide CEA letter no. 66/5/2013-SP&PA/1223-1235 dated 11th July, 2014. No comment from any constituent has been received. The minutes may be confirmed.

3.2 Thereafter, minutes were confirmed.

4.0 Eastern Region Strengthening Scheme-XV (ERSS-XV): System strengthening in Eastern Region for transfer of additional 500MW power to Bangladesh

4.1 Director, CEA stated that presently, Bangladesh is drawing about 500 MW of power through an asynchronous link viz. Baharampur (India)-Bheramara (Bangladesh) 400 kV D/C line with an 500MW HVDC Back-to-Back terminal at Bheramara (Bangladesh). Bangladesh has desired for transfer of additional 500MW power from India. The proposal was discussed in the 7th Joint Working Group (JWG) and 7th Joint Steering Committee (JSC) meetings on Cooperation of Power between India and Bangladesh on 2nd-3rd April 2014 at Dhaka, Bangladesh, wherein, it was decided that both sides would jointly study the requirement of system strengthening in their territories for this additional power transfer from India to Bangladesh.

4.2 He added that to identify the transmission system strengthening required on the Indian side for transfer of additional 500MW power to Bangladesh, joint system study was conducted by CEA and POWERGRID. The scheme as identified was discussed in a meeting held at New Delhi on 13-06-2014 where representatives from CEA, POWERGRID, ERPC, POSOCO, WBSETCL and NTPC attended the meeting. The system strengthening required in Bangladesh was evolved by BPDB / PGCB of Bangladesh. A combined study report of the subject proposal was presented in 8th JSC meeting held on 10th Oct. 2014 at New Delhi, wherein, following system strengthening requirements were identified:

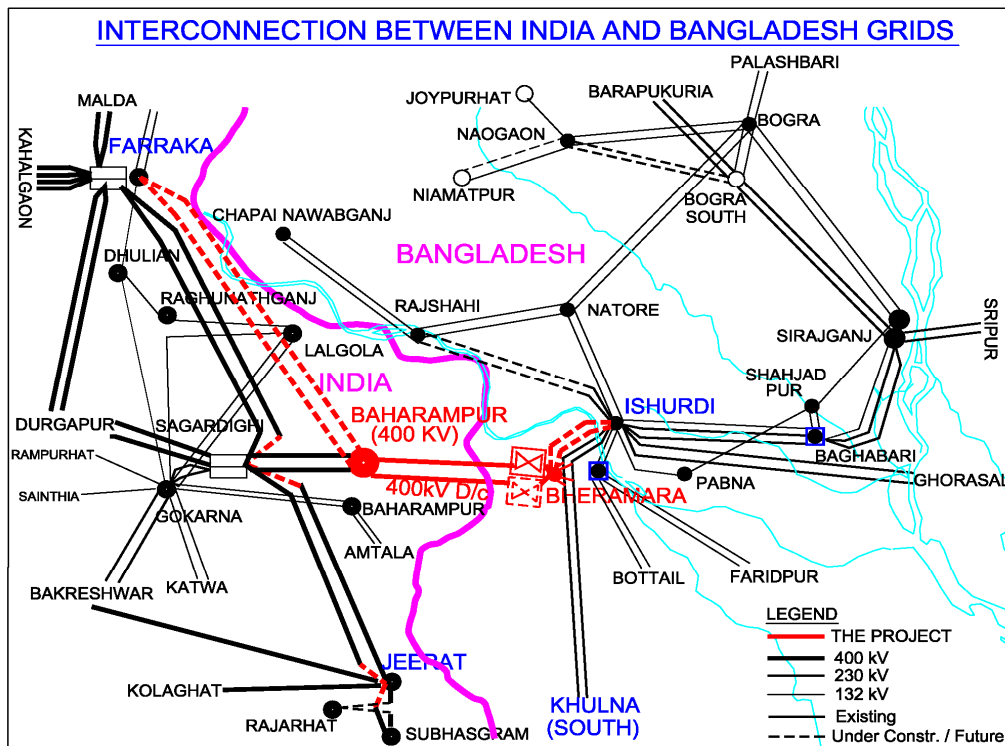
➤ **System Strengthening on Indian side:**

- (i) 400 kV Farakka - Baharampur D/C (HTLS) line (about 70 km.)

- (ii) Removal of the existing LILO of 400 kV Farakka - Jeerat S/c line at Baharampur.
- (iii) LILO of the above Farakka-Jeerat 400 kV S/c line at Sagardighi.
- (iv) LILO of Sagardighi-Subhasgram 400 kV S/c line at Jeerat

➤ **System Strengthening on Bangladesh side:**

- (i) Bheramara - Ishurdi 230 kV D/c line – 12 km.
- (ii) Additional 500 MW HVDC back-to-back converter unit (2nd module) at Bheramara (Bangladesh).



4.3 He added that during outage of one circuit of Baharampur-Bheramara 400kV D/C line, Bangladesh would restrict the drawl with the help of runback control / ramping down facility on the HVDC system. In the 8th JSC, it was decided that POWERGRID of India and PGCB of Bangladesh would take up the work in their respective territory, with target date of completion as June, 2017.

4.4 He said that in addition to the above lines, following reactive compensation is also proposed to be included in the scheme:

- (i) Installation of 1x125 MVar bus reactor at 400kV at Baharampur substation
- (ii) Conversion of 50 MVar fixed line reactor at Subhasgram end of Sagardighi – Subhasgram 400kV S/c line to switchable line reactor.

- 4.5** Director (Project), BSPTCL enquired about additional cost / transmission charges that the constituents would have to bear because of this system strengthening. AGM, POWERGRID said that the scheme would not only help in supplying additional power to Bangladesh but also strengthen the transmission system around Sagardighi, Jeerat and Subhashgram. Further, Bangladesh would be paying POC charges at Baharampur corresponding to about 1000 MW drawl.
- 4.6** Regarding HTLS conductor, Director (Project), BSPTCL stated that the HTLS is a generic name used for the high capacity conductor and various types of conductors are there in HTLS category with different cost implications. He requested that the conductor for HTLS may be specified. AGM, POWERGRID stated that before selecting the HTLS conductor, POWERGRID's engineering group compares the various options of HTLS conductor for the specified current rating. It was decided that POWERGRID would make a small presentation on HTLS conductor in next SCM of ER.
- 4.7** MS, ERPC agreed with the proposed strengthening system under Eastern Regional transmission scheme-XV. He added that for reliable, sustainable and smooth power supply of 1000 MW to Bangladesh in future, entire 400 kV Farakka-Sagardighi-Jeerat-Rajarhat-Subhasgram D/C line and 400 kV Sagardighi-Parulia (PG) D/C to be operated and maintained under ISTS. He emphasised that export to Bangladesh being an international transaction, healthiness of 400 kV Farakka-Sagardighi-Jeerat-Rajarhat-Subhasgram D/C and 400 kV Sagardighi-Durgapur D/C lines would help in ensuring the quality and reliable export.
- 4.8** After further discussions, following regional system strengthening named as "Eastern Region Strengthening Scheme-XV" to be implemented by POWERGRID was agreed. It was also decided that in case of space constraint at Farakka / Sagardighi/ Baharampur, GIS bays may be considered instead of AIS.

Transmission Line:

- (i) Farakka - Baharampur 400kV D/C (HTLS) line
- (ii) Removal of the existing LILO of Farakka - Jeerat 400 kV S/c line at Baharampur
- (iii) LILO of the above Farakka - Jeerat 400 kV S/c line at Sagardighi
- (iv) LILO of Sagardighi - Subhasgram 400 kV S/c line at Jeerat

Substation:

- (i) Extension at 400/220 kV Farakka S/s of NTPC
 - 2 nos. 400kV line bays for Farakka– Behrampur 400kV D/C (HTLS) line
- (ii) Extension at 400/220 kV Sagardighi S/s of West Bengal

- 2 nos. 400 kV line bays for LILO of Farakka – Jeerat 400kV S/c line (formed after removal of the existing LILO of Farakka – Jeerat 400kV S/c line at Baharampur) at Sagardighi
- (iii) Extension at 400/220 kV Jeerat S/s of West Bengal
 - 2 nos. 400 kV GIS line bays for LILO of Sagardighi – Subhasgram 400 kV S/c line
- (iv) Extension at 400 kV Baharampur s/s of POWERGRID
 - 2 nos. 400 kV line bays for termination of Farakka - Baharampur 400 kV D/C (HTLS) line
 - 125 MVAr bus reactor at 400kV at Baharampur substation
- (v) Extension at 400 kV Subhasgram S/s of POWERGRID
 - Conversion of 50 MVAr fixed line reactor at Subhasgram end of Sagaradighi - Subhasgram 400 kV S/c line to switchable line reactor

Note: 2 nos. of 400 kV line bays released after removal of existing LILO of Farakka - Jeerat 400 kV S/c line at Baharampur are proposed to be utilized for connection of one existing bus reactor which is presently connected to one end of the bus due to space constraint and one new bus reactor mentioned above.

4.8 Further, it was also agreed that for any scheme involving substation extension, if there is a space constraint, GIS bays may be considered in place of AIS bays as a general principle. However, if a new substation needs to be constructed as GIS one, the same may be discussed.

5.0 High Capacity multi-terminal HVDC bi-pole line interconnecting North-Eastern Region (NER), India, Northern Region (NR), India and Bangladesh

5.1 Director, CEA stated that the master plan for evacuation of Power from Hydro projects in Arunachal Pradesh envisages construction of high capacity HVDC / HVAC lines from NER to other parts of the country. The power from hydro projects in Kameng and Twang basin is proposed to be pooled at Rangia / Rowta pooling station from where it would be transferred to Northern Region. In view of Right of Way (RoW) constraints in chicken neck area, the possibility of routing the HVDC line through Bangladesh was explored, wherein it was proposed to build multi terminal HVDC line with one inverter station in Bangladesh. A concept paper on the same was presented by the Indian side in 8th JSC meeting on Indo-Bangladesh Co-operation in power sector held on 10th Oct, 2014 at New Delhi. Further, in the 9th JSC meeting at Dhaka, Bangladesh on 14-5-2015, it was decided that joint technical teams of India and Bangladesh would prepare the revised DPR,

keeping in view the generation addition programme in Arunachal Pradesh and possibility of phasing the transmission system.

5.2 In this regard following transmission system is proposed:

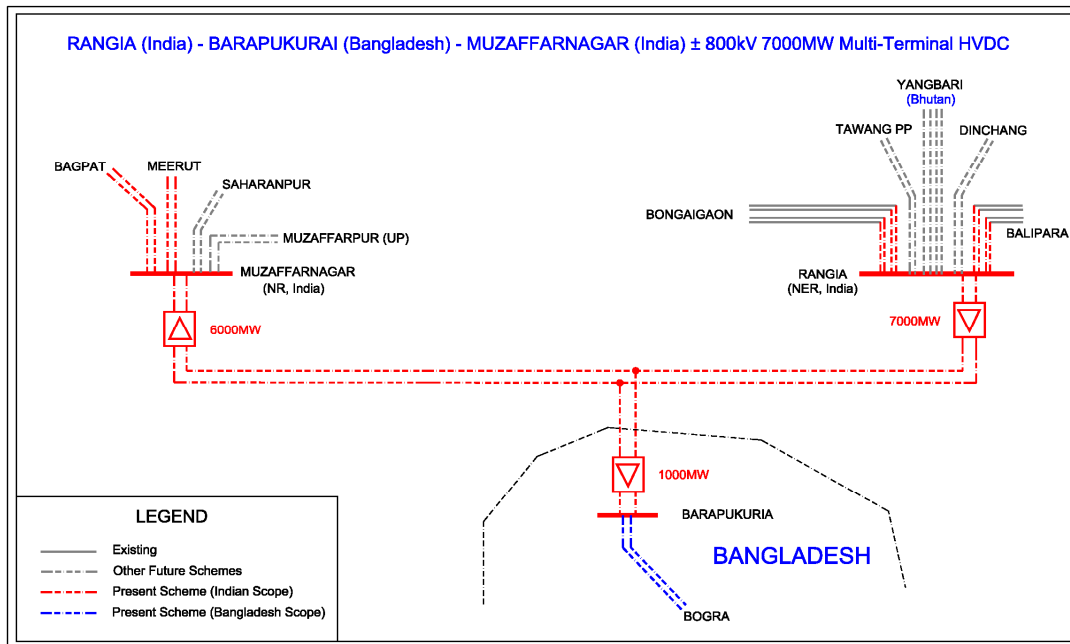
- Establishment of 2x500 MVA, 400/220 kV Pooling Station at Rangia / Rowta[§] in Upper Assam
- LILO of both ckts of Balipara-Bongaigaon 400 kV D/C (twin moose) line at Rangia / Rowta Pooling Station
- LILO of both ckts of Balipara-Bongaigaon 400 kV D/C (quad moose) line at Rangia / Rowta Pooling Station
- 7000MW[@] (2 x 3500 MW), \pm 800kV HVDC terminal at Rangia
- 2 x 500 MW, \pm 800kV HVDC terminal at Barapukuria
- 2 x 3000 MW, \pm 800kV HVDC terminal at Muzaffarnagar (New)
- Rangia – Barapukuria–Muzaffarnagar# (New) 7000MW, \pm 800kV HVDC bipole line
- Muzaffarnagar (New) – Bagpat 400kV D/c line (HTLS)
- Muzaffarnagar (New) – Meerut 400kV D/c line (HTLS)

Note:

1-§: *Rangia/Rowta pooling station would also have infeed from Bhutan through Yangbari-Rangia/Rowta 400kV 2xD/c (quad) line; from hydro projects in Tawang Basin of Ar. Pradesh through Tawang PP – Rangia/Rowta 400kV D/c (HTLS) line and from hydro projects in Kameng Basin of Ar. Pradesh through Dinchang PP - Rangia/Rowta 400kV D/c (Quad) line.*

2-#: *Muzaffarnagar 765/400/220kV substation along with Muzaffarnagar(New)– Muzaffarnagar(UP) 400kV D/c line (HTLS) and Muzaffarnagar (New) – Saharanpur 400kV D/c line (HTLS) are being planned as a part of high capacity 765kV D/c WR – NR corridor viz. Vindhyachal Pool (WR) – Fatehpur (NR) – Lucknow(NR) – Aligarh(NR) – Muzaffarnagar(NR) – Mohali(NR) – Gurdaspur(NR).*

3-@ : *Regarding MW rating of HVDC terminals, it is to mention that rating of HVDC terminals may be decided so as to ensure injection of 2x3500MW at 400kV AC substation of Rangia/Rowta and 2x500 MW at 400kV AC substation of Barapukuria (Bangladesh).*



5.3 He added that in view of uncertainties of the commissioning schedules of the generation projects envisaged in Kameng and Twang basins, the above transmission system would be taken up for re-discussion and concurrence after firming up of the generation projects.

6.0 Deletion of 3rd 500 MVA transformer at Kishanganj 400/220kV substation and modification of transformation capacity at Kishanganj from 2x315 MVA to 2x500 MVA

6.1 Director, CEA stated that establishment of 2x315 MVA 400/220 kV substation at Kishanganj in Bihar was agreed, as a part of Transmission System associated with Phase-I IPPs in Sikkim and the S/S is under construction by POWERGRID. In the previous SCM, an additional (3rd) transformer of 500 MVA at Kishanganj was discussed and approved. However, ERPC in its 28th meeting on 28th-29th Sep., 2014 held at Goa had suggested that the 400/220 kV transformation capacity at Kishanganj be changed to 2x500 MVA instead of 2x315 MVA + 1x500 MVA.

- 6.2** Accordingly, Members agreed to endorse following decision of ERPC.
- i) Installation of 2x500 MVA, 400/220 kV ICTs at Kishanganj instead of earlier approved 2x315MVA, 400/220 kV ICTs under Transmission System for Phase-I IPPs in Sikkim.
 - ii) Deletion of 3rd 500 MVA 400/220 kV ICT at Kishanganj approved in the 16th meeting of Standing Committee on Power System Planning for Eastern Region held on 02-05-2014 at New Delhi.

7.0 Installation of STATCOMs in Eastern Region

7.1 Director, CEA stated that proposal for installation of STATCOM in combination with mechanically switched Reactors (MSR) and Capacitors (MSC) and co-ordinated control mechanism of MSCs and MSRs at Ranchi, Rourkela, Jeypore and Kishanganj substations in Eastern Region as given below was discussed and agreed in the 15th meeting of SCM.

Sl. No.	Location /Sub-Station of POWERGRID in ER	STATCOM - Dynamic Shunt Controller (MVar)	Mechanically Switched Compensation (MVar)	
			Reactor (MSR)	Capacitor (MSC)
1.	Rourkela	± 300	2x125	-
2.	Kishanganj	± 200	2x125	-
3.	Ranchi(New)	± 300	2x125	-
4.	Jeypore	± 200	2x125	2x125

7.2 He added that the proposal was subsequently taken up for discussion in the 25th TCC and ERPC meetings held on 20th-21st September, 2013 wherein ERPC, in principle, agreed for installation of STATCOM, subject to funding through PSDF to the maximum extent possible. The matter was again discussed in the 28th ERPC/TCC meeting held on 12th -13th September, 2014 at Goa, wherein, it was decided that POWERGRID may go ahead with implementation of the STATCOM project in Eastern Region with debt - equity ratio of 70:30 funding. The debt part should be refunded through PSDF and Equity Component (30%) to be funded by POWERGRID to be recovered through regulated tariff mechanism. CTU should initiate the process of availing fund from PSDF.

7.3 COO, CTU informed that the DPR has been prepared and application for PSDF funding shall be submitted shortly. She stated that respective constituents have agreed for implementation of STATCOM project in WR, NR and SR without the PSDF fund. A similar approach can also be followed in ER. Alternatively, the debt portion may be arranged by POWERGRID through loan which would be repaid if PSDF funding becomes available. The constituents were of the view that the decision of PSDF funding has been taken by the ERPC and the same may be discussed in ERPC, if PSDF funding is not available. On a query about the estimated cost of the scheme, AGM POWERGRID stated that the cost of STATCOM depends upon its rating; however, the cost of subject scheme is expected to be about ₹1100 Cr. including that of MSR and MSC.

7.4 Director (operations), WBSETCL requested for installation of STATCOM at Subhashgram 400 kV sub-station also. AGM, POWERGRID stated that

system studies need to be carried out for establishing the need of STATCOM at Subhashgram.

- 7.5** After further discussions, it was decided that POWERGRID would approach NLDC (Nodal Agency for PSDF fund) for recommendation of PSDF funding for the debt portion and if PSDF funding is not available then the matter would be discussed again in ERPC meeting. POWERGRID was requested to share the study report of STATCOM with the constituents. Accordingly, the same is enclosed herewith at **Annexure-II**.

8.0 Transmission System associated with Odisha UMPP (4000 MW)

- 8.1** Director, CEA stated that the transmission system associated with Odisha UMPP was discussed and agreed in the 16th SCM. The same was also agreed in 27th TCC/ERPC meeting held on 30th– 31st May 2014 and 28thTCC/ERPC meeting held on 12th– 13th Sept 2014. Subsequently, the transmission system has been modified keeping in view the space constraints at Sundargarh (Jharsuguda) substation and development of other generation projects in the vicinity. Accordingly, it is now proposed to pool the power to a new pooling substation viz. Sundargarh (New) and plan HVDC bipole line from Sundargarh (New) to NR instead of Angul to NR as envisaged earlier. The modified transmission system for evacuation of power from UMPP is as below :

(A) Evacuation system for Odisha UMPP project

(a) For Immediate Evacuation of power from UMPP Project

1. Odisha UMPP – Sundergarh (New) 765kV 2xD/c line
2. Odisha UMPP – Lapanga 400kV D/c line (quad/HTLS)
3. Odisha UMPP – Kesinga 400kV D/c line (quad/HTLS)

(b) System Strengthening Scheme associated with Odisha UMPP

1. New 3x1500MVA, 765/400 kV Pooling Station at Sundargarh (New)
2. LILO of Jharsuguda – Raipur pool 765 kV D/c line at Sundargarh (New)
3. ± 800 kV, 3000 MW HVDC terminal at Sundargarh (New) and suitable location in NR (Delhi – Maharani Bagh / Badarpur) with HVDC bipole line capacity of 6000MW for future utilization
4. Suitable AC strengthening system at the remote end of the HVDC bipole line in NR (Delhi – Maharani Bagh / Badarpur)

(c) Scope of evacuation arrangement at UMPP switchyard

1. Generation to be stepped up at 765kV
2. Provision for Split Bus Arrangement on 765kV UMPP Bus*
3. 4 no. 765 kV line bays
4. 4 no. 400 kV line bays (suitable for quad conductor lines)

5. 2X1500 MVA, 765/400kV ICT with OLTC +/- 5.5 % (as per CEA Standard for 765kV Substation Equipment) (7 nos 1-phase 500 MVA transformers) along with associated bays at Generation Switchyard
6. 2 nos. 240 MVAR (7x80 MVAR Banks) Bus Reactor at 765 kV bus of Generation Switchyard
7. 2x125 MVAR Bus Reactor at 400 kV bus of Generation Switchyard
8. 4x80MVAR switchable line reactor along with 450 ohm NGR each for Odisha UMPP – Lapanga 400kV D/c line (quad/HTLS) & Odisha UMPP – Kesinga 400kV D/c line (quad/HTLS) lines
9. Space for future – 2 nos. 400 kV line bays

Note:

1. * Bus splitting is required to control power rushing towards Odisha which has a share of 1300 MW.
2. The 765KV and 400kV switchyard may be designed for 50kA and 63kA fault levels respectively.

8.2 He added that in view of the modifications in Standard Bidding Documents, Ministry of Power vide its letter dated 29-12-2014 has asked the bid process co-ordinator for Odisha UMPP i.e. PFC for termination of the bidding process for Odisha UMPP. Therefore, the transmission system associated with Odisha UMPP would be taken up for discussion and concurrence of members when the implementation of the generation project is firmed up.

8.3 Members noted the same.

9.0 765 kV System Strengthening Scheme in Eastern Region

9.1 Director, CEA stated that 765 kV system strengthening in ER as given below was discussed and approved along with transmission system associated with Odisha UMPP in the previous SCM.

765kV System

1. Establishment of 765/400 kV new substations at Banka (New), Gokarna (New), Medinipur, Jeerat (New) and Jajpur Road
2. Angul – Jajpur Road 765 kV D/c line
3. Jajpur Road – Medinipur 765 kV D/c line
4. Ranchi (New) – Medinipur 765 kV D/c line
5. Medinipur – Jeerat (New) 765 kV D/c line
6. Jeerat (New) – Gokarna (New) 765 kV D/c line
7. Gokarna(New) – Banka(New) 765 kV D/c line
8. Gaya – Banka (New) 765 kV D/c line
9. Gaya – Ranchi (New) 765 kV D/c line

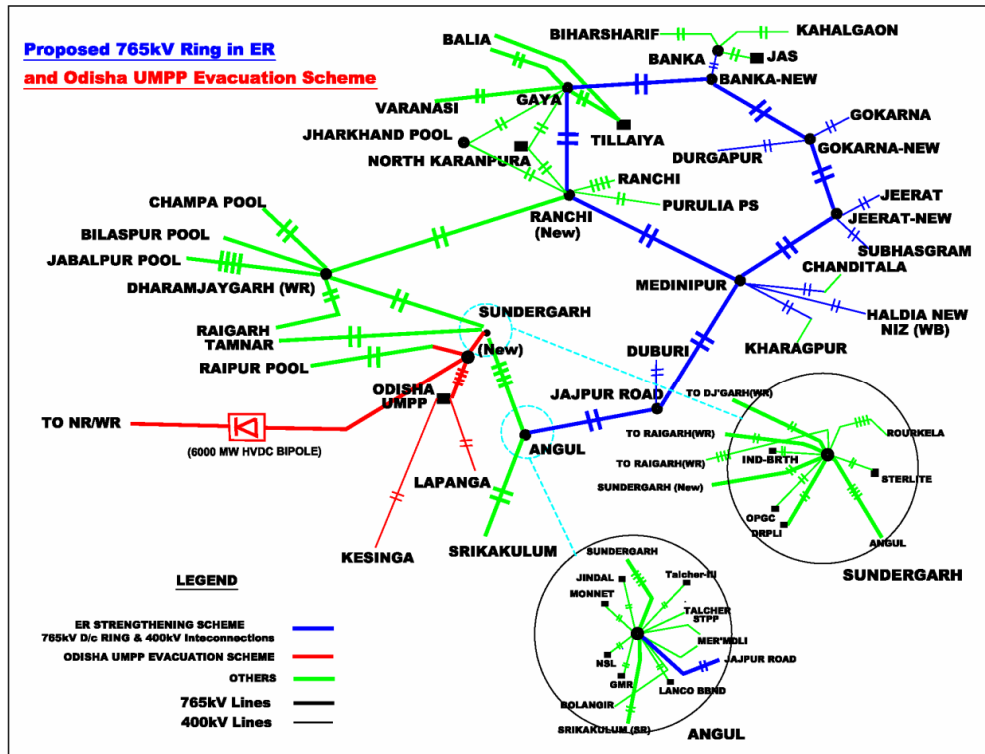
400kV Interconnection

10. Jajpur Road – Duburi 400 kV D/c line (quad/HTLS)

11. Medinipur – Haldia New (NIZ) (WBSETCL) 400 kV D/c line (quad/HTLS)
12. LILO of Chandithala – Kharagpur 400 kV D/c line at Medinipur
13. Jeerat (New) – Subhasgram 400kV D/c line (quad/HTLS)
14. Jeerat (New) – Jeerat 400 kV D/c line (quad/HTLS)
15. LILO of Sagardighi – Subhasgram 400 kV S/c line at Rajarhat
16. LILO of Sagardighi – Rajarhat 400kV S/c line (formed through LILO of pt. 15) at Jeerat
17. Gokarna (New) – Gokarna 400 kV D/c line (quad/HTLS)
18. Gokarna (New) – Durgapur (PG) 400 kV D/c line (quad/HTLS)
19. Banka (New) – Banka 400kV D/c line (quad/HTLS)

9.2 He added that the LILO of Sagardighi-Subhashgram 400 kV S/C at Jeerat (item no. 16) has been included in Eastern Region System Strengthening Scheme i.e. ERSS-XV. Therefore, the item no. 15 above i.e. LILO of Sagardighi – Subhasgram 400 kV S/c line at Rajarhat would now become LILO of Jeerat (WB) – Subhasgram 400 kV S/c section at Rajarhat.

The corresponding schematic diagram is given below:



9.3 He said that in view of delay in the implementation of Orissa UMPP and other generation scheme, the 765 kV system strengthening scheme is reviewed. Studies carried out by POWERGRID corresponding to 2018-19 time frame indicate that most of the 765 kV corridors are not getting

adequately loaded. Accordingly the requirement of 765 kV ring may be deferred as of now. However, there is need for a strong East-West connection in the Eastern Region. So to begin with, the middle path of the earlier proposed ring i.e. Ranchi–Medinipur–Jeerat 765 kV D/c line may be taken up for implementation. The power flow study report for 2018-19 condition with and without the above corridor is enclosed at **Annexure-III**. Accordingly, the following scope of work is proposed as of now.

1. Establishment of 765/400kV, 2x1500MVA substations at Medinipur and Jeerat (New)
2. Ranchi (New) – Medinipur 765kV D/c line
3. Medinipur – Jeerat (New) 765kV D/c line
4. Medinipur – Haldia New (NIZ) (WBSETCL) 400kV D/c line (quad/HTLS)
5. LILO of Chandithala – Kharagpur 400kV D/c line at Medinipur
6. Jeerat (New) – Subhasgram 400kV D/c line (quad/HTLS)
7. Jeerat (New) – Jeerat 400kV D/c line (quad/HTLS)
8. LILO of Jeerat (WB) – Subhasgram 400kV S/c section at Rajarhat

9.4 AGM, POWERGRID stated that most of the generation addition in Eastern Region is taking place in the Western & Central part of the Eastern Region i.e. in Bihar, Jharkhand and Odisha, whereas no major generation addition is envisaged in Eastern Part i.e. West Bengal. Further, about 1000 MW export to Bangladesh has been considered as load incident on West Bengal system. The system study has been carried out with 18th EPS load which is on the higher side when compared with the actual load growth that has taken place in Eastern Region in past 4-5 years. From the system studies, it is seen that the Ranchi-Medinipur 765 kV D/C line carries about 1750 MW of power and Medinipur-Jeerat 765 kV D/C carries about 1050 MW of power in a scenario considering normal generation in West Bengal. The power flow on the above lines increases to about 2365 MW and 1450 MW respectively in case of reduced generation scenario in West Bengal.

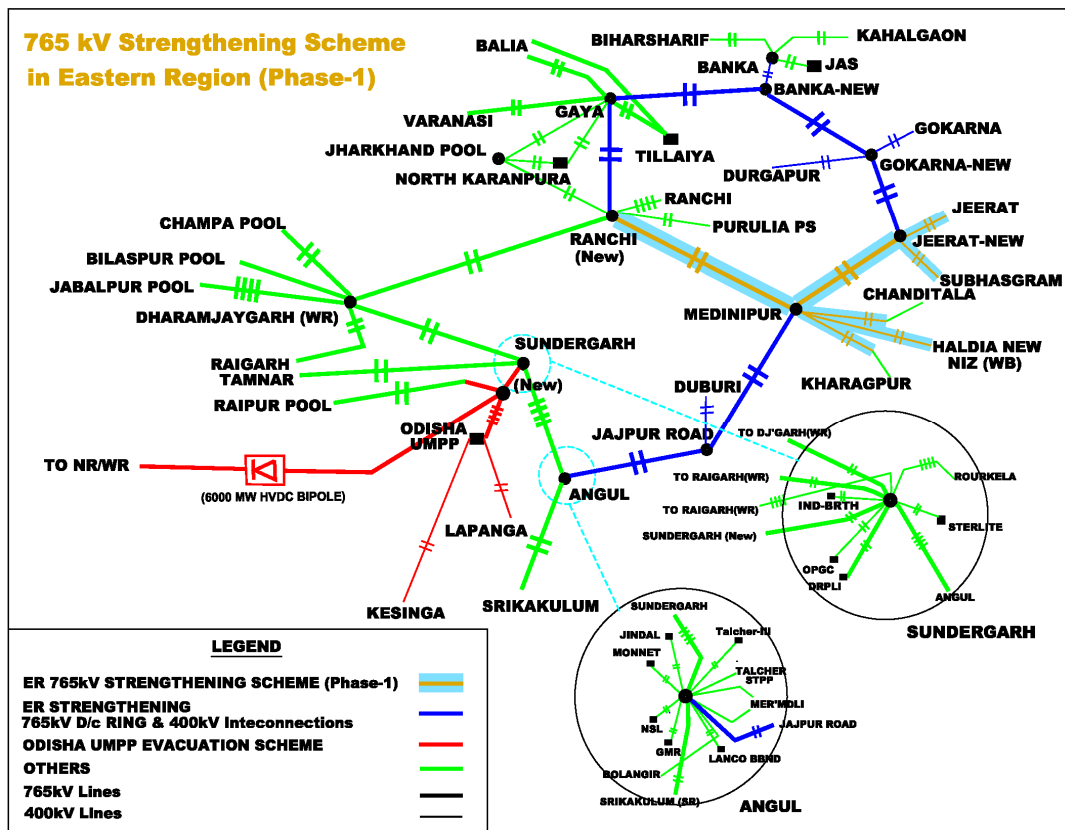
9.5 MS, ERPC requested to take up balance portion of the 765 kV ring as agreed in the previous SCM. Representatives from WBSETCL and NTPC also urged to take up the upper part of the 765kV ring viz. Jeerat – Gokarna (New) – Banka (New) – Gaya 765kV D/c corridor. In response AGM, POWERGRID stated the implementation of 765 kV ring is being taken up in a phased manner depending upon progress of Odisha UMPP and other generation projects. However, in the first phase middle portion of the ring is proposed. Some members pointed out the requirement of Ranchi-Gaya 765 kV section. In reply, AGM, POWERGRID stated that the Ranchi-Gaya 400kV D/c (quad) line via Chandwa pool was originally planned for evacuation from Essar and Corporate generation projects to be pooled at Chandwa pool. However, due to delay of these projects, this high capacity 400kV D/c line

would serve the requirement of regional strengthening scheme in place of 765 kV Ranchi-Gaya section till the commissioning of any new generation project in this area.

9.6 After, further deliberation, Members agreed to the implementation of middle portion of the 765 kV ring as Eastern Region Strengthening Scheme-18 (ERSS-18) : 765 kV System Strengthening in ER (Phase-I) with the scope of works as given below:

- i) Establishment of 765/400kV, 2x1500MVA substations at Medinipur and Jeerat (New)
- ii) Ranchi (New) – Medinipur 765kV D/c line
- iii) Medinipur – Jeerat (New) 765kV D/c line
- iv) Medinipur – Haldia New (NIZ) (WBSETCL) 400kV D/c line (quad/HTLS)
- v) LILO of Chandithala – Kharagpur 400kV D/c line at Medinipur
- vi) Jeerat (New) – Subhasgram 400 kV D/c line (quad/HTLS)
- vii) Jeerat (New) – Jeerat 400 kV D/c line (quad/HTLS)
- viii) LILO of Jeerat (WB) – Subhasgram 400 kV S/c section at Rajarhat

The schematic diagram of the same is as shown below:



10.0 Downstream 220 kV system development of STUs (Bihar, Jharkhand & Odisha) from the various approved and ongoing sub-stations of POWERGRID

10.1 Director, CEA stated that under the ERSS-III scheme, following new 400 kV sub-stations have been / are being implemented by POWERGRID.

- i) 2x200 MVA, 400/132 kV sub-stations at Lakhisarai and Banka in Bihar
- ii) 2x315 MVA, 400/220 kV at Chaibasa and Daltonganj in Jharkhand
- iii) 2x315 MVA, 400/220 kV at Bolangir, Keonjhar and Pandiabil in Odisha

10.2 He added that the sub-stations at Lakhisarai, Banka, Chaibasa, Bolangir and Keonjhar have been commissioned by POWERGRID, but the downlinking 220 kV and 132 kV lines/systems have not yet been commissioned by the respective STUs. He requested BSPTCL, JUSNL and OPTCL to intimate the downlinking system and its status.

10.3 CGM (Const), OPTCL informed that Bolangir 400/220 kV S/S of POWERGRID would be connected to OPTCL system through following 220 kV system of OPTCL.

- a) LILO of one circuit of Sadeipalli-Kesinga 220 kV D/C line at Bolangir S/S
- b) LILO of one circuit of Katapalli-Sadeipalli 220 kV D/C line at Bolangir S/S

Severe RoW problems are being faced in both the above lines and negotiations with land owners are going on. The first line is expected to be completed by July 15 and second line by June 15.

10.4 CGM (Const), OPTCL added that Keonjhar 400/220 kV S/S of POWERGRID would be connected to OPTCL system through following 220 kV System

- a) Keonjhar (PG)-Keonjhar (OPTCL) 220 kV D/C line
- b) Keonjhar (PG)-Turumunga (OPTCL) 220 kV D/C line

He informed that OPTCL has planned to construct one 220/33 kV Grid S/s at Keonjhar for which in-principle approval of BoD has already been taken and construction of 220/132/33kV Grid S/s at Turumunga has already been initiated to be funded under JICA funding. The above lines are expected to be completed by 2019.

10.5 CGM (Const), OPTCL further informed that the 400/220kV Pandiabil Grid S/s of POWERGRID which is under construction would be connected to OPTCL 220 kV System through following 220 kV links.

- a) Pratapsasan (OPTCL)-Pandiabil (PG) 220 kV D/C line
- b) LILO of one circuit of Atri-Puri (Samangara) 220 kV D/C line at Pandiabil (PG)

He added that the above lines are expected to be completed by Dec 2015.

- 10.6** CE (Trans), JUSNL informed that 220/132/33 kV Chaibasa is under construction and Chaibasa 400/220 kV S/S of POWERGRID would be linked to Chaibasa (JUSNL) through 220 kV D/C line. The remaining 2 no. 220 kV bays at Chaibasa (PG) would also be utilised in 2016-17 for connecting to Chaibasa (JUSNL) for feeding power to Noamundi, Kendposi and other HT consumers.
- 10.7** Director (Projects), BSPTCL informed that 2x200 MVA, 400/132 kV substations at Lakhisarai would be connected to BSPTCL system through following 132 kV lines.
- Lakhisarai (PG)-Lakhisarai (BSPTCL) 132 kV D/C line (completed except Railway crossing))
 - Lakhisarai-Jamui (BSPTCL) 132 kV D/C line (expected by June 2015)
- 10.8** Director (Projects), BSPTCL informed that 2x200 MVA, 400/132 kV substations at Banka would be connected to BSPTCL system through following 132 kV lines.
- LILO of both circuits of Banka (BSPTCL)-Sabour (BSPTCL) 132 kV D/C line at Banka (PG) (expected by June 15)
 - Banka (PG)-Sultanganj (BSPTCL) 132 kV D/C line (by May 15)
- 10.9** Director, CEA said that the downlinking system from Daltonganj 400 kV S/S in Jharkhand has been discussed as a separate agenda item. He requested Bihar, Jharkhand and Odisha to expedite their downlinking system for drawl of power from these substations so as to properly utilize the transmission assets.
- 11.0 Transformer augmentation requirements in Eastern Region**
- 11.1** Director, CEA stated that as per the data furnished by ERLDC, the peak loading on various ICTs in Eastern Region during 2012-13 and 2014-15 as given below violates the N-1 contingency.

Sl. No.	Substation	Peak Loading (2012-13 & 2014-15) (MW)	Aggregate Existing/Planned Tr. Capacity (MVA)	N-1 Capacity (MVA)
1	Durgapur	409	630	315
2	Malda	440	630	315
3	New Siliguri	410	630	315
4	Jeypore	478	630	315
5	Rourkela	424	630	315
6	Gaya	533	815 (500+315)	315/500

- 11.2** He added that in order to meet the N-1 criterion, it is proposed to augment transformations capacities at above S/S as given below:

1. Installation of 3rd 400/220 kV, 1x315 MVA ICT at Durgapur Substation
2. Replacement of 400/220kV, 2x315 MVA ICTs at Malda Substation with 400/220 kV, 2x500 MVA ICTs
3. Installation of 3rd 400/220 kV, 1x315 MVA ICT at New Siliguri Substation
4. Replacement of 400/220 kV, 2x315 MVA ICTs at Jeypore Substation with 400/220 kV, 2x500 MVA ICTs
5. Replacement of 400/220 kV, 2x315 MVA ICTs at Rourkela Substation with 400/220 kV, 2x500 MVA ICTs
6. Installation of 400/220 kV, 1x500 MVA ICT at Gaya Substation

11.3 He added that replacement of transformers at Malda, Jeypore and Rourkela would create 6 units of 315 MVA transformers as spare and out of which 2 would be utilised at Durgapur and New Siliguri. The other 4 would be kept as regional spare.

11.4 Director (Project), BSPTCL stated that for replacement of a transformer about 70-80 days shutdown is required. COO, CTU informed that in order to minimise the shut down time during replacement, new transformer would be temporarily installed before starting replacement work. She added that site specific arrangements would be made to reduce the shut down time at the time of replacement of the transformers.

11.5 After further discussion, the above scheme of transformer augmentation was agreed as a part of Eastern Region strengthening scheme-17 (ERSS-17). It was also decided that in case of space constraint, GIS bays may be used, wherever required.

12.0 Conversion of fixed Line Reactors to switchable Line Reactors

12.1 Director, CEA stated that in Eastern Region two no. 400 kV lines as given below are provided with fixed line reactor at one end. These 400 kV line are short lines and fixed reactors are making these line over compensated.

Sl. No.	Name of the Line	Length (in km)	Capacity (MVAR)		Switchable (S) / Fixed (F)		% Compensation
			End I	End II	End I	End II	
1	Lakhisarai – Biharsharif 400 kV D/c	89	--	50	--	F	85.00
2	Keonjhar – Rengali 400 kV S/c	100	--	63	--	F	95.00

12.2 He added that it is proposed to convert the fixed line reactors into switchable line reactors so that they may be utilised as Bus Reactors, as and when needed to improve voltage profile. Further, NGR removal / bypassing may be considered for the above lines as the line length is short. DOV Studies for the

above lines have been carried out and no DOV phenomenon has been observed in absence of the line reactor.

12.3 Thereafter, members agreed to the conversion of fixed line reactors into switchable line reactors as a part of Easter Region strengthening scheme-17 (ERSS-17).

13.0 Identification of termination substation at Rourkela end, for Rourkela – Goelkera (Jharkhand) 132kV S/c line

13.1 Director, CEA stated that Rourkela (Odisha) – Goelkera (Jharkhand) 132 kV S/c line was originally planned to be terminated at Rourkela substation of OPTCL. However, due to construction of buildings and other structures etc. this line could not be terminated at the Rourkela (OPTCL) substation. POWERGRID is carrying out a consultancy works for the state of Jharkhand, wherein Rourkela-Goelkera 132kV S/c line is to be LILO at Manoharpur new substation of JUSNL, Jharkhand. As per preliminary survey at three substations namely 132 kV Rourkela S/S, 132 kV Chhend S/S and 220 kV Tarkera S/S for the termination of the line, it has been found that the line could only be terminated at 220 kV Tarkera S/s of OPTCL.

13.2 He added that the Rourkela (Odisha) – Goelkera (Jharkhand) 132 kV S/c line would now become Tarkera (OPTCL)-Goelkera (Jharkhand) 132 kV S/c line.

13.3 OPTCL was requested to confirm regarding availability / construction of one 132 kV bay required for termination of this line at its Tarkera sub-station. CGM (Const), OPTCL assured to check and confirm.

13.4 Members noted the same.

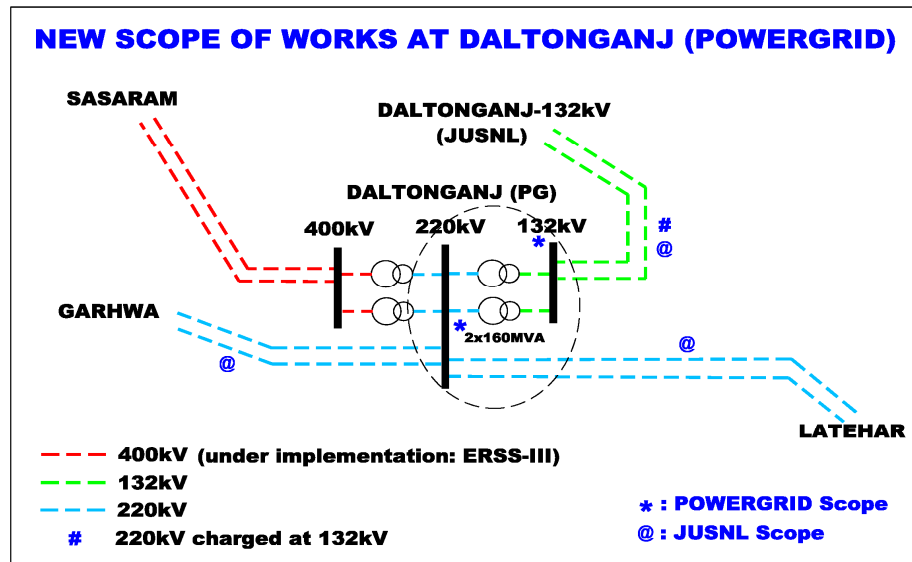
14.0 Proposal of JUSNL (Jharkhand Urja Sancharan Nigam Limited) for provision of 220/132 kV Auto transformer in proposed 400/220 kV GSS of M/s POWERGRID at Daltonganj with provision of 02 nos. 132 kV bays for JUSNL

14.1 Director, CEA stated that JUSNL has informed that due to land acquisition constraints at Daltonganj, it is not possible to create 220 kV level at Daltonganj. POWERGRID is constructing 2x315 MVA 400/220 kV S/S at Daltonganj. JUSNL has requested to provide 2x160 MVA 220/132 kV Auto transformer in the Daltonganj 400 kV S/S of POWERGRID along with necessary 132 kV bays. The existing 220 kV D/C Latehar – Daltonganj transmission line (presently charged at 132 kV level) of JUSNL is passing nearby Daltonganj of POWERGRID. JUSNL has proposed that line from Latehar to Daltonganj will be LILO at Daltonganj (PG) in such a way Daltonganj (PG)-Latehar would be operated at 220 kV and Daltonganj (PG)-Daltonganj (JUSNL) would be operated at 132 kV. JUSNL has also informed that they are constructing 220/132kV Garhwa Rd. S/S as well as Daltonganj-

Garwah Rd. 220kV line which would now be connected at Daltonganj (PG) substation.

14.2 He added that taking care of the reliability aspect of 220/132 kV ICT at Daltonganj, the following is proposed :

- a) 2x160 MVA, 220/132 kV Auto transformer at Daltonganj substation along with 4 number of 132 kV line bays (under the scope of POWERGRID)
- b) LILO of Daltonganj (JUSNL)-Latehar 220kV D/c (operated at 132kV) line of JUSNL at Daltonganj (PG) so that Daltonganj (PG)-Latehar D/c would be operated at 220 kV and Daltonganj (PG)-Daltonganj (JUSNL) would be operated at 132 kV. (Scope of JUSNL)
- c) Daltonganj (PG) –Garwa Rd. 220kV D/c line along with 220/132kV S/s at Garwa Rd. (Scope of JUSNL)



14.3 Director (Projects), BSPTCL stated that cost of 220/132 kV ICT and associated bays should be borne by Jharkhand, as Jharkhand is the sole beneficiary. AGM, POWERGRID said that ISTS sub-stations are created for the drawl of power by the state and because of land acquisition constraint, JUSNL is not able to construct 220/132 kV sub-station at Daltonganj.

14.4 CE (Trans), JUSNL informed that following transmission would be constructed by JUSNL for drawl of power at 220 kV and 132 kV level from Daltonganj (PG).

- a) Daltonganj (PG)-Latehar (JUSNL) 220 kV D/C
- b) Daltonganj (PG)-Garwa (JUSNL) 220 kV D/C
- c) Daltonganj (PG)-Daltonganj (JUSNL) 132 kV D/C
- d) Daltonganj (PG)-Chatrapur / Lesliganj (JUSNL) 132 kV D/C

14.5 After, further discussion, it was agreed to create 132 kV level at Daltonganj (PG) along with 2x160 MVA 220/132 kV ICT and 4 no. 132 kV line bays by POWERGRID as a part of Easter Region strengthening scheme-17 (ERSS-17).

15.0 Extension of under construction Latehar-ESSAR 400 kV D/C line to Chandwa pooling station of POWERGRID - Proposal of JUSNL

15.1 Director, CEA stated that as informed by JUSNL due to cancellation of coal blocks of M/s Essar Power Ltd., the generation project of M/s Essar would be considerably delayed. JUSNL is constructing 400 kV D/C line from Essar to Latehar (about 45 km) and has requested for extension of this line to Jharkhand Pooling station of POWERGRID at Chandwa. The proposal of JUSNL involves construction of 400 kV D/C line from Essar to Chandwa (PG), which is about 10 km, along with 2 no. of 400 kV bays at Chandwa (PG) so as to form Latehar (JUSNL) –Chandwa (PG) 400 kV D/c line. The line along with 2 no. 400 kV bays at Chandwa (PG) would be under the scope of JUSNL.

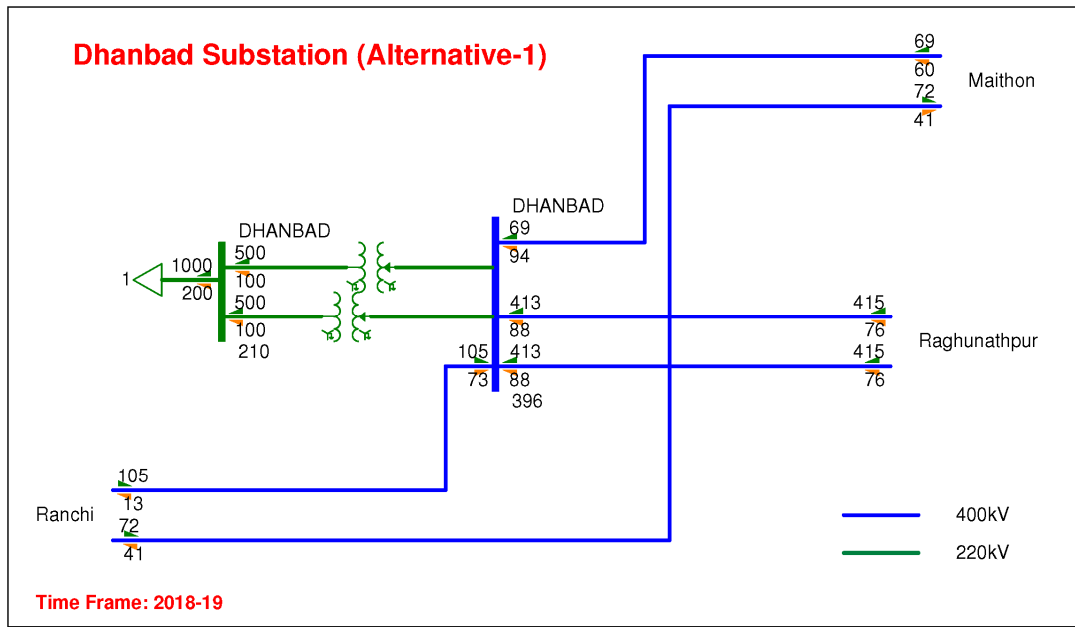
15.2 In view of delay in ESSAR power plant due to cancellation of coal block to M/S ESSAR and to utilise the under construction Latehar-Essar line, Members agreed to extend this line up to Chandwa (PG), under the scope of JUSNL.

16.0 Creation of 400/220 kV sub-station at Dhanbad - Proposal of JUSNL

16.1 Director, CEA stated that JUSNL has informed that under 24x7 power for all scheme, their distribution company has projected a requirement of about 1000 MW in Dhanbad region. To meet the load requirement of Dhanbad region, JUSNL is also constructing 220/132 kV sub-stations each at Govindpur and Jainamore (Bokaro). In order to feed these 220 kV sub-stations, JUSNL has proposed the establishment of 400/220 kV sub-station at Dhanbad by LILO of Maithon-Ranchi 400 kV D/C line. Two alternatives along with power flows as given below have been studied for interconnection with Dhanbad 400kV substation.

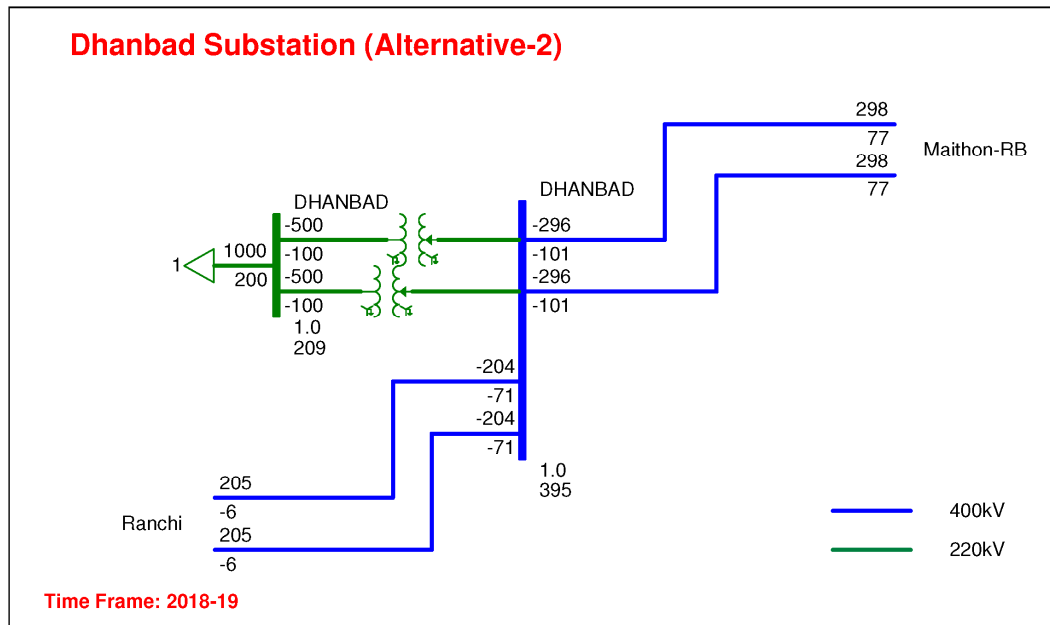
Alternative-1

a) LILO of LILO portion of Maithon-Ranchi line at Raghunathpur so as to form Raghunathpur-Dhanbad 400 kV D/c line and Dhanbad-Maithon and Dhanbad-Ranchi 400kV S/c lines.



Alternative-2

a) LILO of Maithon RB – Ranchi 400kV D/c line at Dhanbad



16.2 AGM, POWERGRID stated that out of the two alternatives studied, the alternative two i.e. LILO of both circuits of Ranchi-Maithon RB 400 kV D/C line at Dhanbad is more suitable.

16.3 After further discussion, establishment of 2x500 MVA 400/220 kV sub-station at Dhanbad by LILO of both circuits of Ranchi-Maithon RB 400 kV D/C line at Dhanbad was agreed as Easter Region strengthening scheme-19 (ERSS-19) to be implemented as ISTS scheme to be built under TBCB. For drawl of

power from Dhanbad, JUSNL would construct 2 no 220kV D/C lines, one each to Govindpur and Jainamore 220 kV sub-stations.

17.0 Evacuation of power from (2x48 MW) Jorethang HEP in Sikkim : Interim arrangement

- 17.1** Director, CEA stated that as per the approved plan, DEPL (Dans Energy Private Limited) was to construct its dedicated transmission line from Jorethang HEP (JHEP) switchyard to the New Melli (PG) sub-station along with 2 nos. 220 kV GIS line bays at New Melli (PG) sub-station. DEPL has informed that due to contractual issues, the transmission line works of DEPL got delayed. Further, they informed that the generation project is expected to be commissioned by June 2015. DEPL has also informed that a section of the dedicated line about 4 km up to tower no. 14 would be completed by them in June 2015. They have intimated that POWERGRID 220 kV D/C line from New Melli sub-station to Rangpo is also expected to be completed by May 2015. As DEPL would not be able to complete the line up to New Melli sub-station of POWERGRID by May 2015, DEPL has requested that they may be allowed to connect completed section of their dedicated line (from tower no. 14) to the POWERGRID line (tower no. 87) as an interim arrangement. They also informed that DEPL is fully committed towards completion of the entire stretch of transmission line. In this regard, order of 2 nos. 220 kV GIS bays at New Melli S/S has already been placed with Alstom in March 2015. DEPL has intimated that they had taken up upon themselves to complete the entire stretch of transmission line up to New Melli S/S matching with the commissioning of 220 kV bays at New Melli. In view of the above, DEPL has requested permission for granting intermediate connection at its 14th tower to POWERGRID 220 kV D/C Rangpo-New Melli line at 87th tower as an interim arrangement.
- 17.2** AGM, POWERGRID informed that the New Melli substation and New Melli – Rangpo 220kV D/c line of POWERGRID would be completed shortly and Jorethang HEP is also expected to be commissioned in June 2015. Accordingly, it is proposed that LILO of New Melli – Rangpo line at 14th tower location to Jorethang – New Melli line may be allowed subject to their commitment towards completion of the remaining part of the dedicated line along with bays at New Melli by Oct 2015. The LILO may be disconnected, if the developer of Jorethang HEP fails to achieve this target. Also the developer of Jorethang would submit regular progress report regarding the balance portion of the transmission system to CEA and CTU.
- 17.3** ACE, Power Dept., Govt. of Sikkim said that the time line of Oct., 2015 for remaining portion of work do not appear to be realistic. He suggested that interim arrangement may be allowed up to March 2016 failing which the LILO may be withdrawn.

- 17.4** After further discussion, it was agreed to either LILO one circuit of New Melli – Rangpo 220 kV D/C line at a suitable point / or make some suitable interconnection, so as to connect New Melli-Rangpo 220 kV D/C line with Jorthang-New Melli 220 kV D/C dedicated line as an interim arrangement. M/s DANS would complete the remaining portion of line and 2 no. 220 kV GIS bays at New Melli by March 2016, failing which the interim arrangement would be disconnected. On the interim arrangement power exchange would be allowed subject to the margins available on transmission system as decided by concerned load dispatch centre.
- 18.0 2x500MVA, 400/220 kV ICT at Pandiabil instead of approved 2x315MVA**
- 18.1** Director, CEA stated that establishment of 2x315 MVA, 400/220 kV new sub-station at Pandiabil in Odisha is under implementation by POWERGRID as part of ERSS-III. In this regard, it is to inform that 2x500 MVA, 400/220 kV ICTs are being installed at Pandiabil instead of 2x315 MVA ICTs earlier approved at the same cost. This shall further augment transformation capacity at this substation to meet future load growth.
- 18.2** Director (Proj.), BSPTCL requested POWERGRID to change all under implementation 315 MVA transformers to 500 MVA transformers as no additional cost is involved. COO, CTU informed that the contactor has agreed to supply 500 MVA transformer at the cost of 315 MVA transformer as they are not having 315 MVA type tested transformer and his 500 MVA transformer is type tested.
- 18.3** Members noted and approved the change in rating of Pandiabil 400/220 kV transformer from 2x315 MVA to 2x500 MVA.
- 19.0 400kV GIS bays at Jharsuguda (Sundargarh) substation for already approved Odisha Phase-II and OPGC Transmission schemes**
- 19.1** Director, CEA stated that in the previous Standing Committee Meeting LILO of both circuits of Rourkela - Raigarh 400 kV D/c (2nd line) at Jharsuguda (Sundargarh) was approved under Common Transmission System for Phase-II Generation Projects in Odisha and OPGC – Jharsuguda 400 kV D/c line under Immediate evacuation system for OPGC generation project in Odisha. The said schemes have already been approved in 27th TCC/ERPC meeting held on 30th-31st May 2014 and 33rd meeting of Empowered Committee on transmission held on 30th Sept 2014.
- 19.2** He added that the scheme require six (6) 400 kV line bays at Jharsuguda (Sundargarh) substation for LILO and dedicated line terminations and there is not enough space for construction of six no. 400 kV AIS line bays at Jharsuguda. Therefore, in view of space constraints, it is proposed that these 400 kV line bays (6 nos.) at Jharsuguda (Sundargarh) be constructed with GIS instead of earlier approved AIS. Further, the scheme also includes bus

splitting at Angul and Jharsuguda. In view of space constraints at Jharsuguda, the split bus arrangement at Jharsuguda (Sundergarh) shall also be implemented with GIS, whereas split bus arrangement at Angul shall also be implemented with AIS.

19.3 In view of space constraint at Jharsuguda (Sundargarh), members agreed to the construction of 6 no. 400 kV line bays and bus splitting (765 kV & 400 kV) arrangement at Jharsuguda (Sundargarh) as GIS instead of AIS.

20.0 LILO of Jharsuguda (Sundargarh) – Dharamjaygarh 765kV D/c (2nd) line at Raigarh (Tamnar) substation of POWERGRID in Western Region

20.1 Director, CEA stated that the Raigarh (Tamnar) 765/400kV is a pooling substation in Western Region in Chhattisgarh, where power from a number of generation projects (totalling to about 4500MW) is being pooled at 400kV level. Further, for evacuation of power from Raigarh (Tamnar) at 765kV level, there is only Raigarh (Tamnar) – Raigarh (Kotra) 765kV D/c line. Thus to improve the reliability of power evacuation from Raigarh (Tamnar) substation, it was decided, in the 36th Standing Committee Meeting on Power System Planning in Western Region held on 29th Aug 2013, to LILO Jharsuguda (Sundargarh) – Dharamjaygarh 765kV D/c (2nd) line at Raigarh (Tamnar), as the line passes in close vicinity to Raigarh (Tamnar) substation.

20.2 Member Secretary, ERPC stated that Sundargarh-Dharamjaygarh 765 kV lines were planned for evacuation of power from Odisha IPPs and Surplus generation in ER to Western and Northern Regions. Therefore, the proposed LILO of both circuits of Sundargarh-Dharamjaygarh at Raigarh (Tamnar) may restrict power evacuation from ER side and also create congestion, thereby overloading in Eastern regional networks.

20.3 AGM, POWERGRID said that for evacuation of power from IPPs in Chhattisgarh, transmission system planned, interalia include \pm 800 kV HVDC from Champa to Kurukshetra, which is under construction. The first HVDC module of 3000 MW is expected to be commissioned by June, 2016. The second module of 3000 MW is scheduled for commissioning by 2017-18.

20.4 After further deliberation, it was decided that the proposal of LILO may be reviewed and considered after the commissioning of 1st module of 3000 MW of +/- 800 kV HVDC from Champa to Kurukhetra by 2016 as indicated by POWERGRID.

21.0 Change of conductor in “Transmission System for Transfer of power from generation projects in Sikkim to NR/WR” scheme

21.1 Director, CEA stated that in order to optimize the RoW / cost, conductor of few transmission lines being implemented by POWERGRID as mentioned

below has been changed from Moose to HTLS, having similar transmission capacity.

Transmission Line	Earlier Conductor	Revised Conductor
LILO of both circuits of Teesta-III – Kishanganj 400kV D/c (quad) line at Rangpo	Quad Moose	Twin HTLS
Rangpo – New Melli 220kV D/c	Twin Moose	Single HTLS

21.2 Members agreed and noted the same.

22.0 Reconductoring of Maithon RB - Maithon 400kV D/c line of POWERGRID

22.1 Director, CEA stated that Maithon RB (MPL) generation project is connected through 400kV D/c line with Maithon and Ranchi sub-stations of POWERGRID. In case of import of power from Western Region, the Maithon RB – Maithon 400 kV D/C line is critically loaded. POSOCO has also highlighted this problem in their operational report. It is therefore, proposed to enhance the capacity of this line by re-conductoring it with high capacity HTLS conductor.

22.2 Members agreed for reconductoring of Maithon RB-Maithon 400 kV D/C line with HTLS conductor by POWERGRID as a part of Eastern Region strengthening scheme-17 (ERSS-17).

23.0 Proposal of BSPTCL regarding LILO of Sasaram – Ara 220 kV D/c line at Pusauli 220/132 kV sub-station of BSPTCL

23.1 Director, CEA stated that BSPTCL has informed that they are establishing a 220/132 kV sub-station at Pusauli through LILO of both circuits of Sasaram - Ara 220 kV D/c line. The scheme is a part of “Sub-Transmission Strengthening in Bihar (Phase-2, Part-II Addendum). The works are nearing completion. Since, Sasaram - Ara 220 kV D/c line is part of ISTS, a formal approval of the Standing Committee is required before charging.

23.2 Members agreed for the LILO of both circuits of Sasaram - Ara 220 kV D/c line at Pusauli by BSPTCL.

24.0 Interim Arrangement for India – Nepal Interconnection through Muzaffarpur (India) – Dhalkebar (Nepal) 400 kV D/c line

24.1 Director, CEA stated that Muzaffarpur (POWERGRID) - Dhalkebar (NEA) 400 kV D/c line is under implementation for interconnection of Indian and Nepalese grids. The line is initially proposed to be operated at 220 kV. While the transmission line is expected to be completed shortly, the 220 kV sub-station at Dhalkebar of NEA is getting delayed. In order to enhance power supply to Nepal, it is proposed to charge the above line at 132 kV as an interim arrangement. For this a 220/132 kV ICT is proposed to be installed at

Muzaffarpur (POWERGRID) from regional pool of spare ICTs as a goodwill gesture.

24.2 Director (Proj.), BSPTCL stated that at present 2x315 MVA 400/220 kV transformers at Muzaffarpur are getting overloaded and the Muzaffarpur (POWERGRID) - Dhalkebar (NEA) line should be charged at 132 kV, only after installation of 3rd transformer at Muzaffarpur (POWERGRID).

24.3 After further discussion, Members agreed to charging of Muzaffarpur (POWERGRID) - Dhalkebar (NEA) 400 kV line at 132 kV and requested POWERGRID to expedite installation of 3rd 400/220 kV 500 MVA transformer at Muzaffarpur.

25.0 Additional works at Sasaram (Pusauli) 765/400 kV sub-station of POWERGRID

25.1 Director, CEA stated that 2x1500 MVA, 765/400 kV sub-station at Sasaram was planned as a part of transmission system associated with DVC and Maithon RB generation projects. However, a part of the scope including 1x1500 MVA, 765/400 kV ICT and 330 MVAR, 765 kV Bus Reactor could not be installed due to severe space constraints. Further, Sasaram - Gaya 765 kV S/c and Sasaram - Fatehpur 765 kV S/c lines, constructed under the same scheme, could not be terminated at Sasaram due to space constraints and these lines are being operated as Gaya – Sasaram - Fatehpur 765 kV line with 330 MVAR mid-point reactor at Sasaram. Accordingly, equipments for these works were not purchased. This along with other issues viz. one tie CB at 765 kV, 765/400 kV ICT connected with one 400 kV main CB etc. results in operational constraints. POWERGRID has informed that the layout of Sasaram sub-station has been reviewed to accommodate additional elements. Accordingly, it is proposed to install 2nd 1500 MVA, 765/400 kV ICT, 2nd 330 MVAR, 765 kV Bus Reactor, terminate Sasaram - Gaya 765 kV S/c and Sasaram - Fatehpur 765 kV S/c line (with 330 MVAR line reactor at Sasaram) and other associated works with GIS at 765 kV level and AIS at 400 kV level. This additional scope is proposed to be implemented as a system strengthening scheme.

25.2 POWERGRID informed that the scheme needs further analyses and may be discussed in the next SCM.

26.0 Immediate evacuation for North Karanpura (3x660MW) generation project of NTPC

26.1 Director, CEA informed that NTPC Ltd. had planned a 1980 MW (3x660MW) thermal power project at North Karanpura in the state of Jharkhand. Accordingly Immediate evacuation system and Transmission system strengthening was planned for North Karanpura project in 2007-08. Following transmission system associated with North Karanpura STPP was finalised:

- a) North Karanpura – Gaya 400kV D/c (quad)
- b) North Karanpura – Ranchi 400kV D/c (quad)
- c) WR Pooling Station – Seoni 765kV S/c
- d) Lucknow – Bareilly 765kV S/c
- e) Bareilly – Meerut 765kV S/c
- f) Agra – Gurgaon (ITP) – Gurgaon (PG) 400kV (quad)
- g) Gurgaon 400/220kV, 2x315MVA GIS sub-station

26.2 He added that the immediate evacuation system from North Karanpura STPP consisting of 400 kV lines from North Karanpura to Ranchi and Gaya pooling stations was entrusted to POWERGRID by Ministry of Power on 13-12-2007. The implementation of the remaining system i.e. from element c) to g) above was entrusted to North Karanpura Transmission Company Ltd. through Tariff Based Competitive Bidding. In view of delay in materialization of North Karanpura generation project, the matter was discussed again in the 29th meeting of Standing Committee in Northern region held on 29-12-2010 at Gurgaon and 19th (Special) meeting of Northern Region Power Committee held on 04-01-2011 at New Delhi, wherein, it was decided that implementation of item no. c) to g) mentioned above are required for transfer of power from Eastern region to Northern region as well as to meet the growing power demand in Northern region. Therefore, implementation of these elements was delinked from the North Karanpura generation project. Matter was also discussed in the 32nd meeting of Standing Committee in Western Region held on 13-05-2011 and 17th meeting of Western Region Power Committee held on 20-05-2011 wherein it was decided to delink item no. c) to g) mentioned above from North Karanpura generation project and consider it as a part of regional system strengthening scheme in Western Region. In view of above, it may be construed that the transmission elements from item no. c) to item no. g) mentioned above have been approved as System Strengthening Scheme for Northern and Western regions and the same was to be implemented by North Karanpura Transmission Company Ltd.

26.3 He added that the implementation of immediate evacuation system by POWERGRID was deferred due to delay in North Karanpura generation project. With revival of North Karanpura generation project, the immediate evacuation system needs to be implemented. As per regulatory requirements, NTPC has submitted applications for grant of Connectivity for North Karanpura, whereas LTA application for the same is awaited. For taking up implementation of the associated transmission system, NTPC need to apply for Long Term Access at the earliest and NTPC / beneficiaries may also sign the LTA agreement at the earliest to enable POWERGRID to proceed further for implementation of transmission system for North Karanpura project.

26.4 He further added that the immediate evacuation system of North Karanpura generation project has been reviewed in light of the transmission system being constructed by POWERGRID as part Transmission System associated with Phase-I Generation Projects (Essar Power-1200 MW, Corporate Power-540MW) in Jharkhand. The transmission system includes Chandwa (Jharkhand) Pooling Station and Chandwa-Ranchi and Chandwa - Gaya 400 kV D/c (Quad) lines. For overall optimisation of transmission system for evacuation of 1740 MW power (from Essar and Corporate) incident at Chandwa pooling station and 1980 MW power of NKSTPP, three high capacity 400kV D/c lines (with quad conductor), two towards Gaya and one towards Ranchi have been proposed. Accordingly, in the immediate evacuation system of North Karanpura, North Karanpura-Chandwa Pool 400 kV D/c line (quad) was proposed in place of North Karanpura-Ranchi 400 kV D/c line (quad). The following revised immediate evacuation System for North Karanpura is proposed to be implemented by POWERGRID:

- a) North Karanpura – Gaya 400 kV D/c with quad moose conductor
- b) North Karanpura – Chandwa (Jharkhand) Pooling Station 400 kV D/c with quad moose conductor

26.5 NTPC informed the commissioning schedule of first unit of North Karanpura generation project as June 2018 and they required start-up power by July 2017.

26.6 After discussion, Members agreed to the revised immediate evacuation system as given above, from North Karanpura (3x660MW) generation project to be implemented by POWERGRID. NTPC was requested to expedite application of LTA and signing of LTA agreement.

27.0 Maintenance of LILO portion (12.6 km) of Farakka-Subhasgram 400 kV line – agenda by ERPC

27.1 Member Secretary, ERPC stated that for facilitating evacuation of Sagardighi TPS generation of WBPDC, the following transmission system was executed by POWERGRID as deposit work:

- i) LILO of Farakka (NTPC)-Subhasgram (PGCIL) 400 kV S/c line at Sagardighi TPS - 12.6 Km
- ii) Sagardighi (WBPDC) –Durgapur / Parulia (PG) 400 kV D/C

27.2 He added that Farakka-Subhasgram 400 kV S/C line is owned and maintained by POWERGRID, but LILO portion (12.6 KM) of the above line at Sagardighi TPS and Sagardighi-Durgapur 400 kV D/C lines owned by WBPDC. However, POWERGRID at present is maintaining both the LILO portion and Sagardighi-Durgapur 400 kV D/C lines on AMC basis. Recently, POWERGRID expressed their unwillingness to renew the AMC for the both

the lines mentioned above. WBPDC, a generation company with lack of expertise in O&M of 400 KV lines, desired to transfer the ownership of existing LILO portion as well as 400 kV Sagardighi-Durgapur D/C to CTU.

- 27.3 He further added that the availability of Farakka-Sagardighi-Jeerat-Rajarhat-Subhasgram 400 kV D/C line and Sagardighi-Durgapur 400 kV D/C line is very much required for exporting about 1000 MW of power to Bangladesh in an uninterrupted manner. In the absence of proper maintenance of the LILO portion and Sagardighi-Durgapur / Parulia (PG) 400 kV D/C line, the required availability may get adversely affected, which in turn may restrict export to Bangladesh. Sagardighi TPS is now supplying power to Bangladesh through 400 kV Sagardighi-Beharampur D/C line. While supplying 1000 MW power to Bangladesh, in the event of outage / tripping of proposed Farakka-Beharampur D/C line (HTLS) line, 400 kV Farakka- Sagardighi D/C 400 kV Sagardighi-Beharampur D/C line, and Sagardighi-Parulia (PG) D/C would be the evacuation route to take care of such contingencies. Also, in case of tripping / outage of one circuit of Beharampur-Bheramara 400 kV D/C line, Run Back of HVDC at Bheramara S/S would take care the power flow to Bangladesh, however, the corresponding increased power availability at Farakka STPS of NTPC and Sagardighi TPS of WBPDC may flow through 400 kV Farakka-Sagardighi-Parulia (PG) D/C line under such contingency. Therefore, 1000 MW power supply to Bangladesh from ER on continuous basis would become reality only when entire transmission system is available under healthy operating condition with well coordinated protection system.
- 27.4 He said that keeping above in view and considering the importance of international transaction, ERPC is of the view that the transmission scheme proposed for additional 500 MW power supply to Bangladesh under Eastern Region Strengthening Scheme-XV (both Transmission lines and Substations in Indian Side), LILO of Farakka (NTPC)-Subhasgram (PGCIL) 400 kV S/c line at Sagardighi TPS (12.6 km) and Sagardighi-Parulia (PG) 400 kV D/c lines be considered as ISTS system.
- 27.5 COO, CTU stated that that taking over the LILO portion and 400 kV Farakka-Durgapur D/C lines on ownership basis involve a lot of commercial issues. She assured that POWERGRID would continue to maintain the proposed line section and 400 kV Sagardighi –Durgapur D/c line as a deposit work of WBPDC as is being done, considering the interest of International power supply agreement.
- 27.6 ERPC requested POWERGRID to take holistic approach to treat the entire transmission system for strengthening and protection point of view in order to maintain supplying of 1000 MW power to Bangladesh

27.7 After further discussion, it was decided that the LILO portion would be maintained by POWERGRID and necessary commercial arrangement in this regard would be made between POWERGRID and WBPDC

28.0 Bypassing arrangement of LILO of 400kV lines at Angul – agenda by POWERGRID

28.1 AGM, POWERGRID stated that LILO of Meramundali – Bolangir / Jeypore 400 kV S/c line at Angul pooling station and LILO of one ckt of Talcher - Meramundali 400 kV D/c line at Angul pooling station has been implemented along with Orissa Phase-I transmission system. While agreeing with these LILOs, it was decided that the LILOs would be disconnected after commissioning of 765 kV Angul pooling station. Now, 765 kV Angul s/s and one ckt of Angul-Jharsuguda 765 kV line has been commissioned and the 2nd circuit of Angul-Jharsuguda line would be commissioned shortly. Further, under Orissa Ph-I generation projects, 5 generation projects are to be connected at Angul. Till date, only GMR and JITPL have been commissioned.

28.2 He added that the 400 kV LILO lines are feeding the load centres of Orissa at Meramundali and Mendasal. It is proposed that the above LILOs at Angul pooling station may not be disconnected. Instead, switching arrangements may be made at Angul substation such that above 400 kV LILOs may be operated either by-passing Angul substation or terminating at Angul substation as and when required, depending upon the power flow condition.

28.3 After, discussion Members agreed to the proposal as a part of Easter Region strengthening scheme-17 (ERSS-17).

29.0 LILO of Teesta-III – Kishanganj 400kV D/c line at Rangpo – agenda by POWERGRID

29.1 AGM POWERGRID stated that the LILO of both ckts of Teesta-III-Kishanganj 400 kV D/c at Rangpo has been agreed as a part of transmission system associated with Sikkim Phase-I generation project and the LILO lines i.e. 400 kV 2xD/C are under construction. One 400 kV D/c line is expected by December 2015. However, the 2nd 400kV D/c line may get considerably delayed as about 8 km of other D/c line involves Tandong Reserve forest. Forest authority has turned down the forest clearance proposal as this area has been identified as proposed Bio-Diversity Park. Physical boundaries of the park yet to be finalised. Therefore, construction of major portion of the 2nd D/c line is not feasible through this area. Revised route of the 2nd D/c line yet to be finalised and may involve substantial quantity variation because of uncertainties. The completion schedule for the same is expected to be around March, 2017

29.2 Members noted.

17th Standing Committee Meeting for ER

Date: 25.05.2015		Venue: NRPC, New Delhi			
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Studies for Dynamic Compensation (STATCOM) requirements

1.0 Background

In the recent past, the dynamic compensation in the form of Static Var Compensator (SVC) was agreed Standing Committee for Power System Planning of various regions which include NR, ER, WR and SR.

Further analysis has been carried out in order to finalise the technology, size etc which would be suitable to Indian Grid conditions. In this process, a series of meetings/discussions with various manufacturers and utilities were undertaken in order to get the insight of the technology along with their opinion/feedback.

To further assist on the above, Dr. Narain G. Hingorani, a consultant of International repute in the field of HVDC, FACTS, Power Electronics, Power Systems and T&D was appointed. After detailed deliberation with him, the following conclusions have been arrived at :

- For dynamic compensation, STATCOM is preferred over SVCs in view of its faster response, requirement of less space and above all its state-of-the-art technology.
- The STATCOMs may be combined with mechanically switched Reactors & Capacitors controlled by STATCOM controller. The STATCOM would be primarily for dynamic compensation while the mechanically switched reactors / capacitors would be for reactive compensation under steady state.

Based on the above, studies were carried out for STATCOM as compared to SVC. The details of the studies are given below:

2.0 Dynamic Compensation

The dynamic compensation facilitates enhanced voltage stability by providing reactive power support to the power system. **Voltage stability** is the ability of a system to maintain steady acceptable voltages at all the buses in the system at all conditions. The ability to transfer reactive power from production source to consumption areas during steady-state operating conditions is a major problem of voltage stability. A system mainly enters a state of voltage instability when a disturbance, increase in load demand, or change in system condition cause a progressive and uncontrollable decline in voltage.

This situation of Voltage instability can be avoided by: (a) appropriate load shedding on the consumer network; (b) on load tap changers; (c) adequate reactive compensation (series and/or shunt). Therefore, the key contributing factor in voltage collapse is the rapid and progressive loss of voltage controllability due to reactive limit violations.

2.1 Static Var Compensator (SVC)

A Static Var Compensator (SVC) is a parallel combination of controlled shunt reactor and capacitor to regulate the voltage at a bus, where it is installed. The arrangement shown in Figure–1 below, is that of a controlled shunt reactor in which thyristors are in series with a reactor that directly control the current flow through the reactor. The effect of controlled firing of the thyristors is to control the effective fundamental frequency admittance of the thyristor-reactor unit as seen from its high-voltage terminals.

Figure–2 below shows the arrangement of combination of controlled reactor in parallel to shunt capacitor.

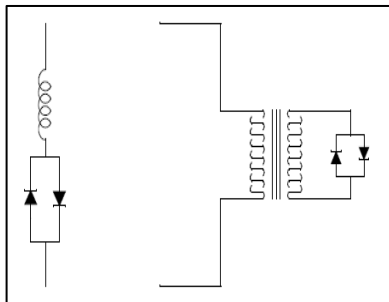


Figure-1

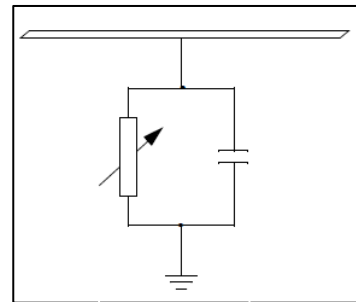


Figure-2

- With the reactor turned “off” through thyristor switching, the installation is a shunt capacitor that will supply reactive power to the system.
- The reactor may be turned “on” in controlled fashion to absorb reactive power of varying quantum, thereby the effective value of reactive VARs absorbed from the system or supplied to the system can be controlled.

In addition SVC also helps in Steady State voltage control, Dynamic voltage control during disturbance, reduction of temporary & dynamic overvoltage, improving transient stability and damping of power oscillations.

2.2 Static Synchronous Compensator (STATCOM)

A Static Synchronous Compensator (STATCOM) is a voltage source converter (VSC)-based device, with the voltage source behind a reactor. The voltage source is created from a DC capacitor and therefore a STATCOM has very little active power capability. The reactive power at the terminals of the STATCOM depends on the amplitude of the voltage source. For example, if the terminal voltage of the VSC is higher than the AC voltage at the point of connection, the STATCOM generates reactive current; on the other hand, when the amplitude of the voltage source is lower than the AC voltage, it absorbs reactive power. The response time of a STATCOM is shorter than that of an SVC, mainly due to the fast switching times provided by the IGBTs of the voltage source converter. The STATCOM also provides better reactive power support at low AC voltages than an SVC, since the reactive power from a STATCOM decreases linearly

with the AC voltage (as the current can be maintained at the rated value even down to low AC voltage).

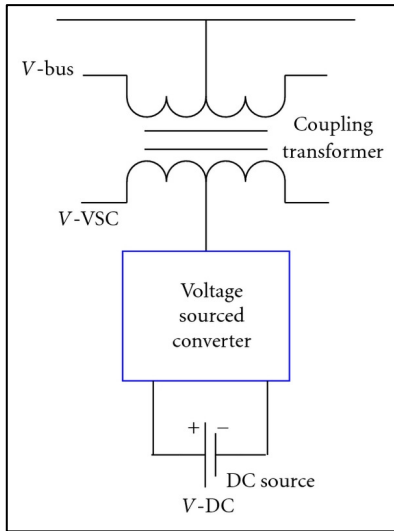


Figure-3

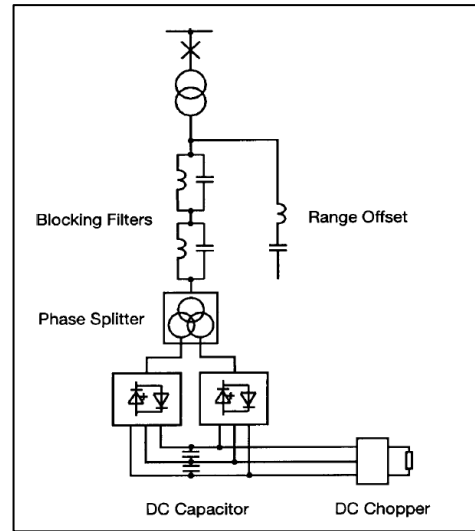


Figure-4

Figure-3 & 4 shows STATCOMs principal diagram and single line diagram respectively.

2.3 STATCOM v/s SVC

Figure-5 & 6 shows VI characteristic of SVC & STATCOMs respectively

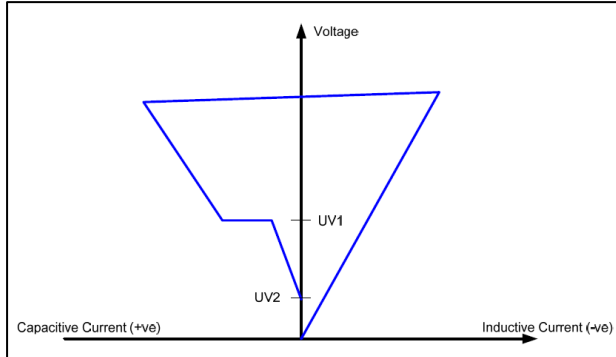


Figure-5

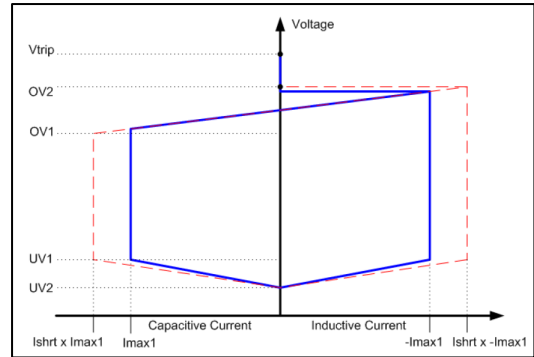


Figure-6

Further advantages of STATCOM as compared to an SVC are

- The reactive power compensation provided by the STATCOM is more than the SVC because at a low voltage limit, the reactive power drops off as the square of the voltage for the SVC, where $Mvar=f(BV^2)$, but drops off linearly with the STATCOM, where $Mvar=f(VI)$. This makes the reactive power controllability of the STATCOM superior to that of the SVC, particularly during times of system distress.

When the system voltage drops sufficiently due to loss of parallel line to force the STATCOM output current to its ceiling, its maximum reactive output current will not be affected by the voltage magnitude. Therefore, it exhibits constant current characteristic. In contrast the SVC's MVA output is proportional to the square of the

voltage magnitude. Thus the capacitive reactive power decreases, just when needed. This is major disadvantage of SVC.

- STATCOM at reduced voltage can still inject maximum current, whereas SVC current capability reduces in proportion to voltage. As a result, STATCOM has superior dynamic response and for comparison, STATCOM may be rated for 75% of SVC rating for same performance in response to line fault.

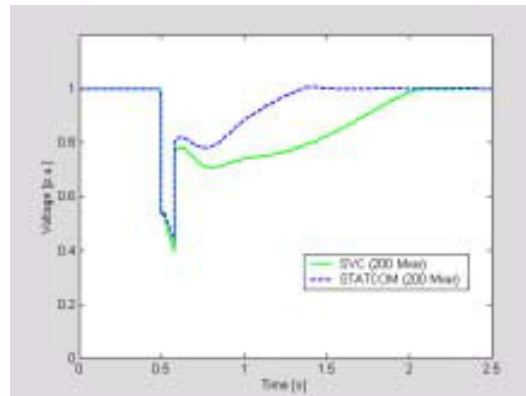


Figure-7 : Voltage variation with SVC & STATCOM

Analytical examination reveals that a STATCOM stability loop is more robust than an SVC with respect to the variation in the network capacity; i.e. for loss of a parallel path. STATCOM also has a quicker response time (step response of 8 ms to 30ms).

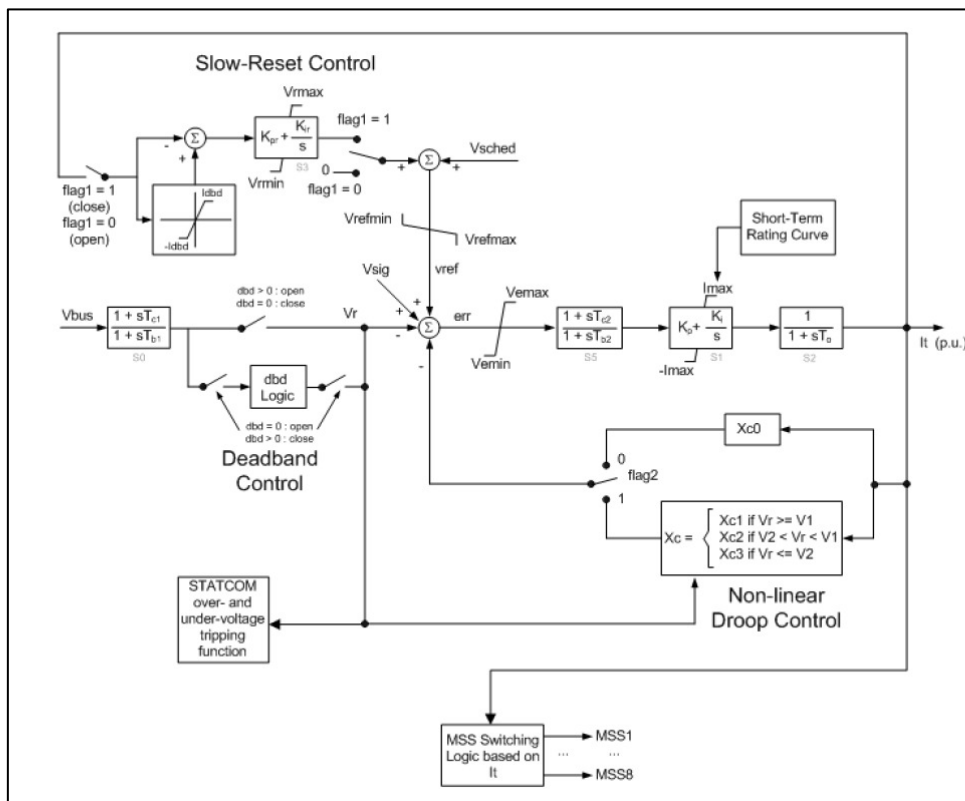
- Active power control is possible with a STATCOM (with optional energy storage on dc circuit). This could further help with system stability control.
- SVCs with TCR need harmonic filters at least 5th-7th, 11th-13th and high pass. The capacitive filter rating is in the range of 30–50% of the TCR size. Filter is not switched and therefore the TCR is offset by 30-50% in capacitive direction. Also low order harmonic filters, depending on the system impedance, may lead to harmonic resonance in the field and may need field modifications. This is also a major disadvantage of TCR. On the other hand, Thyristor Switched Reactors (TSRs) do not need filters but may not be as helpful in damping system oscillations as a continuously variable TCR. Therefore along with TSRs and TSCs, a TCR of a size somewhat greater than each TSR and TSC is still required.

With Thyristors TCR has no current limitation for over-voltage once the reactor is fully in. The STATCOM on the other hand has to be designed for the maximum allowable temporary over voltage in the system.

- No potential for creating a resonance point, as no capacitor banks or reactors are required to generate the reactive power. For modern STATCOMs, only a small blocking filter is required and do not need field modifications.

3.2 STATCOM model considered in the Study:

Following STATCOM model (SVSMO3) was taken in the dynamic study:



3.3 Voltage Profile Analysis for Candidate Locations:

The voltage profile analysis has been carried out for the 400kV inter-state transmission system (ISTS) buses in Northern, Western, Southern and Eastern Region where the SVC were agreed. The comparative analysis of the voltages and MVAR injection at each location with SVC and STATCOM both for peak and off-peak conditions are given in respective Exhibits.

Sl. No.	Bus Name	Short Circuit (GVA/kA)	Peak Dynamic results Exhibit No.		Off-peak Dynamic results Exhibit No.	
			Voltage	MVAR	Voltage	MVAR
Northern Region:						
1.	Nalagarh	19.3 / 27.8	1-P(a)	1-P(b)	1-OP(a)	1-OP(b)
2.	New Lucknow	34.6 / 50.0	2-P(a)	2-P(b)	2-OP(a)	2-OP(b)
Western Region:						
3.	Solapur	24.0 / 34.6	3-P(A)	3-P(B)	3-O(A)	3-O(B)
4.	Gwalior	16.6 / 24.0	4-P(A)	4-P(B)	4-O(A)	4-O(B)
5.	Satna	27.2 / 39.3	5-P(A)	5-P(B)	5-O(A)	5-O(B)
6.	Aurangabad (PG)	30.0 / 43.3	6-P(A)	6-P(B)	6-O(A)	6-O(B)
Southern Region:						
7.	Hyderabad (PG)	18.4 / 26.5	7-P(a)	7-P(b)	7-OP(a)	7-OP(b)
8.	Udumalpet	19.4 / 28.0	8-P(a)	8-P(b)	8-OP(a)	8-OP(b)
9.	Trichy	12.5 / 18.0	9-P(a)	9-P(b)	9-OP(a)	9-OP(b)

Eastern Region:						
10.	Jeypore	10 / 14.4	10-P(a)	10-P(b)	10-O(a)	10-O(b)
11.	Kishanganj	20.2 / 29.2	11-P(a)	11-P(b)	11-O(a)	11-O(b)
12.	Ranchi (New)	32.2 / 46.5	12-P(a)	12-P(b)	12-O(a)	12-O(b)
13.	Rourkela	25.5 / 36.8	13-P(a)	13-P(b)	13-O(a)	13-O(b)

The study results show improvement in voltage profile with STATCOMs compared to that with the SVCs.

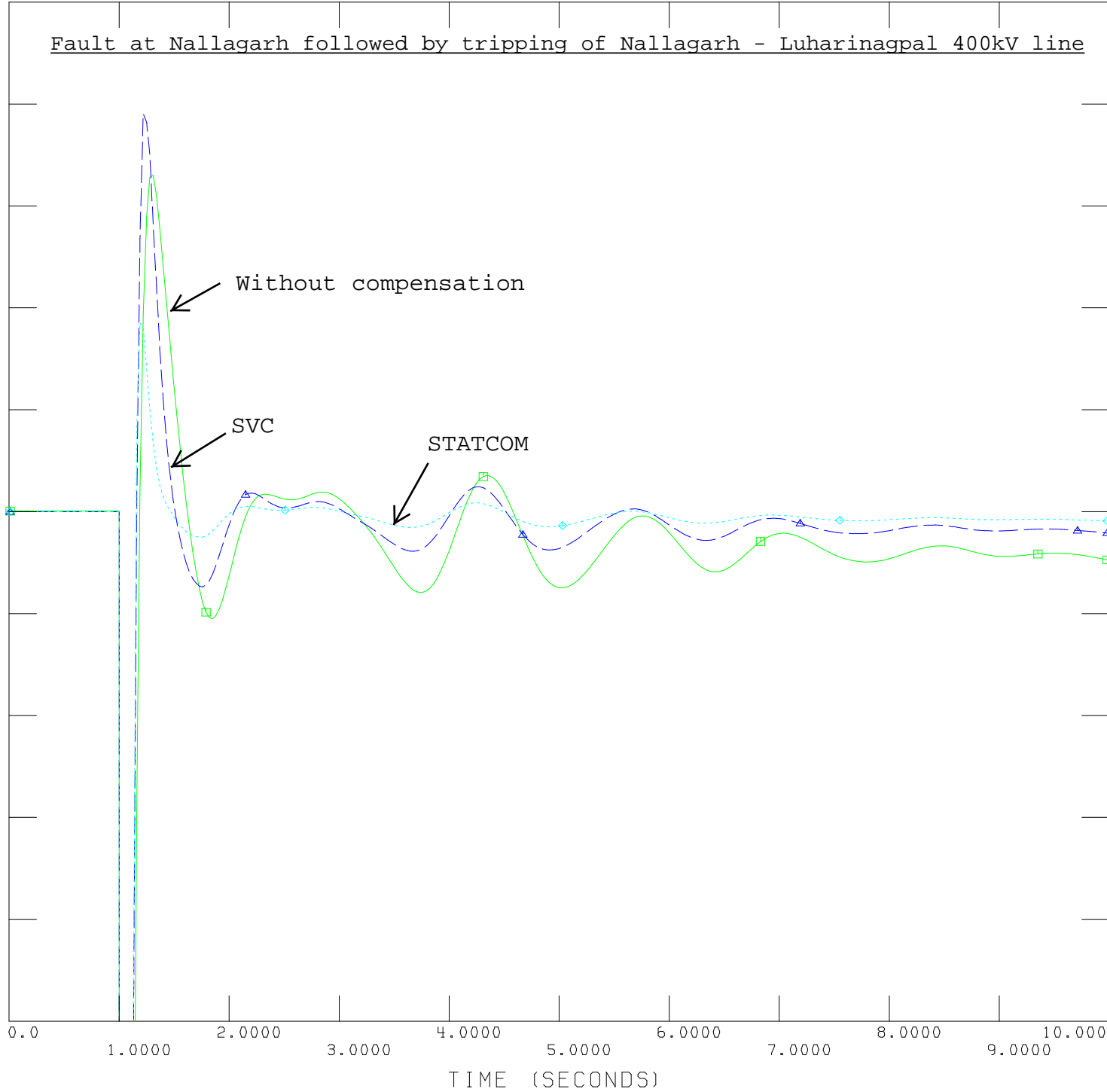
4.0 Conclusion

For optimisation of dynamic compensation, hybrid solutions of STATCOM along with mechanically switched capacitors & reactors controlled by STATCOM controller has been considered. The STATCOM would be primarily for dynamic compensation while the mechanically switched reactors / capacitors would be for reactive compensation under steady state. Accordingly, in place of ± 400 MVAR dynamic compensation in the form of SVC approved earlier, a variable component of ± 200 MVAR to ± 300 MVAR has been considered while the balance reactive compensation has been provided through Mechanically Switched Reactors & Capacitors.

Based on the above considerations and studies, it is proposed that following STATCOMs may be considered to meet the dynamic reactive compensation requirements at following sub-stations:

Sl. No.	Location	Dynamic Compensation (STATCOM)	Mechanically Switched Compensation (MVAR)	
			Reactor	Capacitor
Northern Region:				
14.	Nalagarh	± 200 MVAR	2 x 125	2 x 125
15.	New Lucknow	± 300 MVAR	2 x 125	1 x 125
Western Region:				
16.	Solapur	± 300 MVAR	2 x 125	1 x 125
17.	Gwalior	± 200 MVAR	2 x 125	1 x 125
18.	Satna	± 300 MVAR	2 x 125	1 x 125
19.	Aurangabad (PG)	± 300 MVAR	2 x 125	1 x 125
Southern Region:				
20.	Hyderabad (PG)	± 200 MVAR	2 x 125	1 x 125
21.	Udumalpet	± 200 MVAR	2 x 125	1 x 125
22.	Trichy	± 200 MVAR	2 x 125	1 x 125
Eastern Region:				
23.	Rourkela	± 300 MVAR	2 x 125	-
24.	Kishanganj	± 200 MVAR	2 x 125	-
25.	Ranchi (New)	± 300 MVAR	2 x 125	-
26.	Jeypore	± 200 MVAR	2 x 125	2 x 125

Fault at Nallagarh followed by tripping of Nallagarh - Luharinagpal 400kV line



1.0200 FILE: D:\South on Anil\PSSE\STATCOM_Study\Nallagarh=STATCOM=P.out CHNL # 23: [NALLAGARH VOLTAGE] 0.98000

1.0200 FILE: D:\South on Anil\PSSE\STATCOM_Study\Nallagarh=SVC=P.out CHNL # 23: [NALLAGARH VOLTAGE] 0.98000

1.0200 FILE: D:\South on Anil\PSSE\STATCOM_Study\Nallagarh=P.out CHNL # 23: [NALLAGARH VOLTAGE] 0.98000

EXHIBIT-1-P(a)

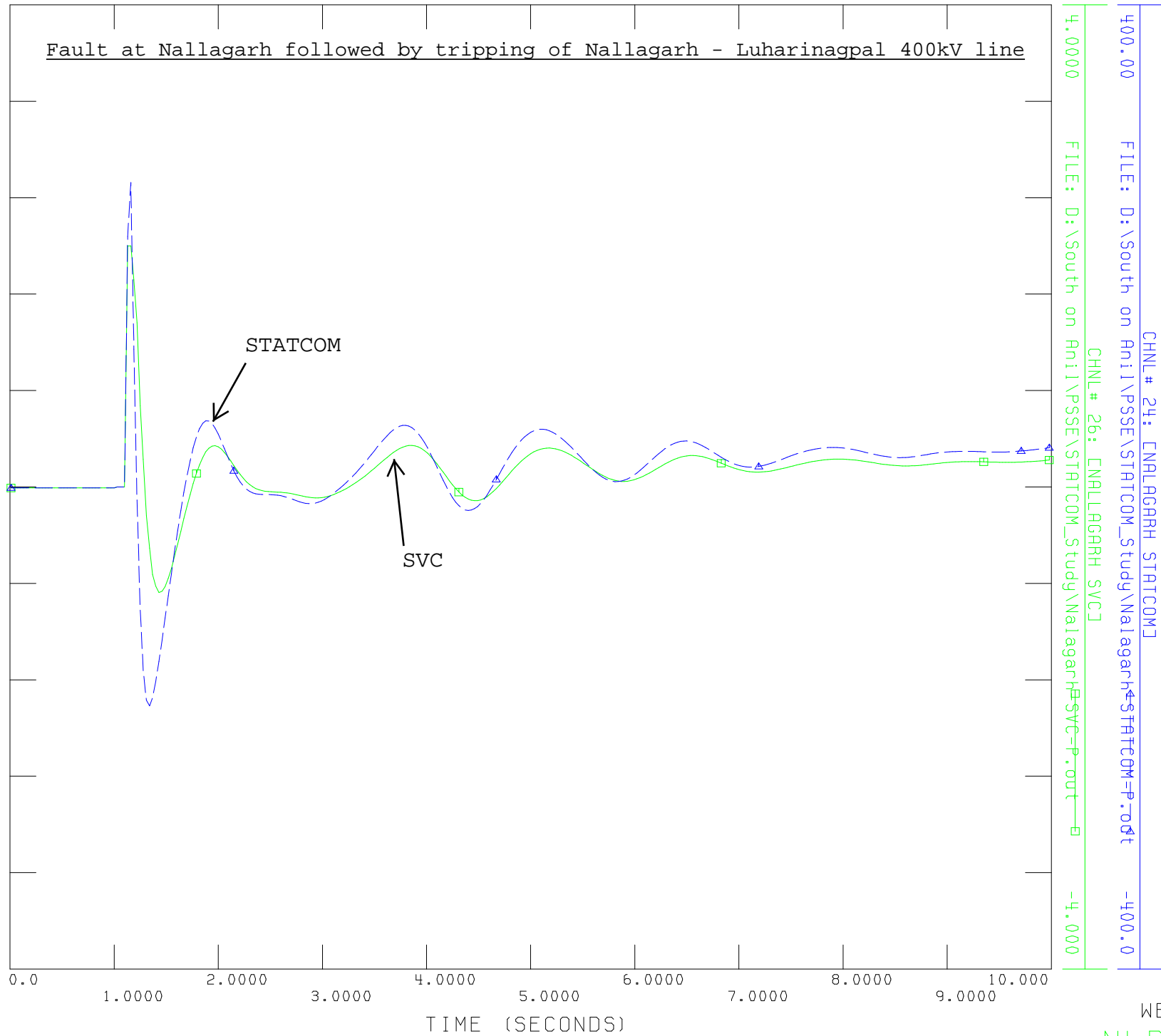
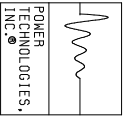
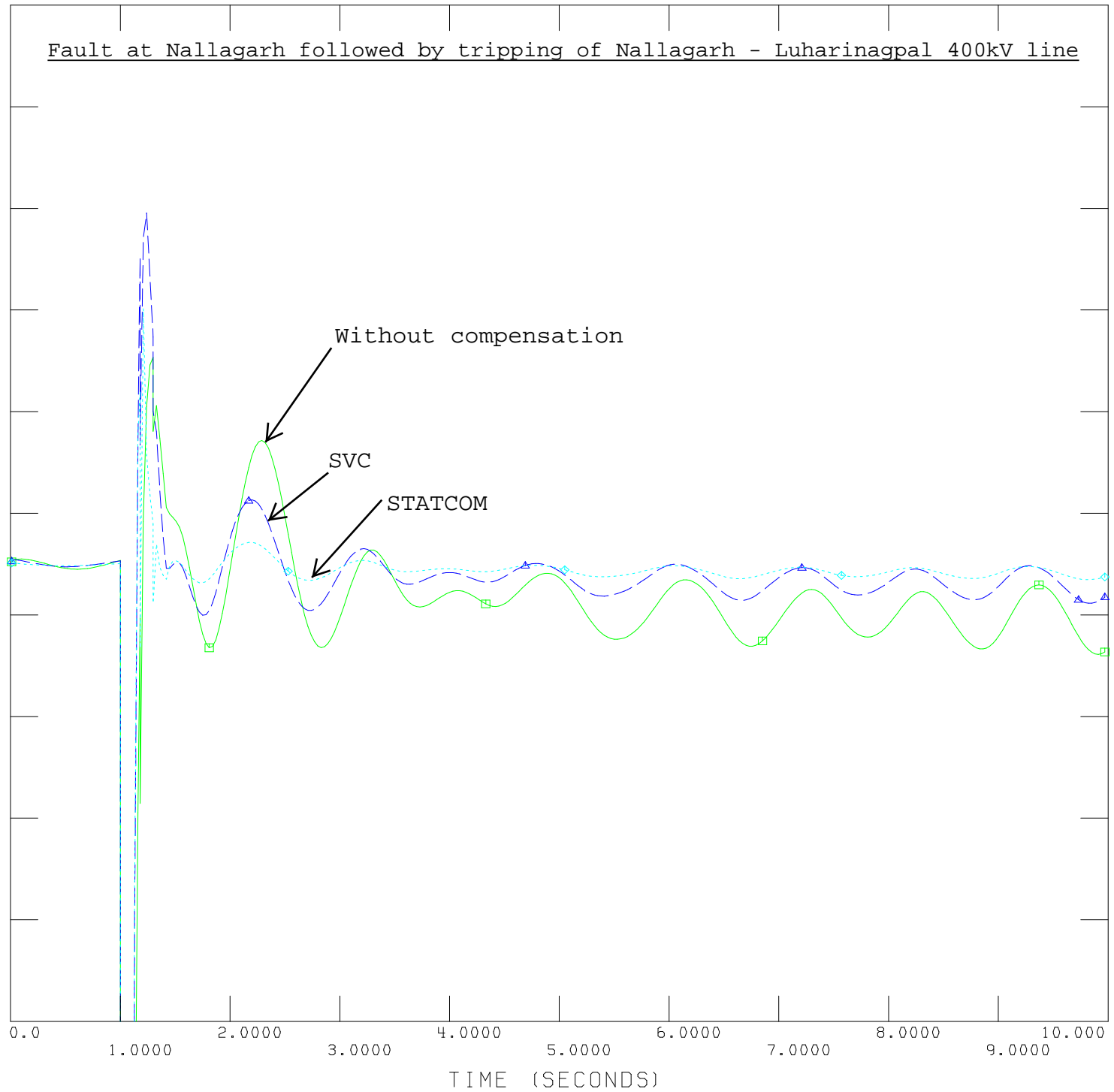


EXHIBIT-1-P(b)

WED, AUG 07 2013 22:41
NLRGH MVAR - PEAK

Fault at Nallagarh followed by tripping of Nallagarh - Luharinagpal 400kV line



1.0300 FILE: D:\South on Anil\PSSE\STATCOM_Study\Nallagarh-VOLTAGCE] CHNL# 23: [NALLAGARH VOLTAGE] 0.99000

1.0300 FILE: D:\South on Anil\PSSE\STATCOM_Study\Nallagarh-VOLTAGCE] CHNL# 23: [NALLAGARH VOLTAGE] 0.99000

1.0300 FILE: D:\South on Anil\PSSE\STATCOM_Study\Nallagarh-VOLTAGCE] CHNL# 23: [NALLAGARH VOLTAGE] 0.99000

EXHIBIT-1-OP(a)

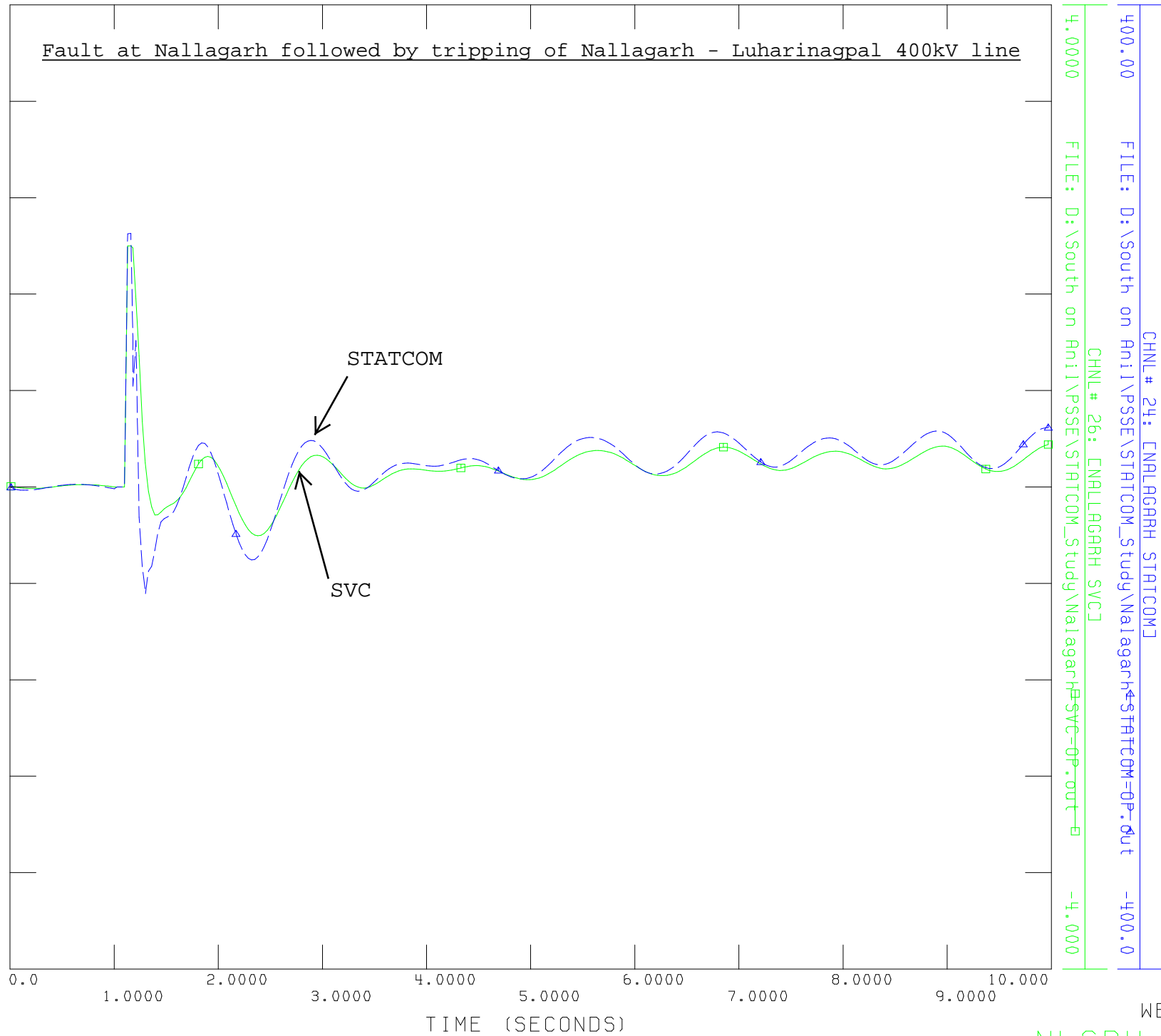
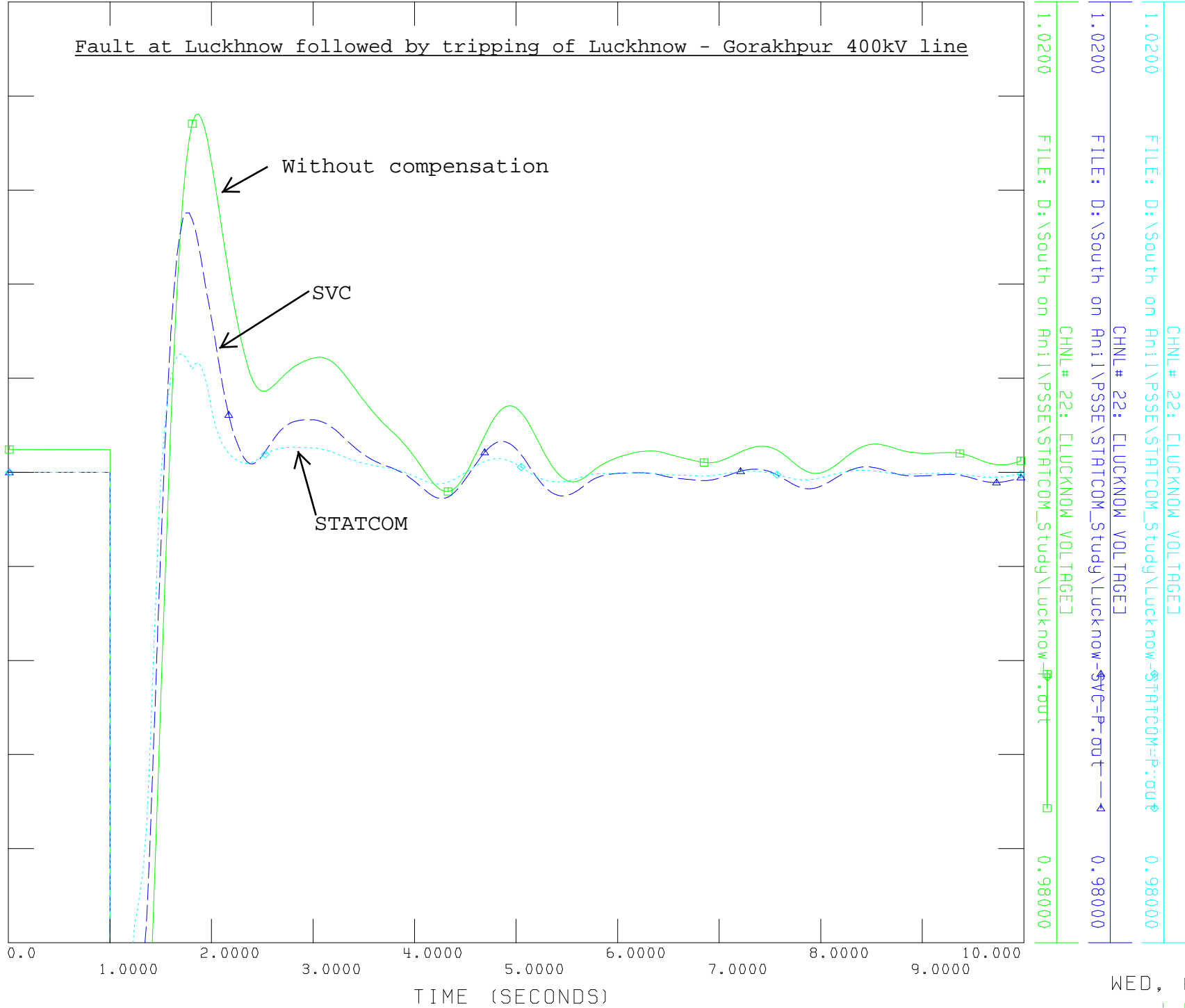


EXHIBIT-1-OP(b)

Fault at Luckhnow followed by tripping of Luckhnow - Gorakhpur 400kV line



1.0200 FILE: D:\South on Anil\PSSE\STATCOM_Study\Lucknow-STATCOM-P.out CHNL# 22: CLUCKNOW VOLTAGE] 0.98000

1.0200 FILE: D:\South on Anil\PSSE\STATCOM_Study\Lucknow-SVC-P.out CHNL# 22: CLUCKNOW VOLTAGE] 0.98000

1.0200 FILE: D:\South on Anil\PSSE\STATCOM_Study\Lucknow-STATCOM-P.out CHNL# 22: CLUCKNOW VOLTAGE] 0.98000

EXHIBIT-2-P(a)

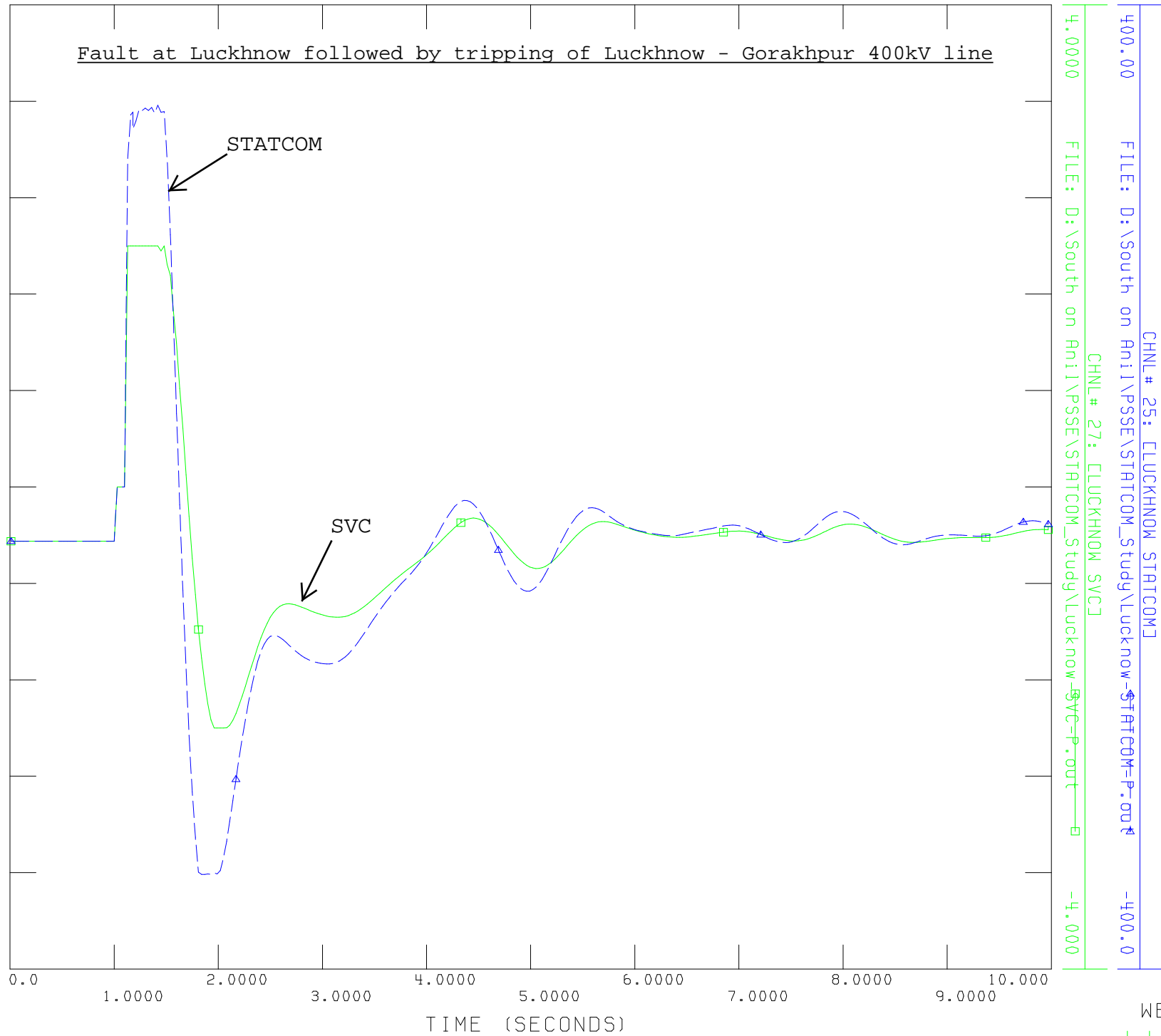


EXHIBIT-2-P(b)

WED, AUG 07 2013 22:30
LUCK MVAR - PEAK

Fault at Luckhnow followed by tripping of Luckhnow - Gorakhpur 400kV line

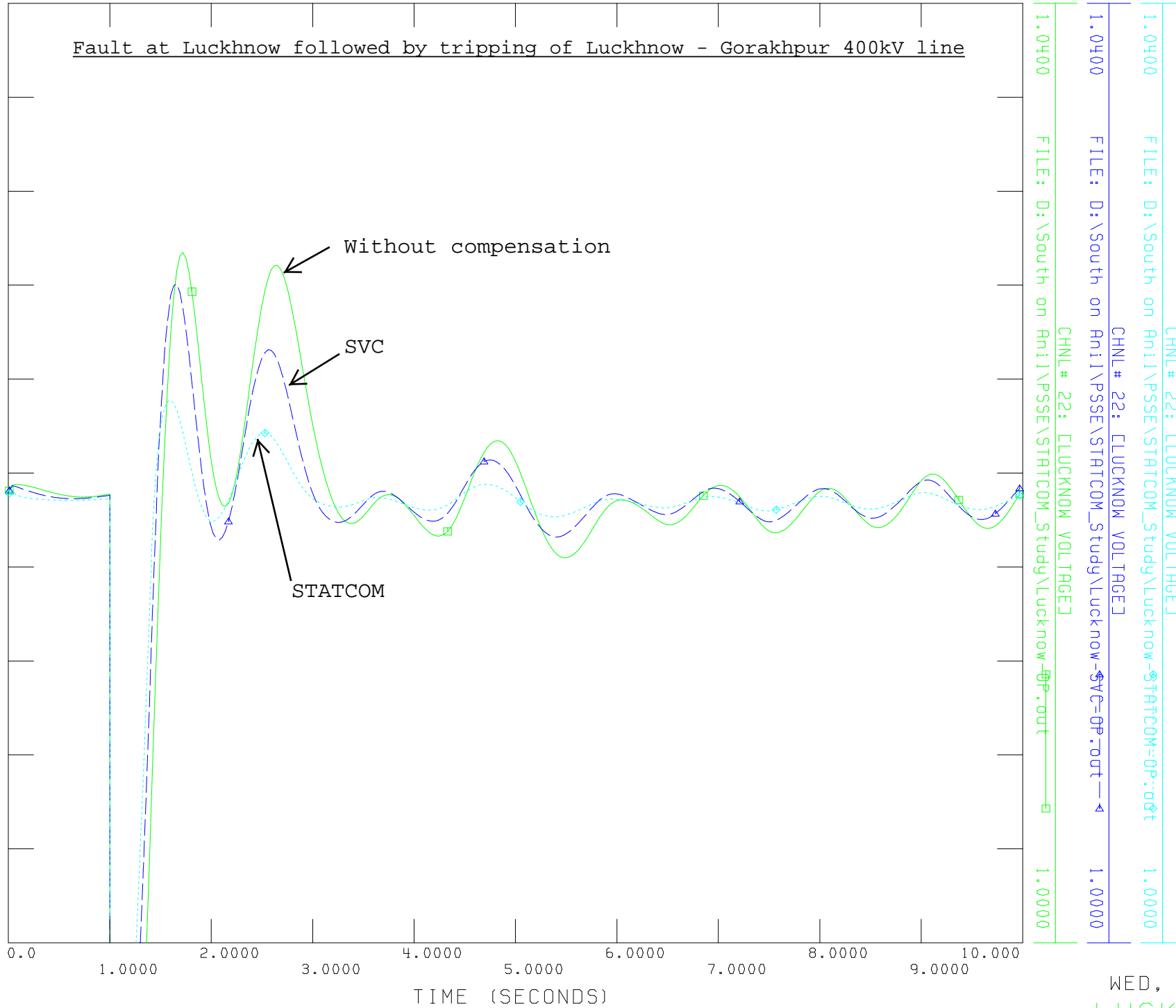


EXHIBIT-2-OP(a)

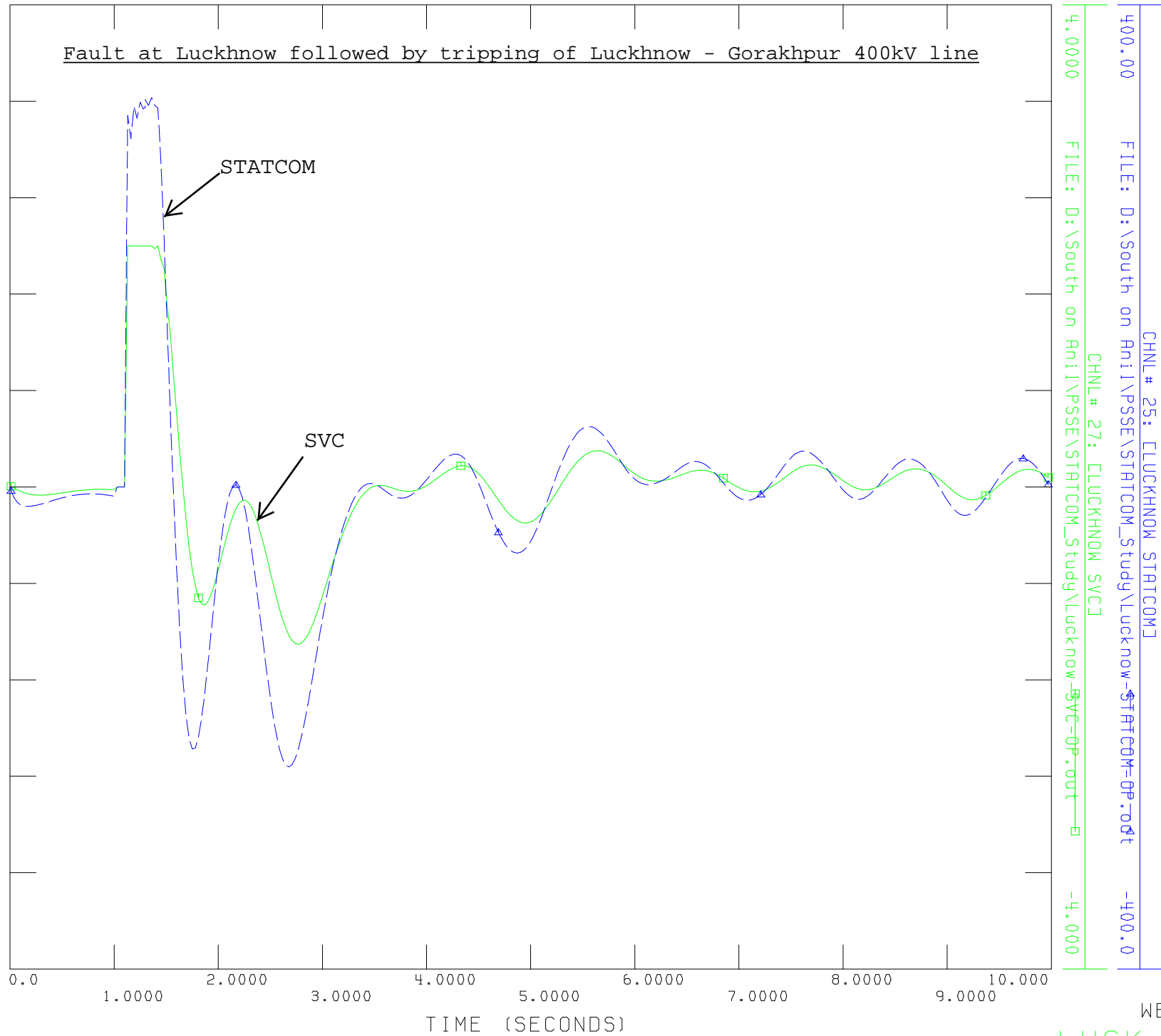
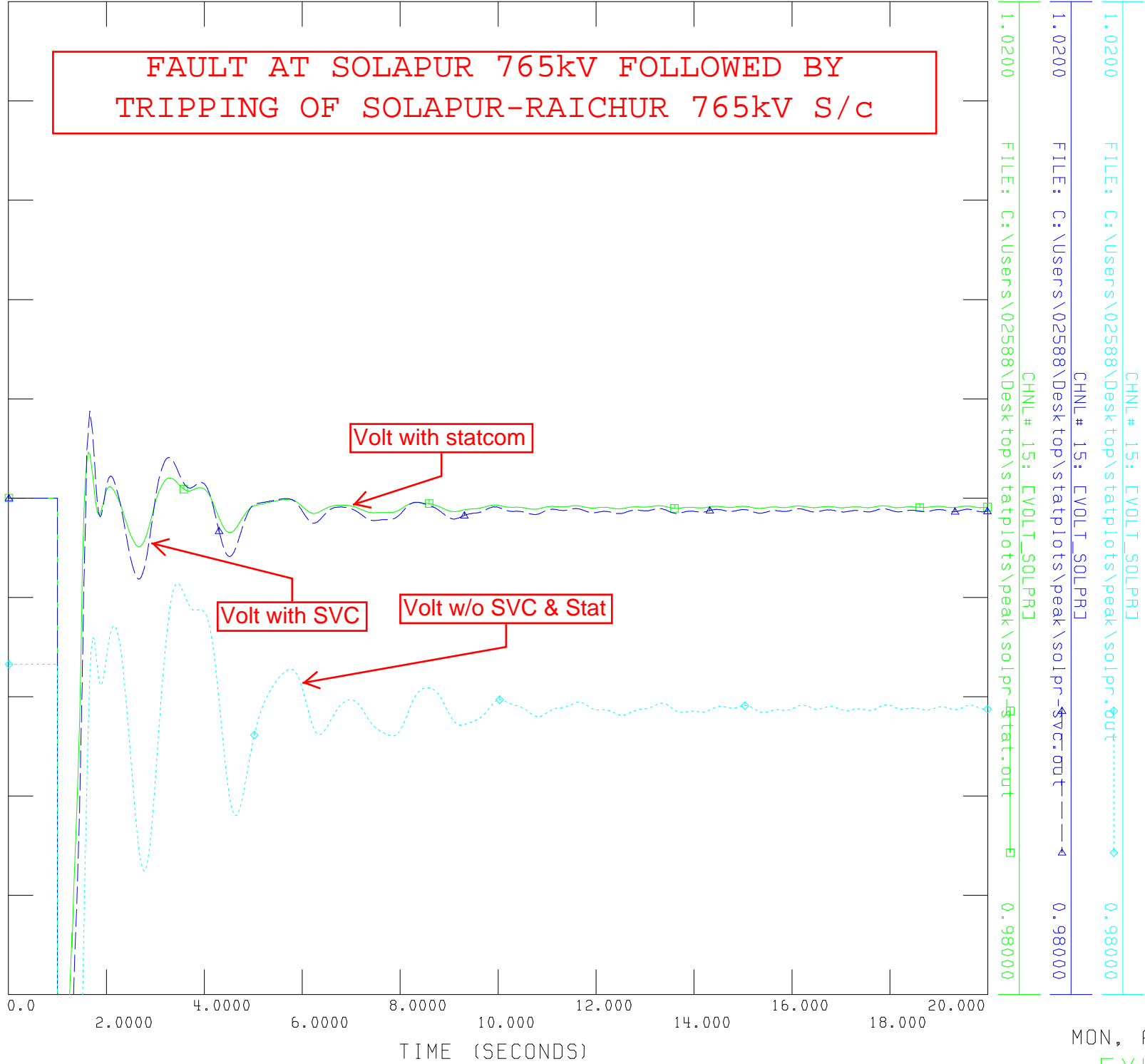
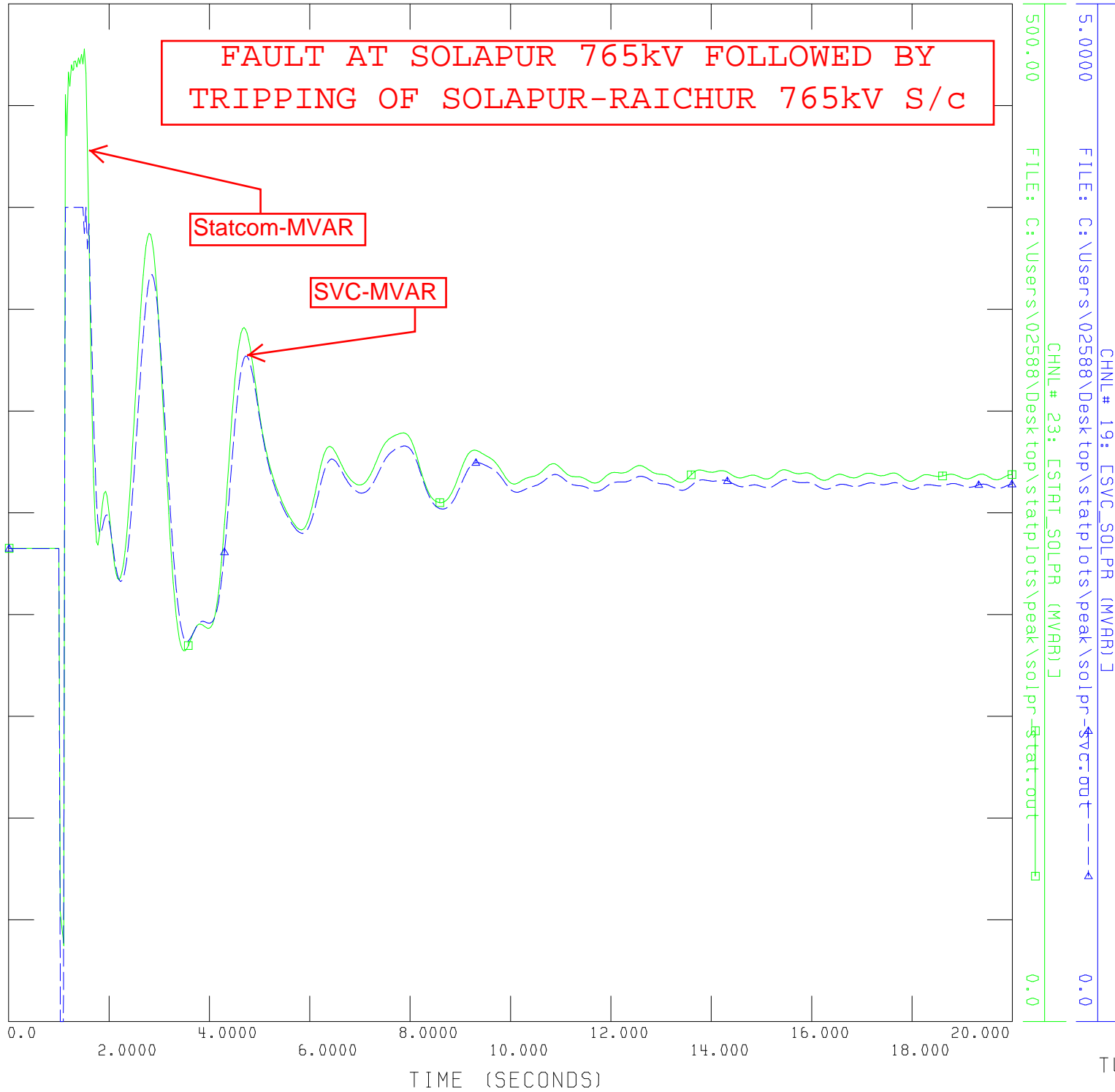


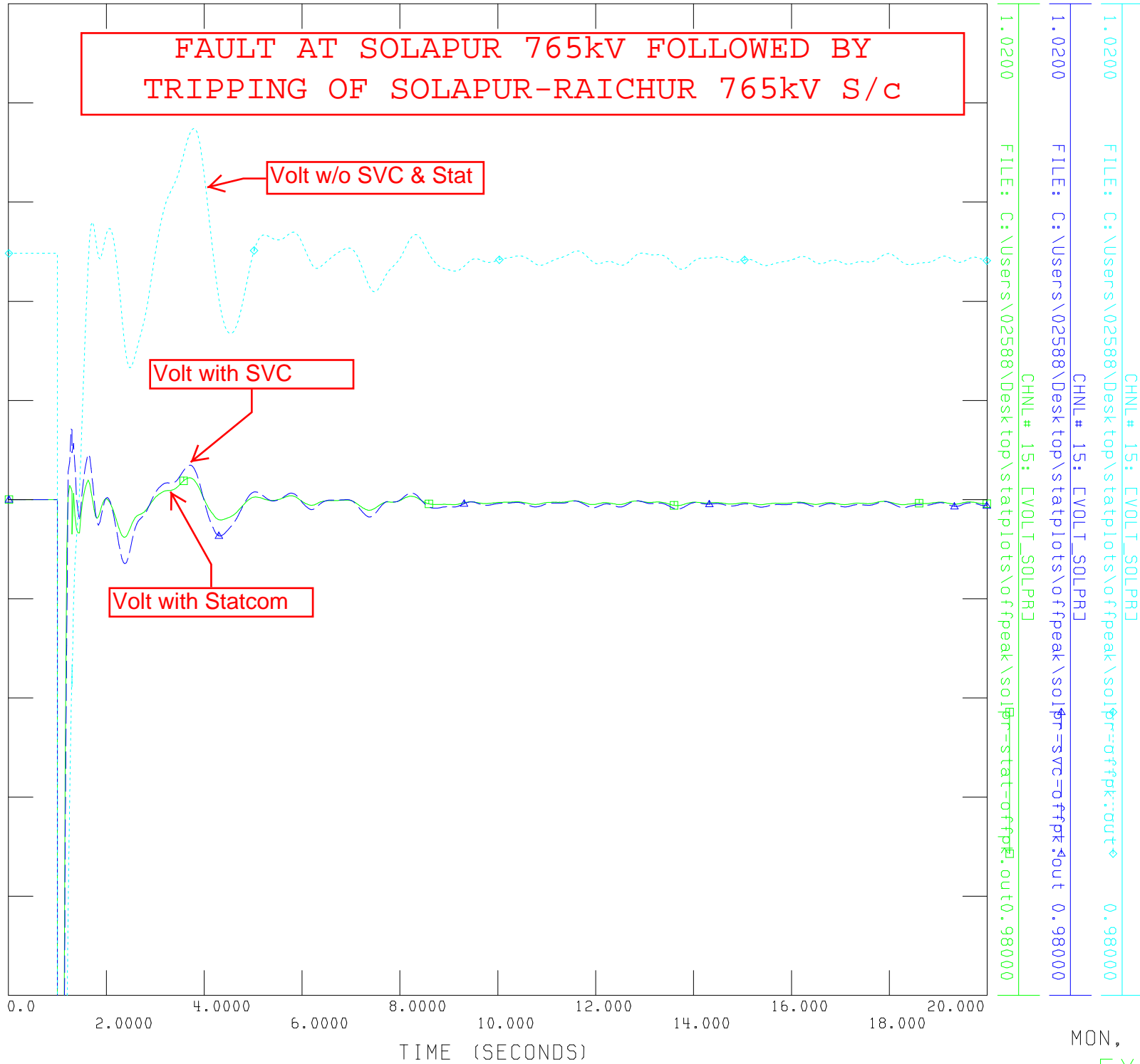
EXHIBIT-2-OP(b)

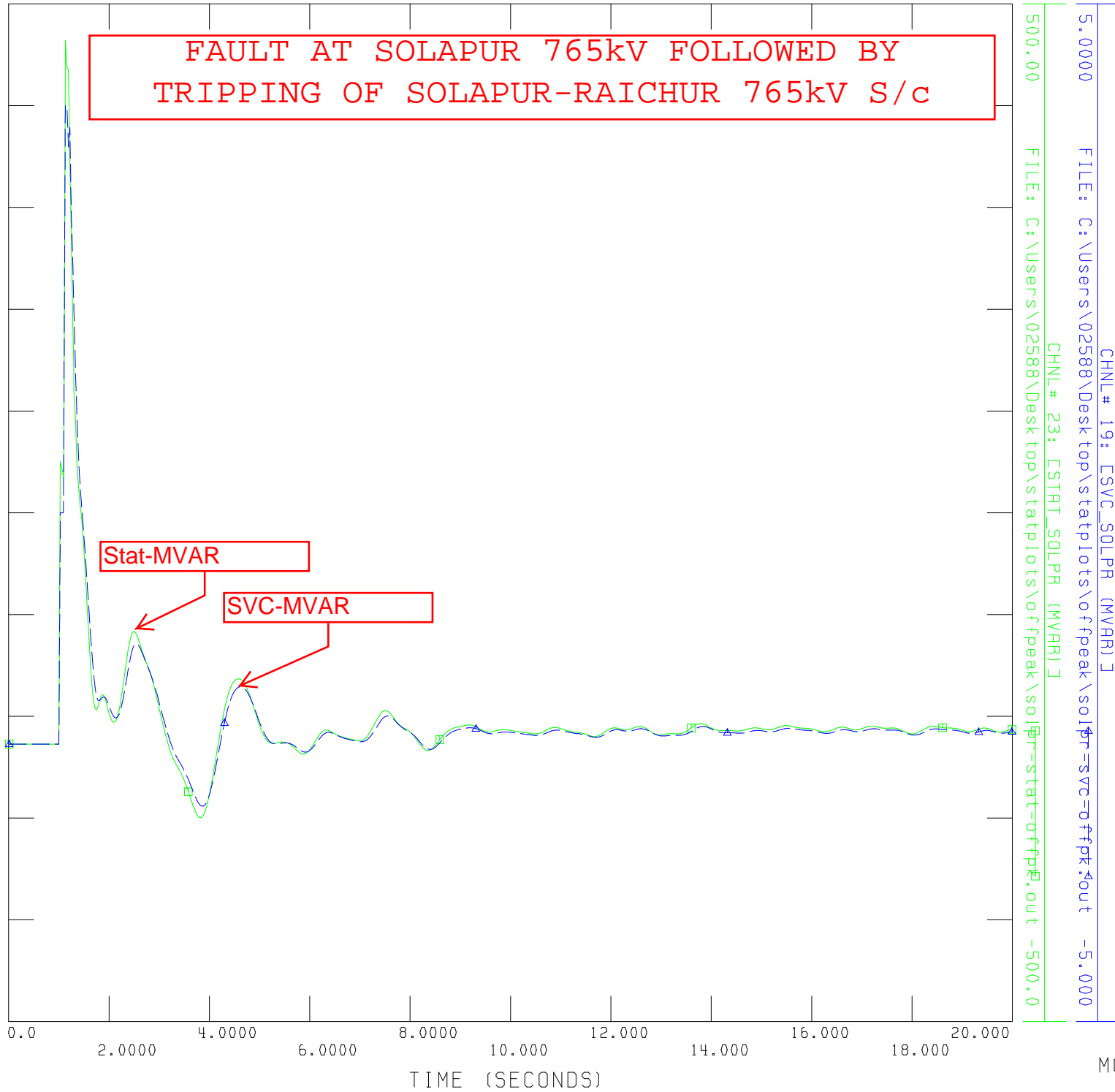
FAULT AT SOLAPUR 765kV FOLLOWED BY TRIPPING OF SOLAPUR-RAICHUR 765kV S/c



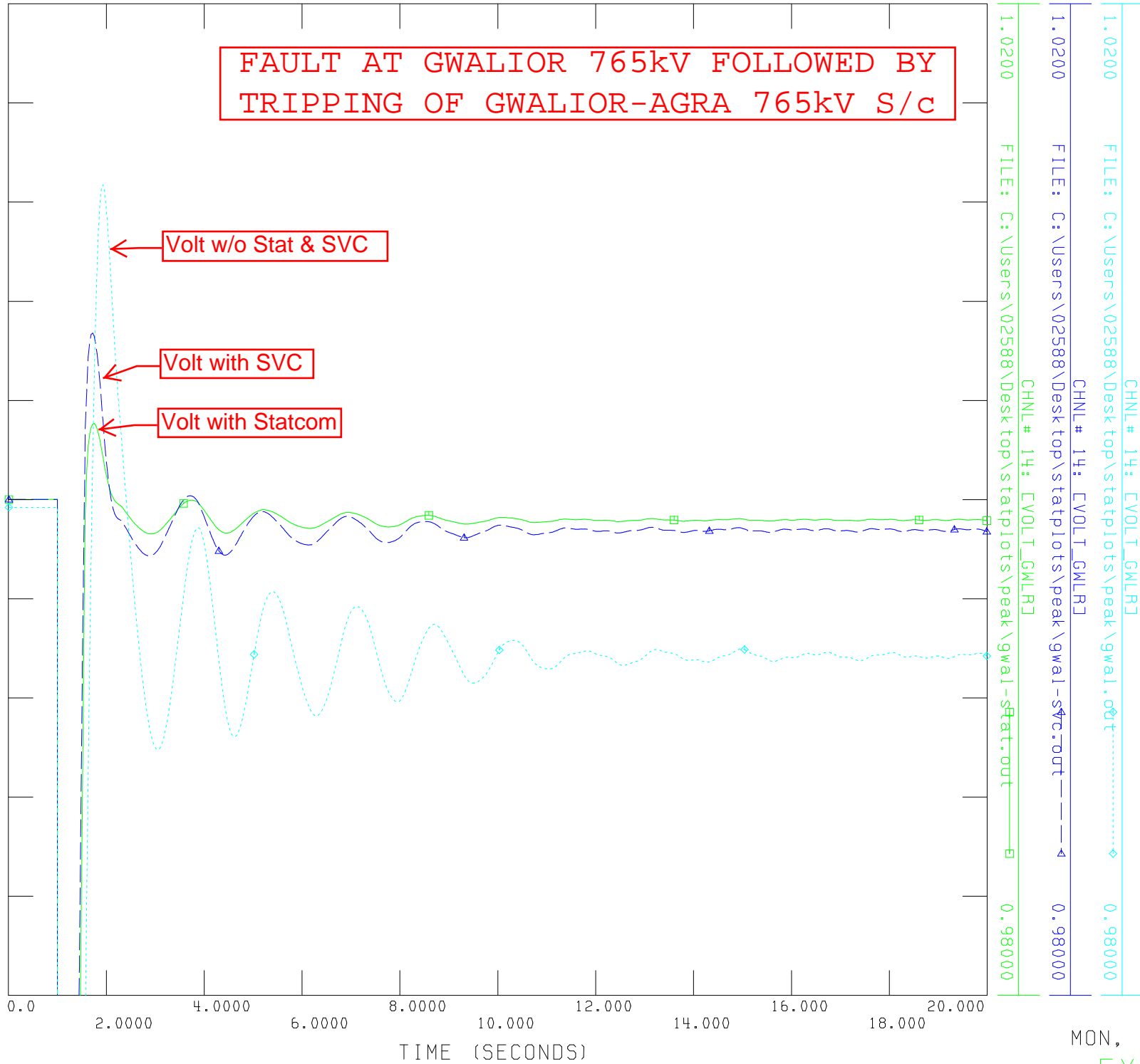


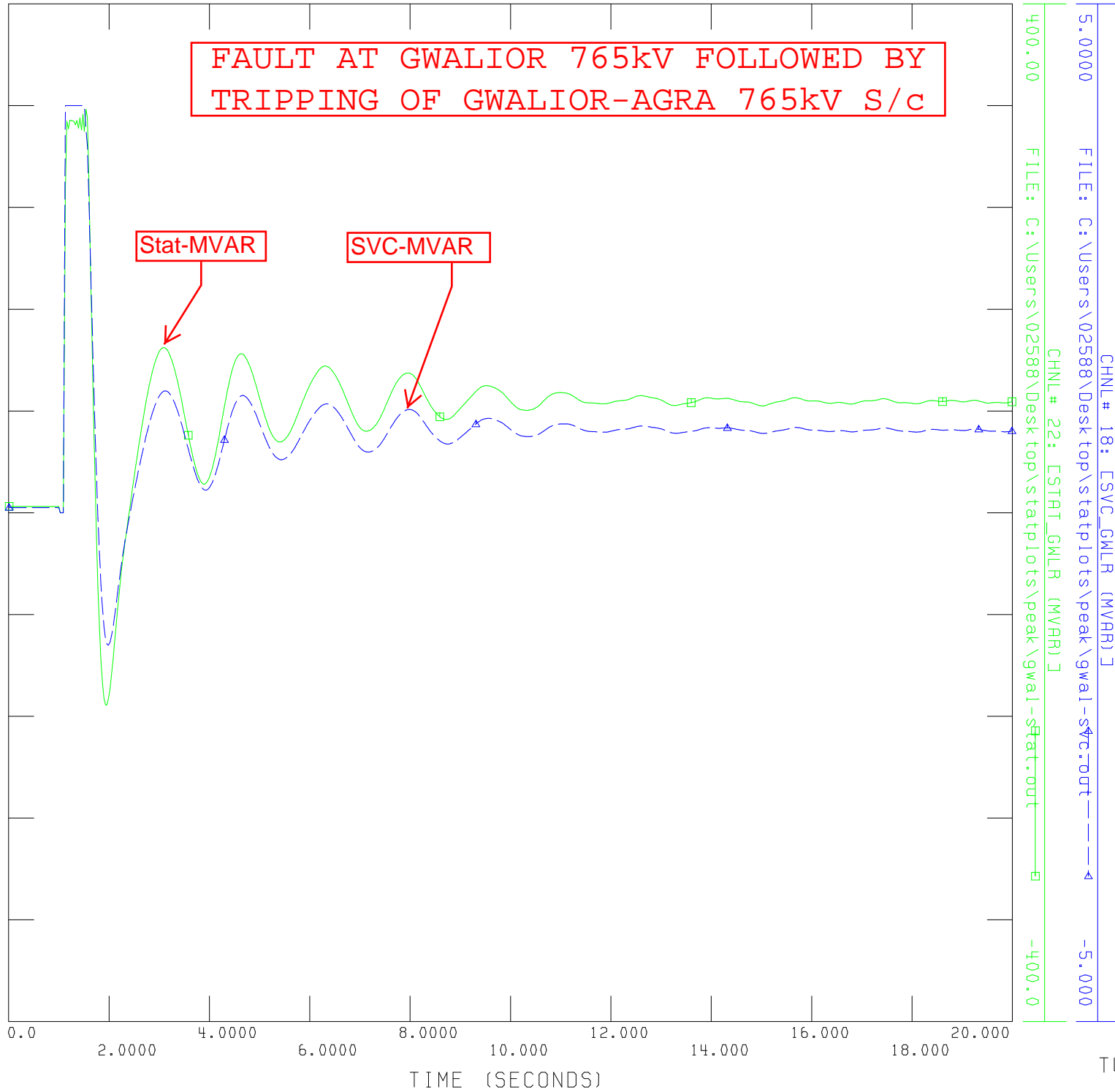
FAULT AT SOLAPUR 765kV FOLLOWED BY TRIPPING OF SOLAPUR-RAICHUR 765kV S/c



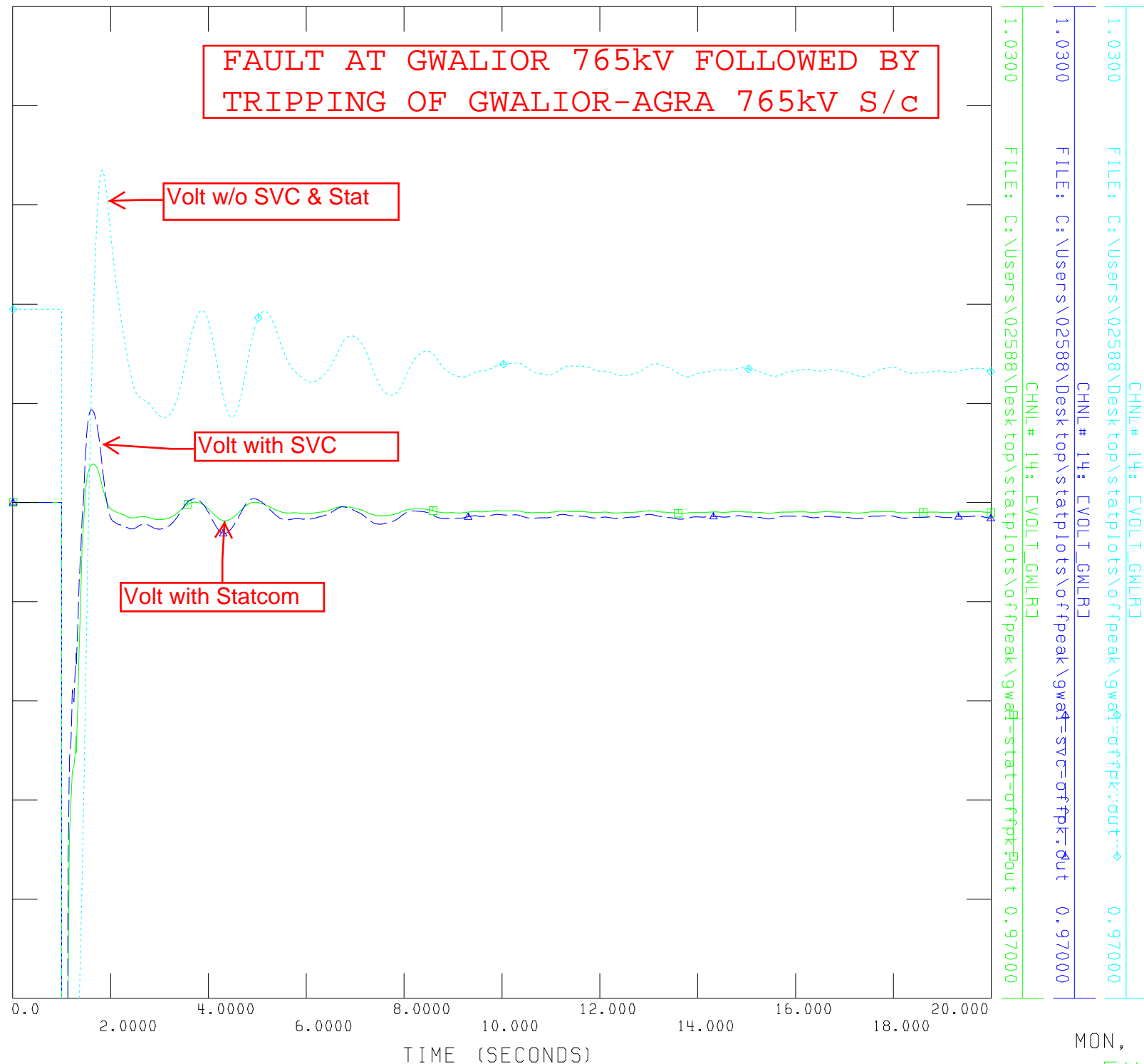


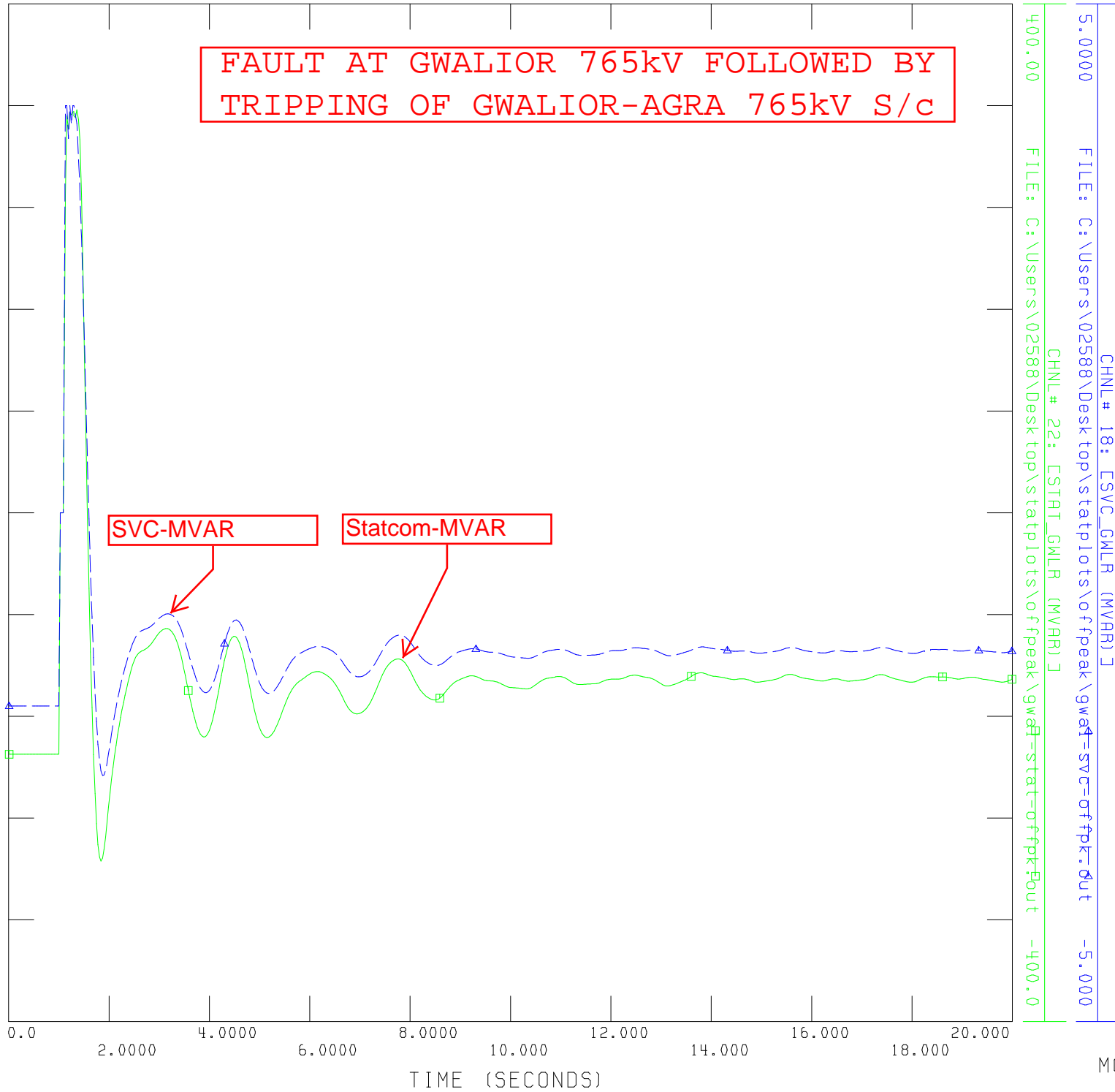
FAULT AT GWALIOR 765kV FOLLOWED BY TRIPPING OF GWALIOR-AGRA 765kV S/c



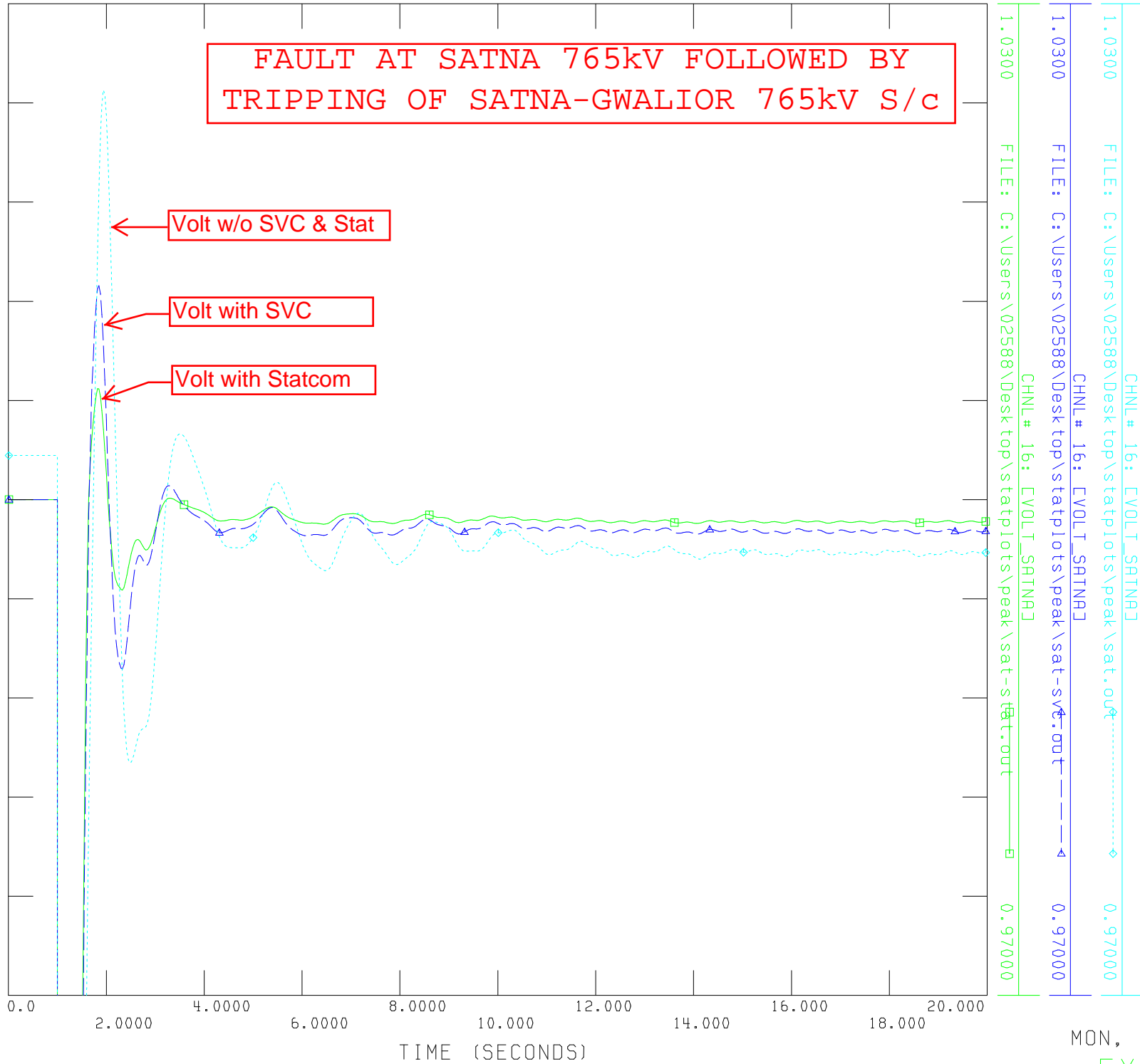


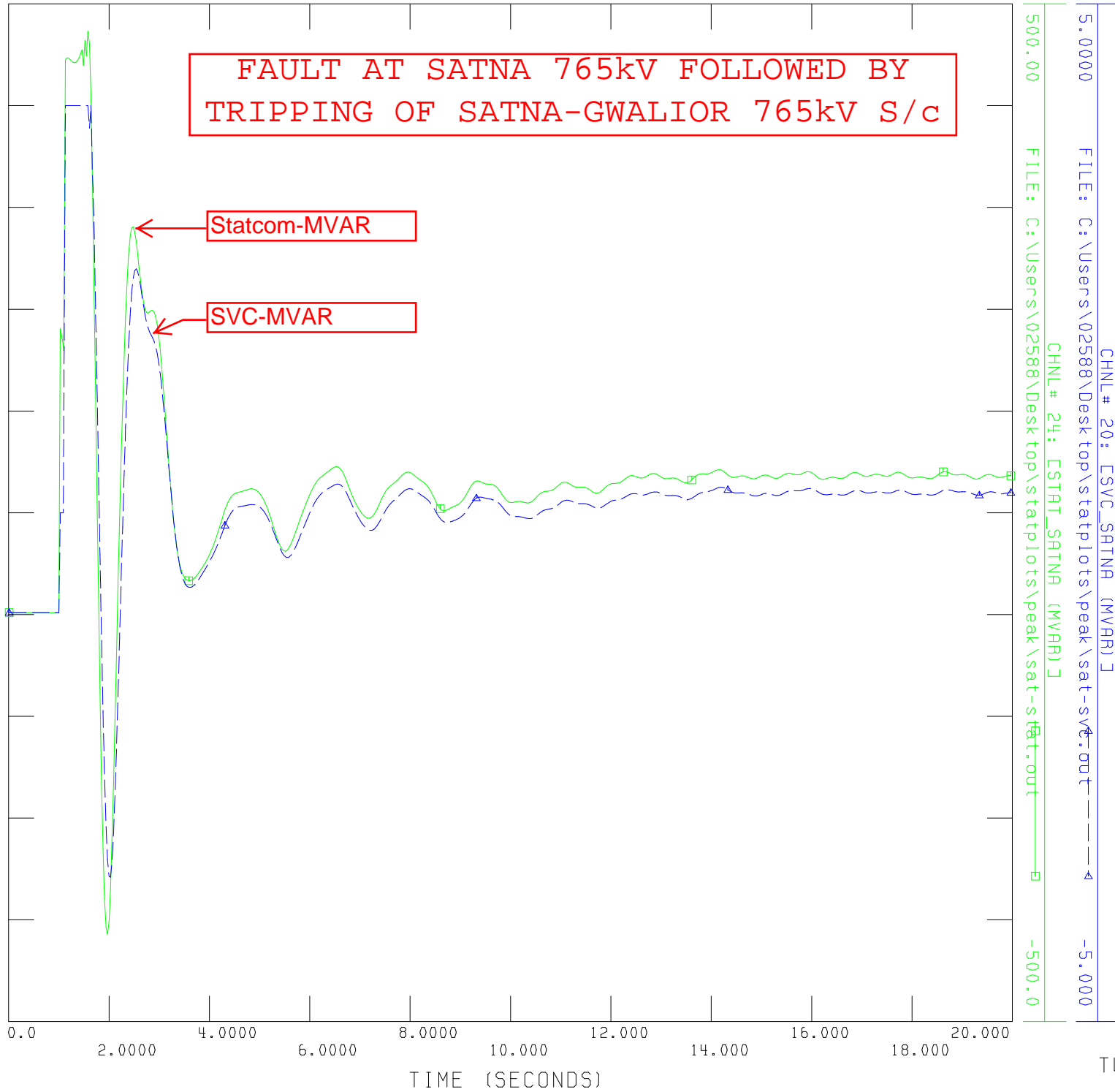
FAULT AT GWALIOR 765kV FOLLOWED BY TRIPPING OF GWALIOR-AGRA 765kV S/c



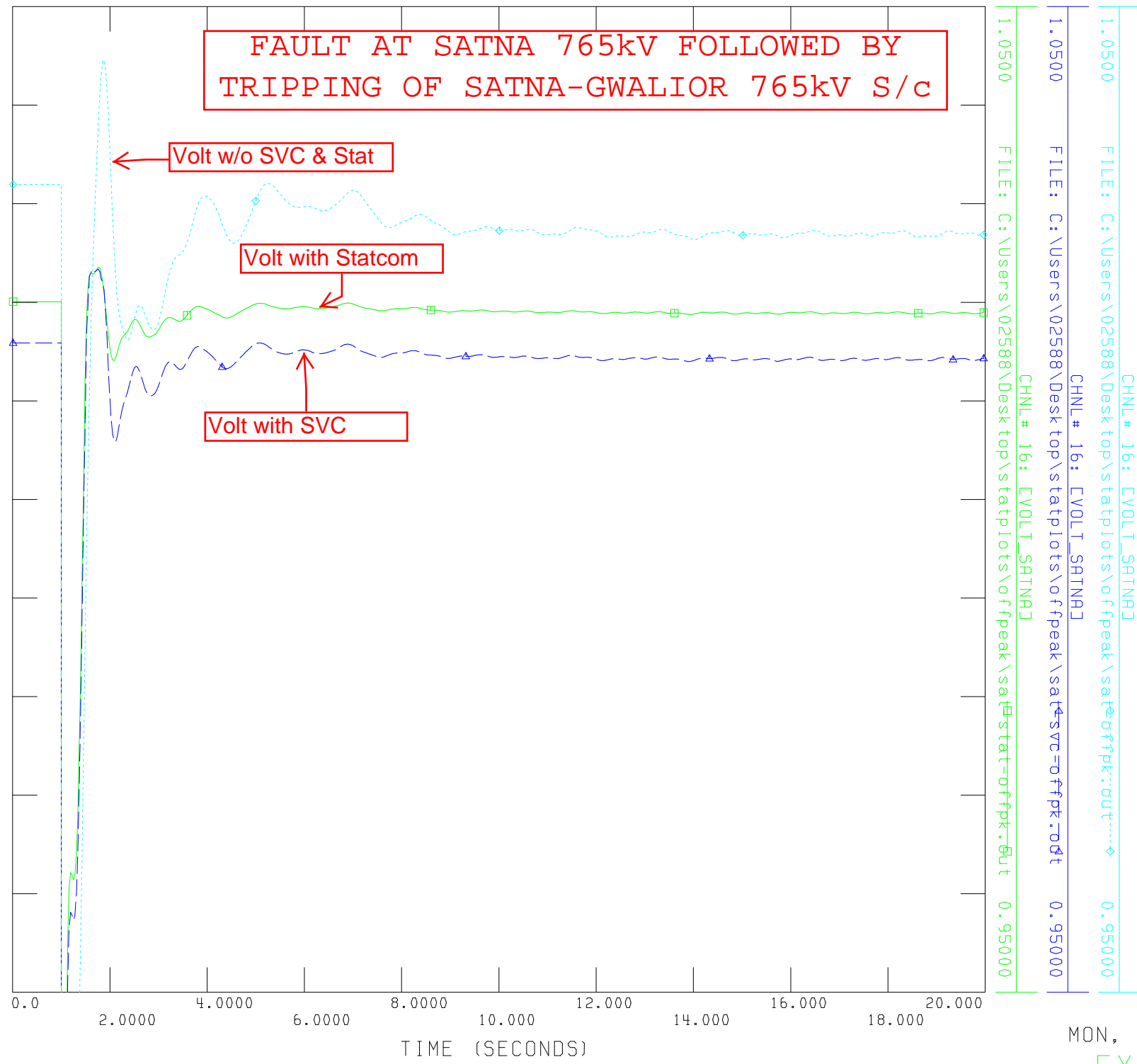


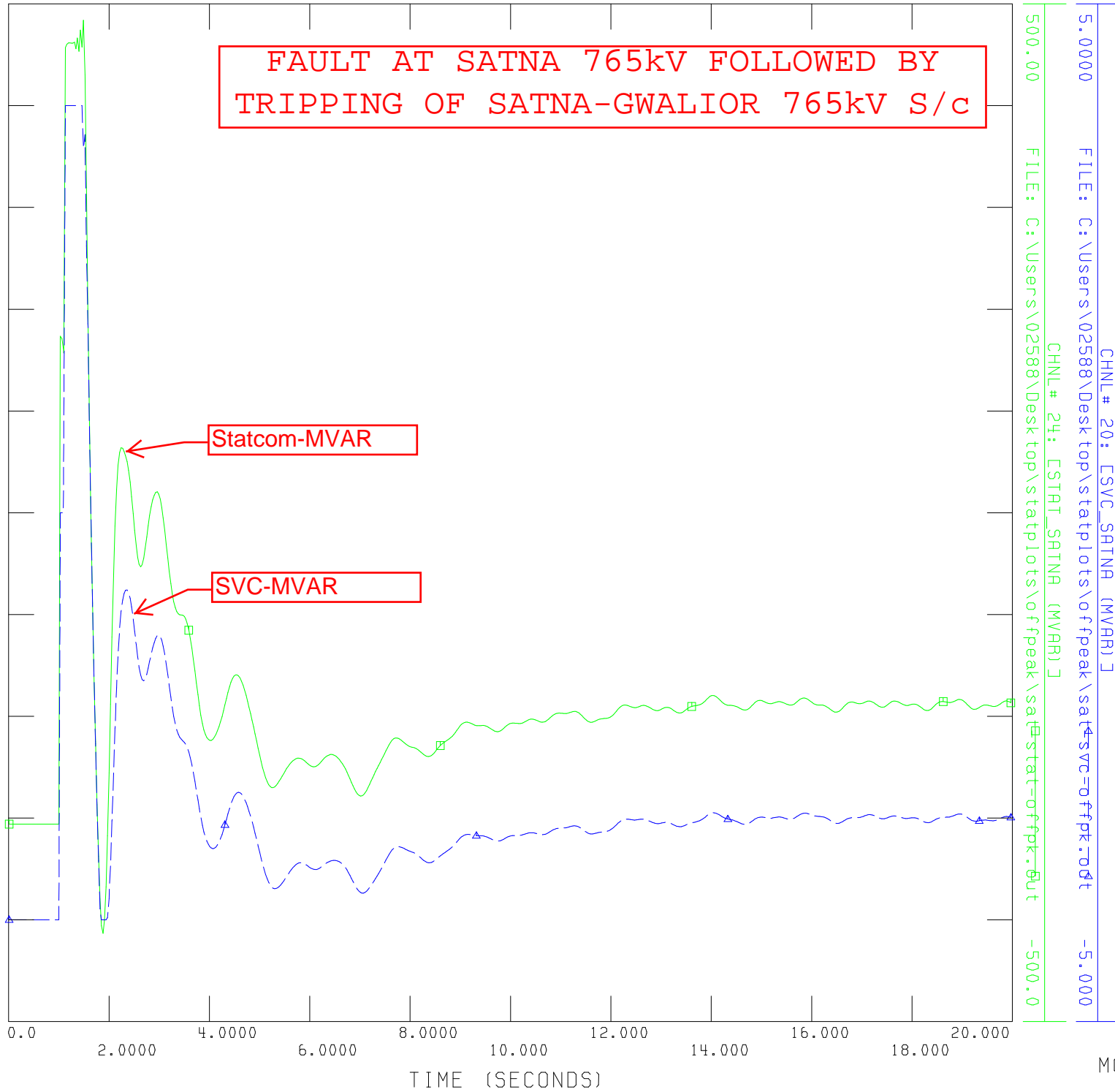
FAULT AT SATNA 765kV FOLLOWED BY TRIPPING OF SATNA-GWALIOR 765kV S/c

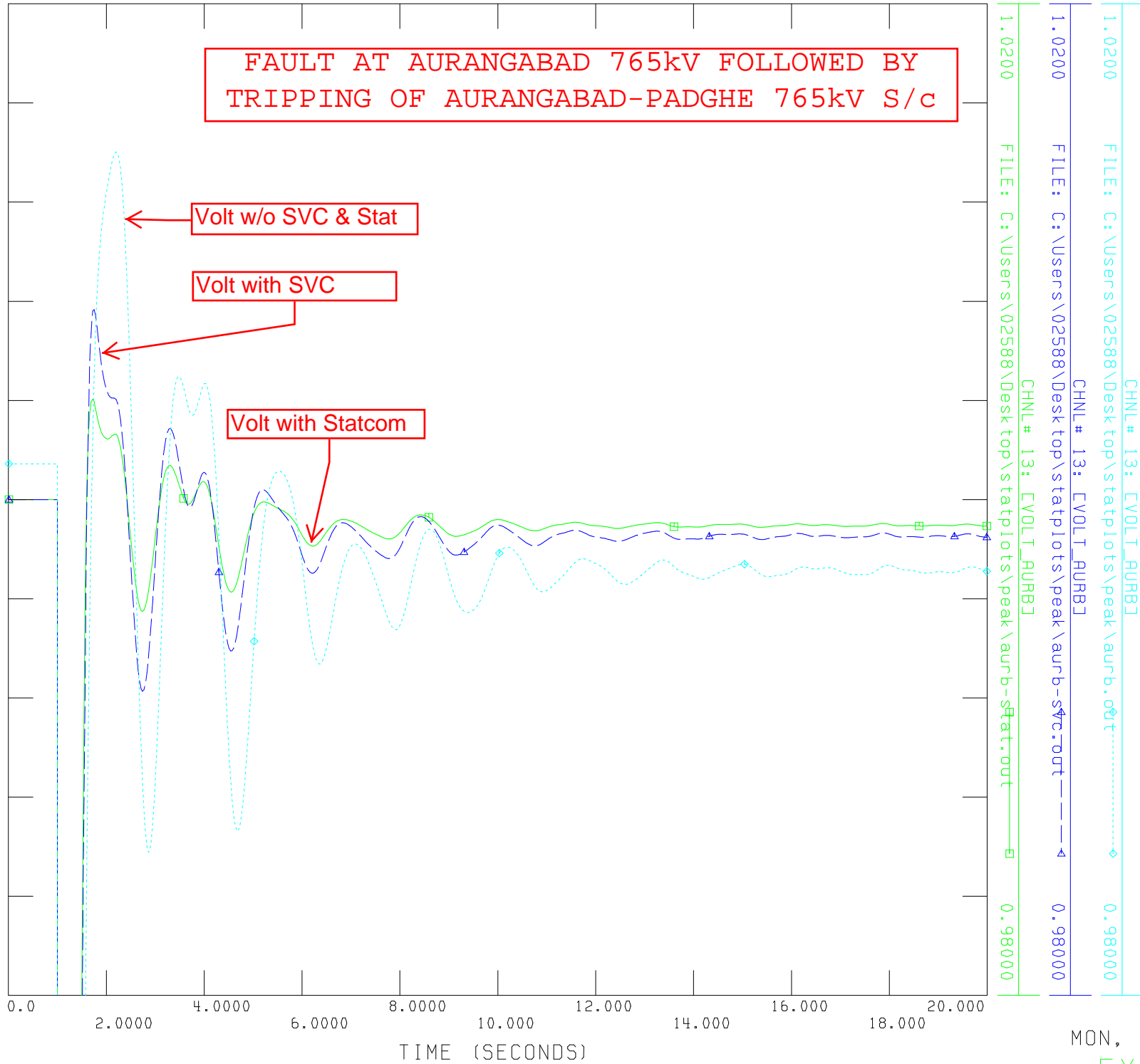


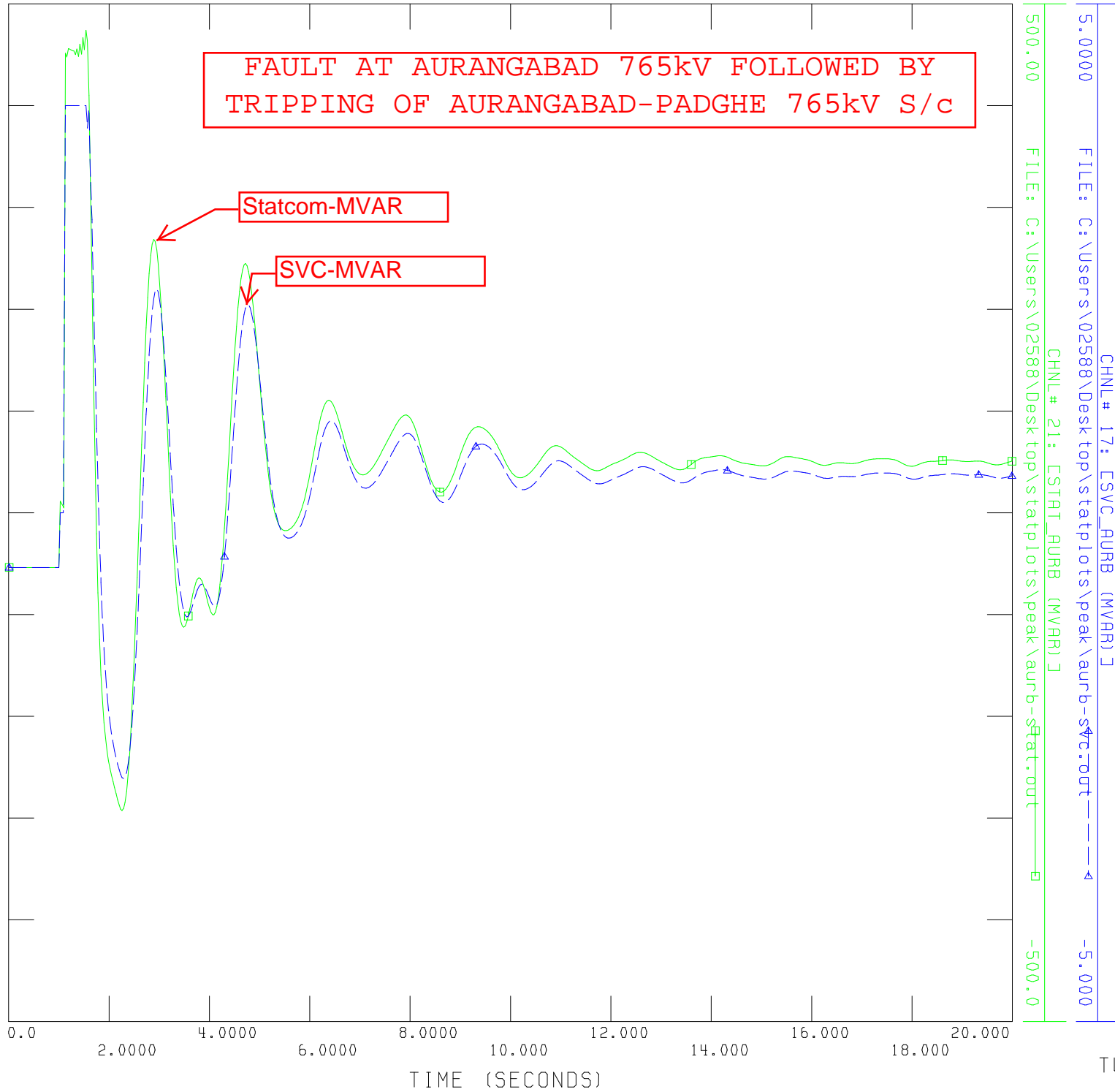


FAULT AT SATNA 765kV FOLLOWED BY TRIPPING OF SATNA-GWALIOR 765kV S/c

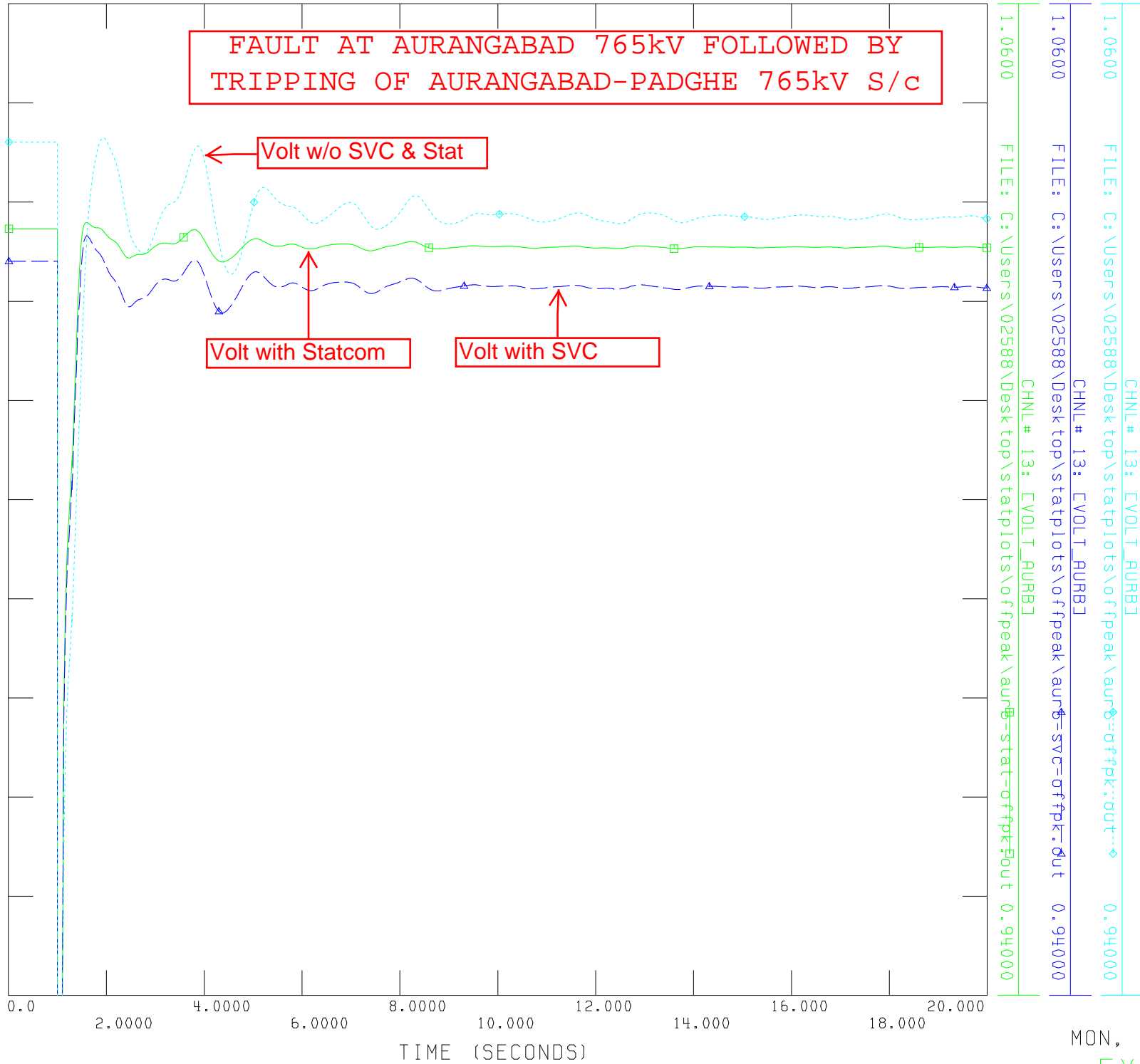


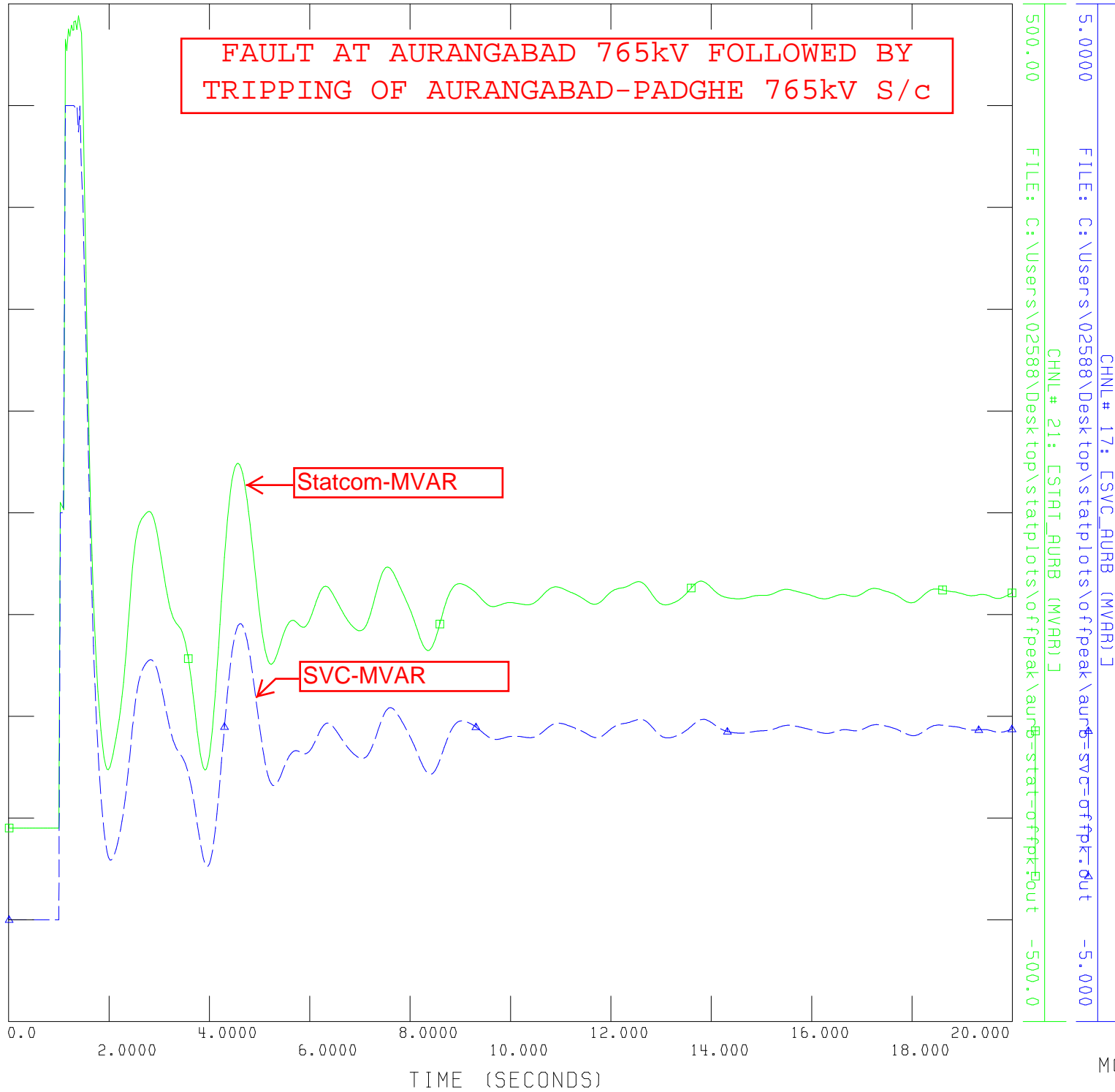




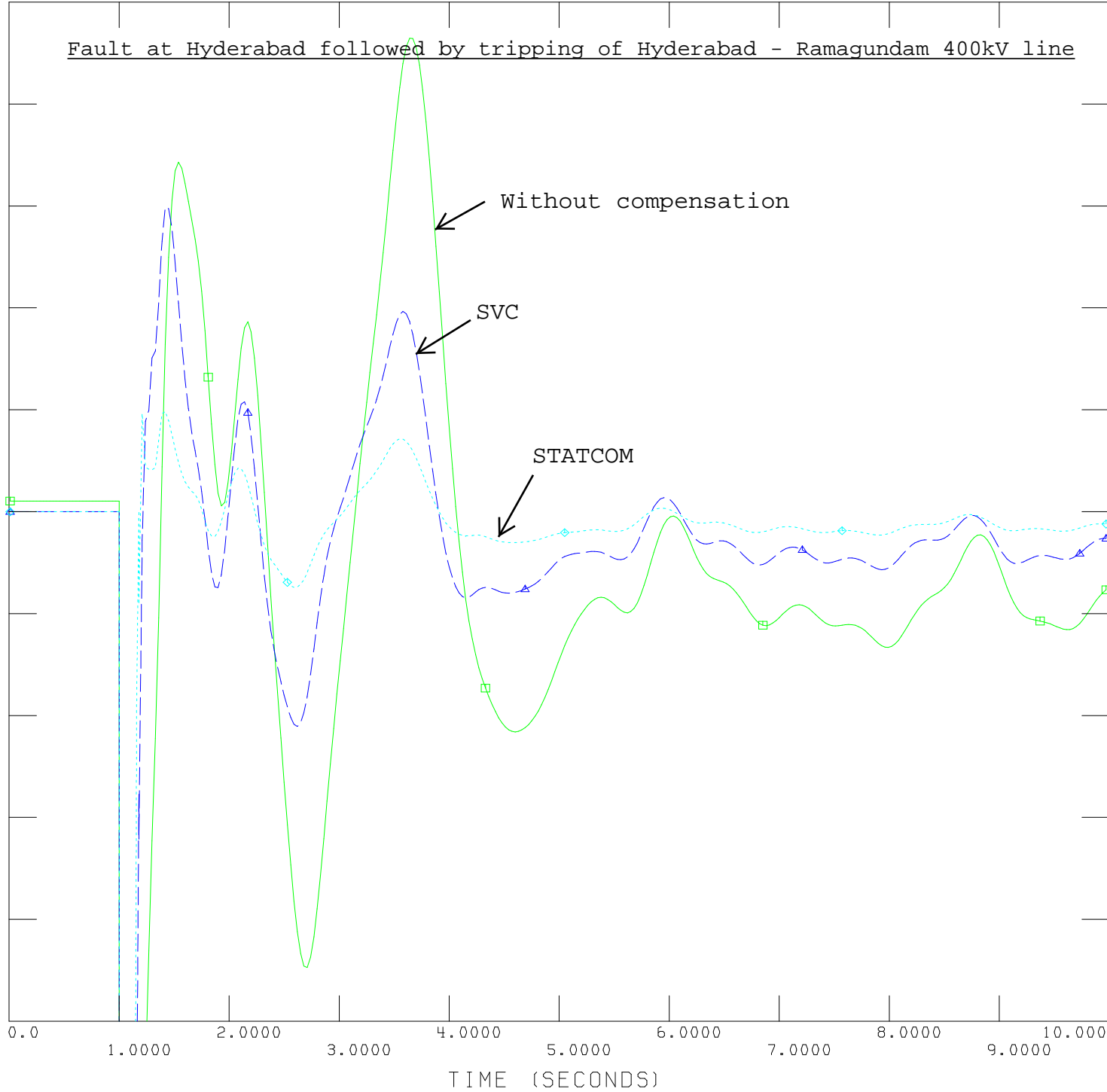


FAULT AT AURANGABAD 765kV FOLLOWED BY TRIPPING OF AURANGABAD-PADGHE 765kV S/c





Fault at Hyderabad followed by tripping of Hyderabad - Ramagundam 400kV line



1.0100 FILE: D:\South on An11\PSSE\STATCOM_Study\Hyderabad\STATCOM=P.out 0.99000
 CHNL# 13: CHYDERABAD VOLTAGE]

1.0100 FILE: D:\South on An11\PSSE\STATCOM_Study\Hyderabad\STATCOM=SVC=P.out 0.99000
 CHNL# 13: CHYDERABAD VOLTAGE]

1.0100 FILE: D:\South on An11\PSSE\STATCOM_Study\Hyderabad\STATCOM=STATCOM=P.out 0.99000
 CHNL# 13: CHYDERABAD VOLTAGE]

EXHIBIT-7-P(a)

WED, AUG 07 2013 22:04

HYDERABAD V - PEAK

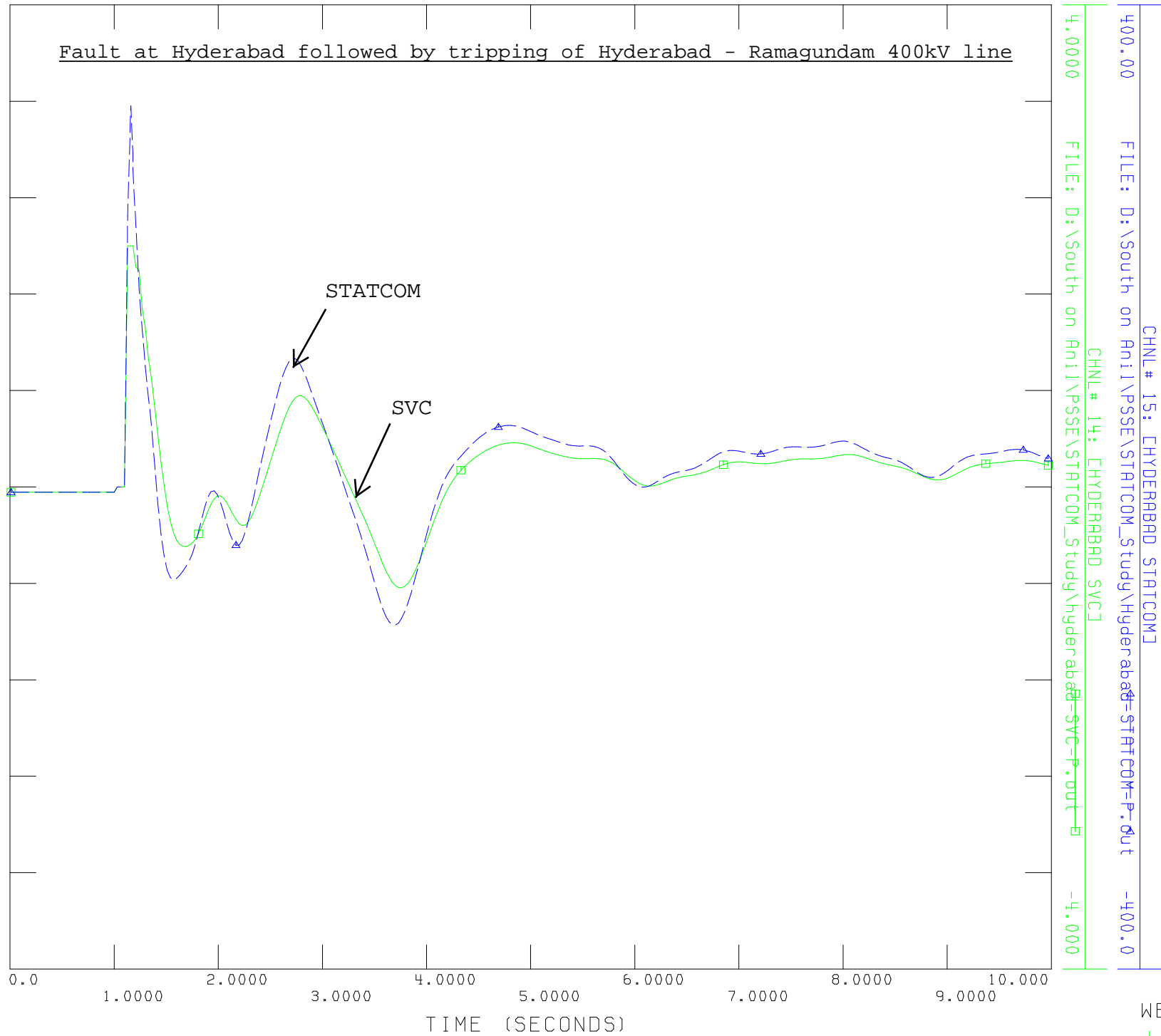


EXHIBIT-7-P(b)

Fault at Hyderabad followed by tripping of Hyderabad - Ramagundam 400kV line

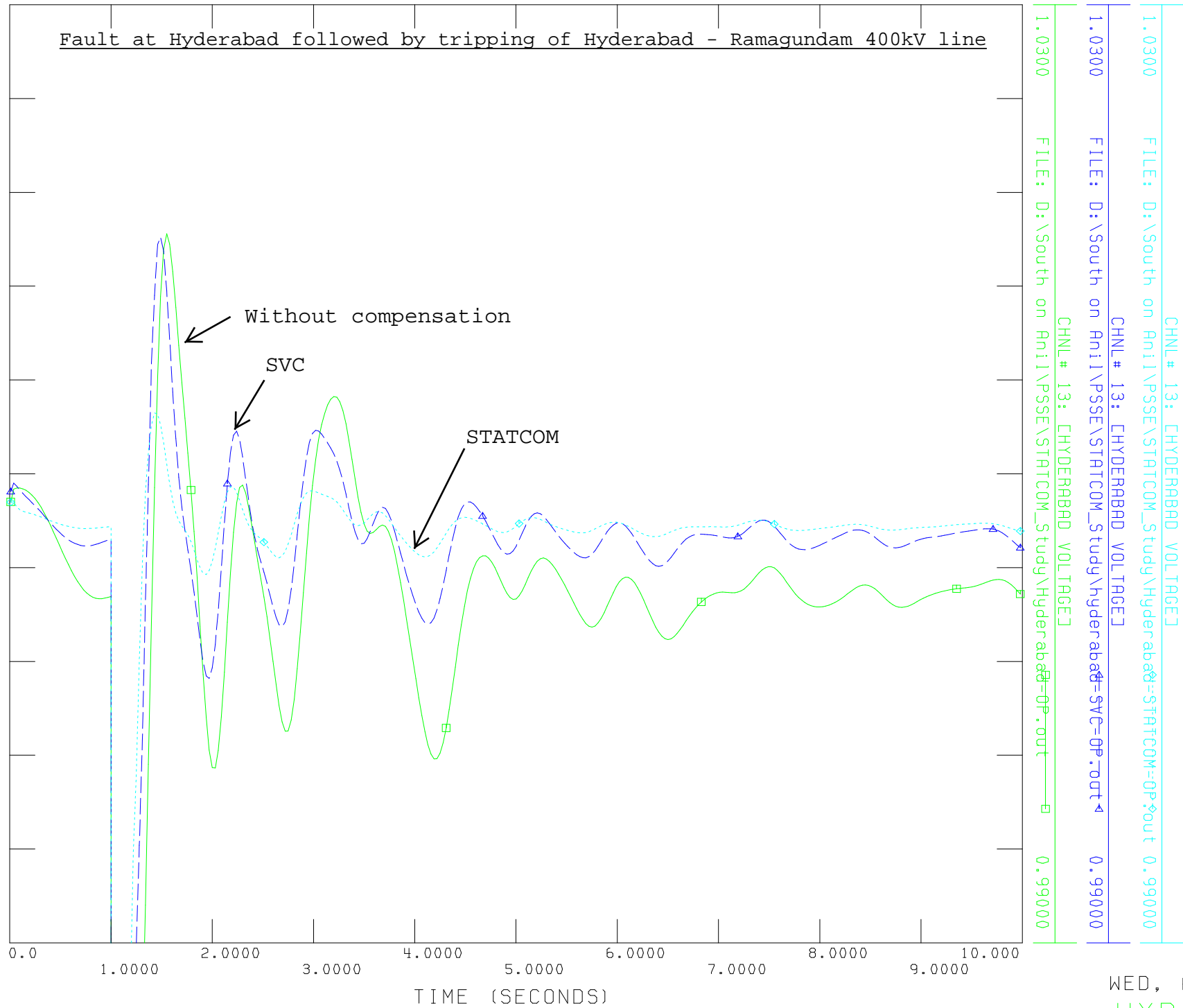


EXHIBIT-7-OP(a)

WED, AUG 07 2013 22:09

HYD V - OFFPEAK

Fault at Hyderabad followed by tripping of Hyderabad - Ramagundam 400kV line

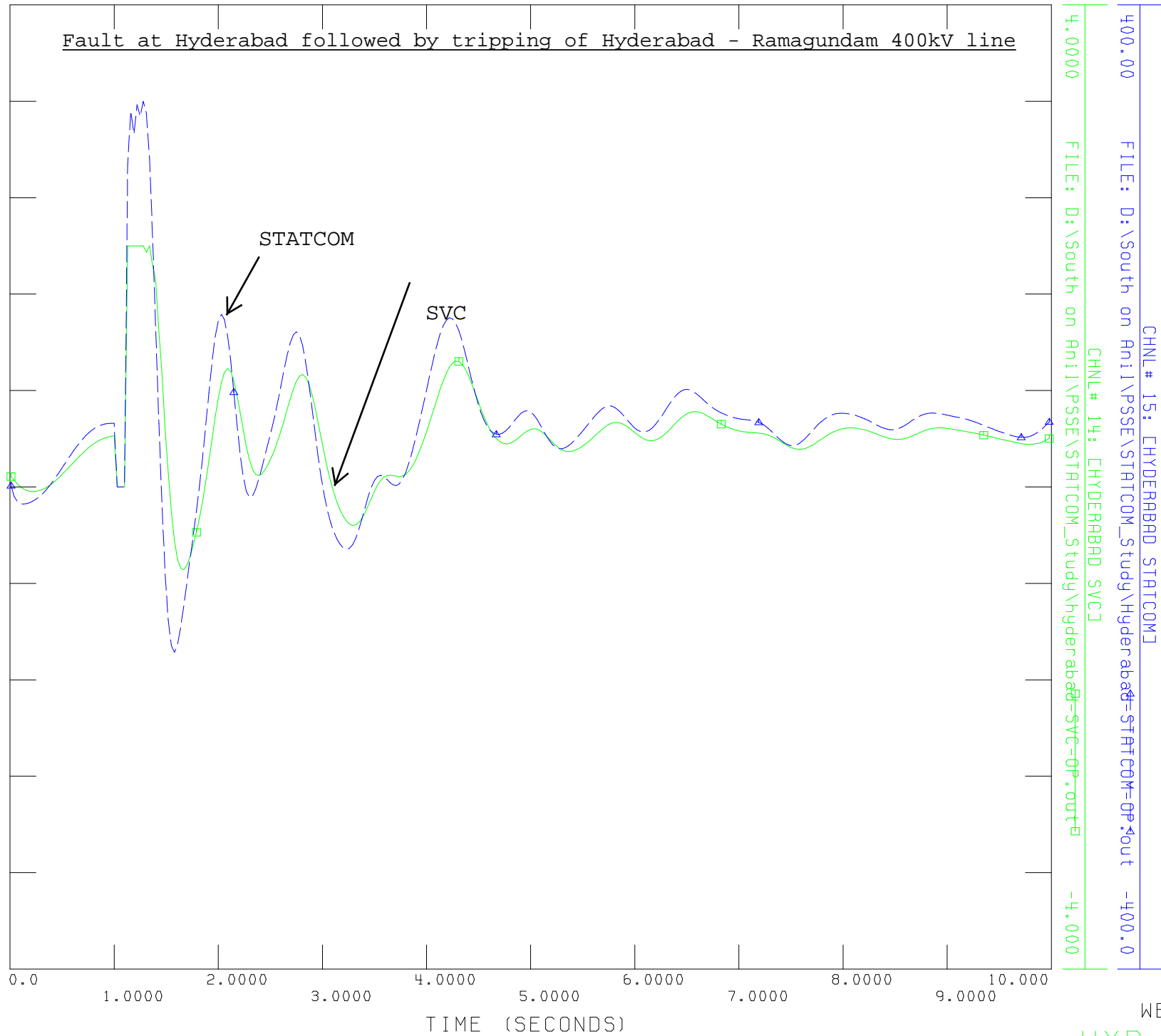


EXHIBIT-7-OP(b)

WED, AUG 07 2013 22:12

HYD MVAR - OFFPEAK

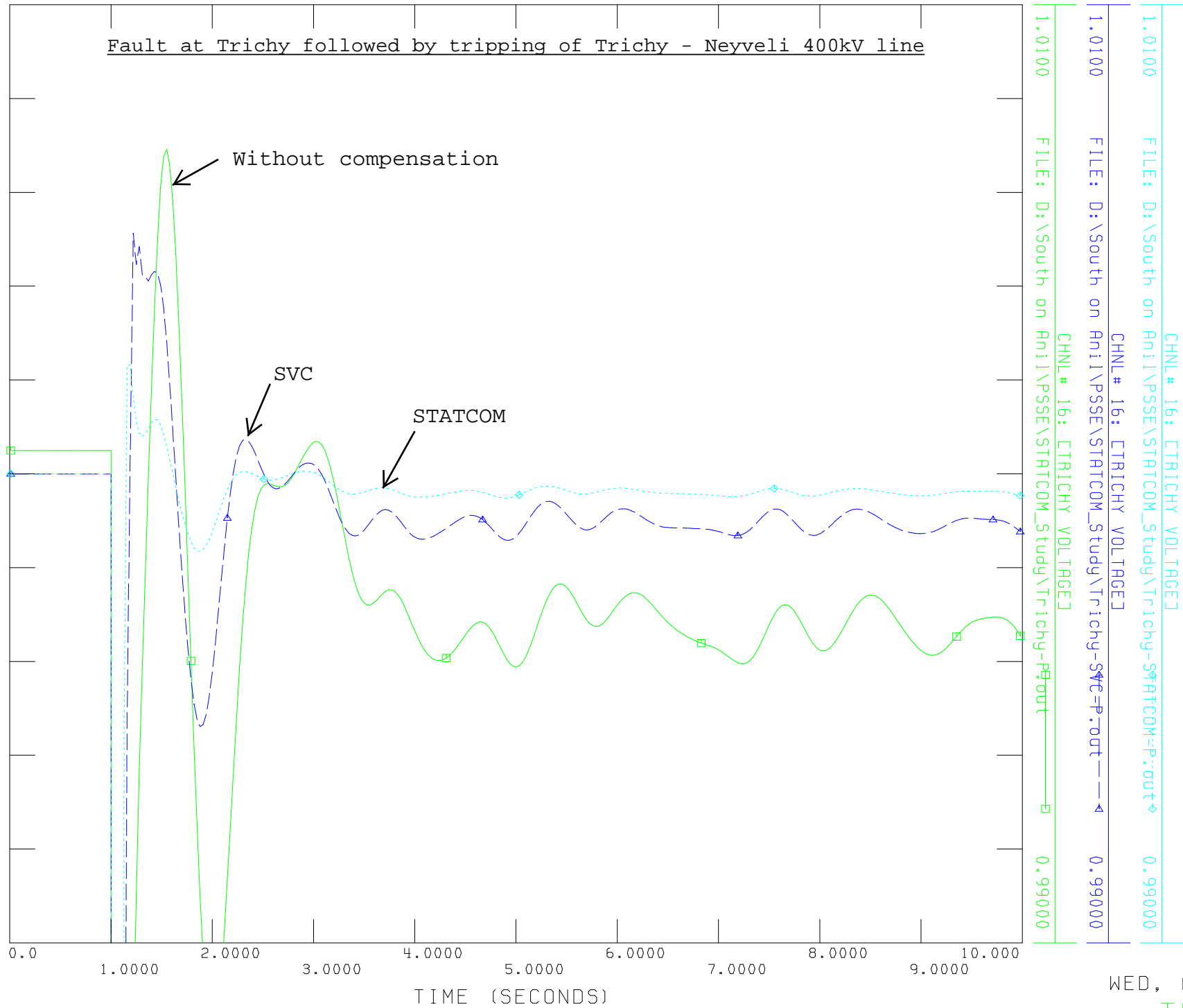


EXHIBIT-8-P(a)

WED, AUG 07 2013 22:14

TRIC V - PEAK

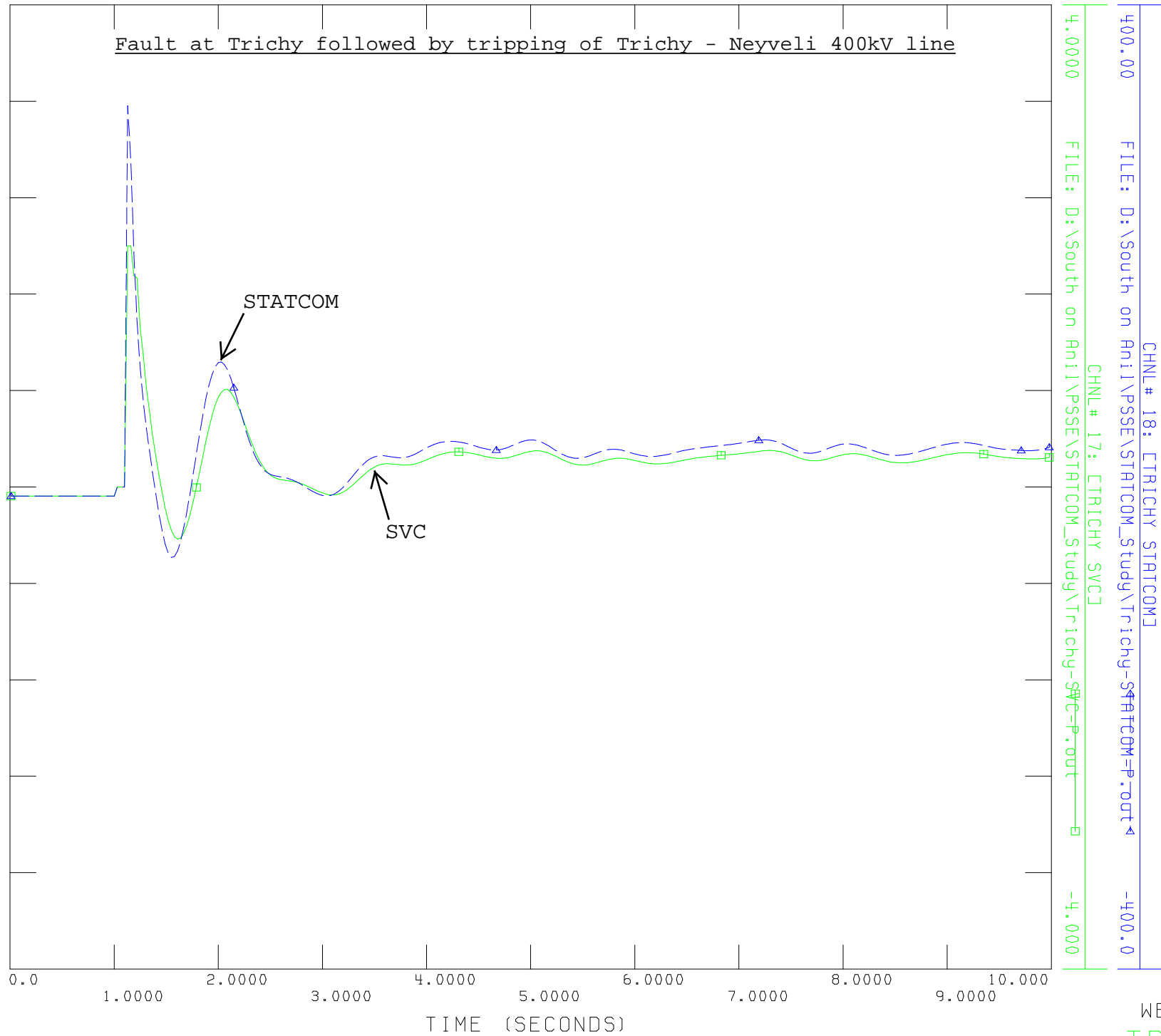
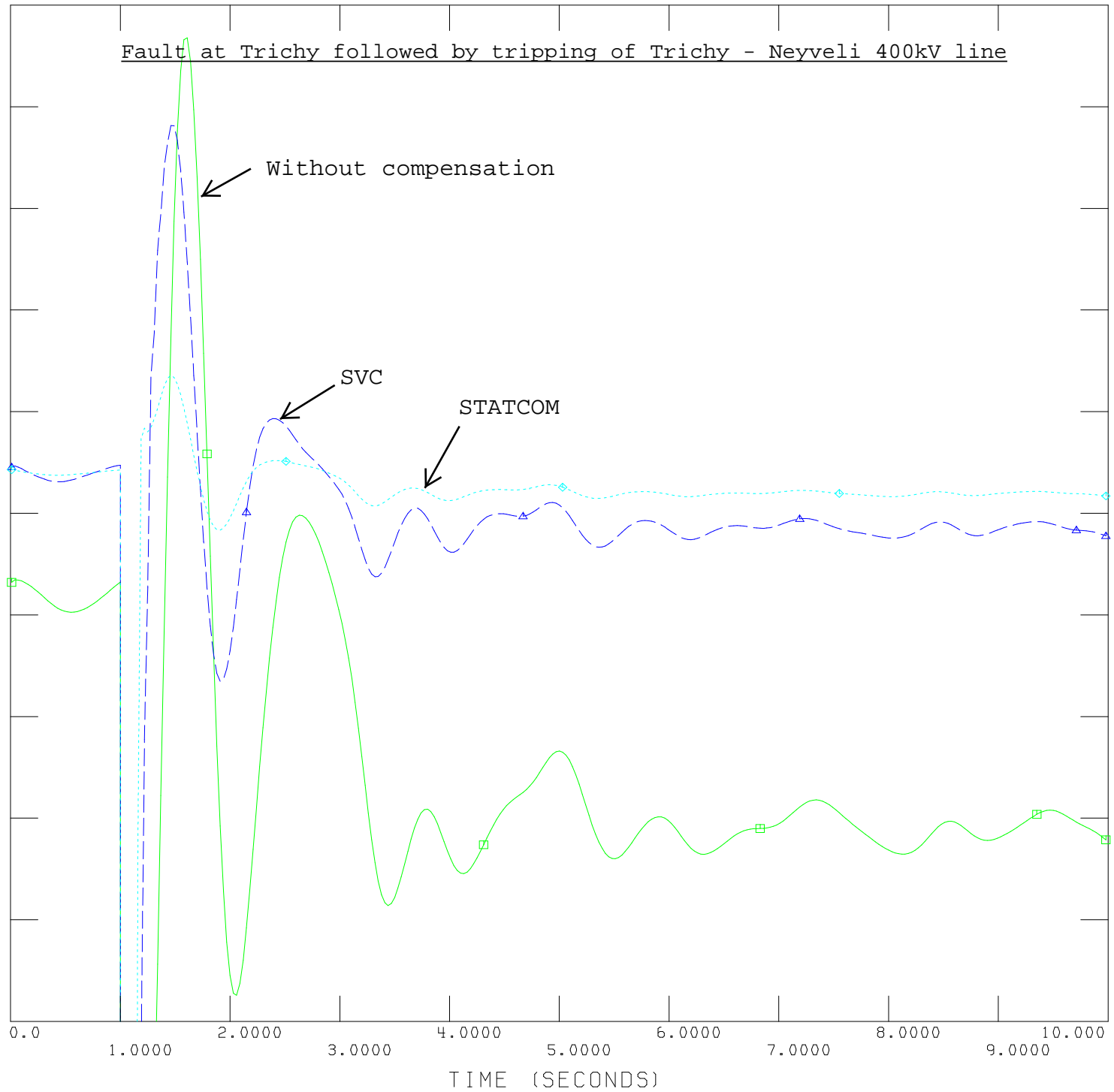


EXHIBIT-8-P(b)



Fault at Trichy followed by tripping of Trichy - Neyveli 400kV line

Without compensation

SVC

STATCOM

1.0100 CHNL# 16: [TRICHY VOLTAGE] FILE: D:\South on Anil\PSSE\STATCOM_Study\Trichy-STATCOM=0P.out 0.99000

1.0100 CHNL# 16: [TRICHY VOLTAGE] FILE: D:\South on Anil\PSSE\STATCOM_Study\Trichy-SVC=0P.out 0.99000

1.0100 CHNL# 16: [TRICHY VOLTAGE] FILE: D:\South on Anil\PSSE\STATCOM_Study\Trichy-Off.out 0.99000

EXHIBIT-8-OP(a)

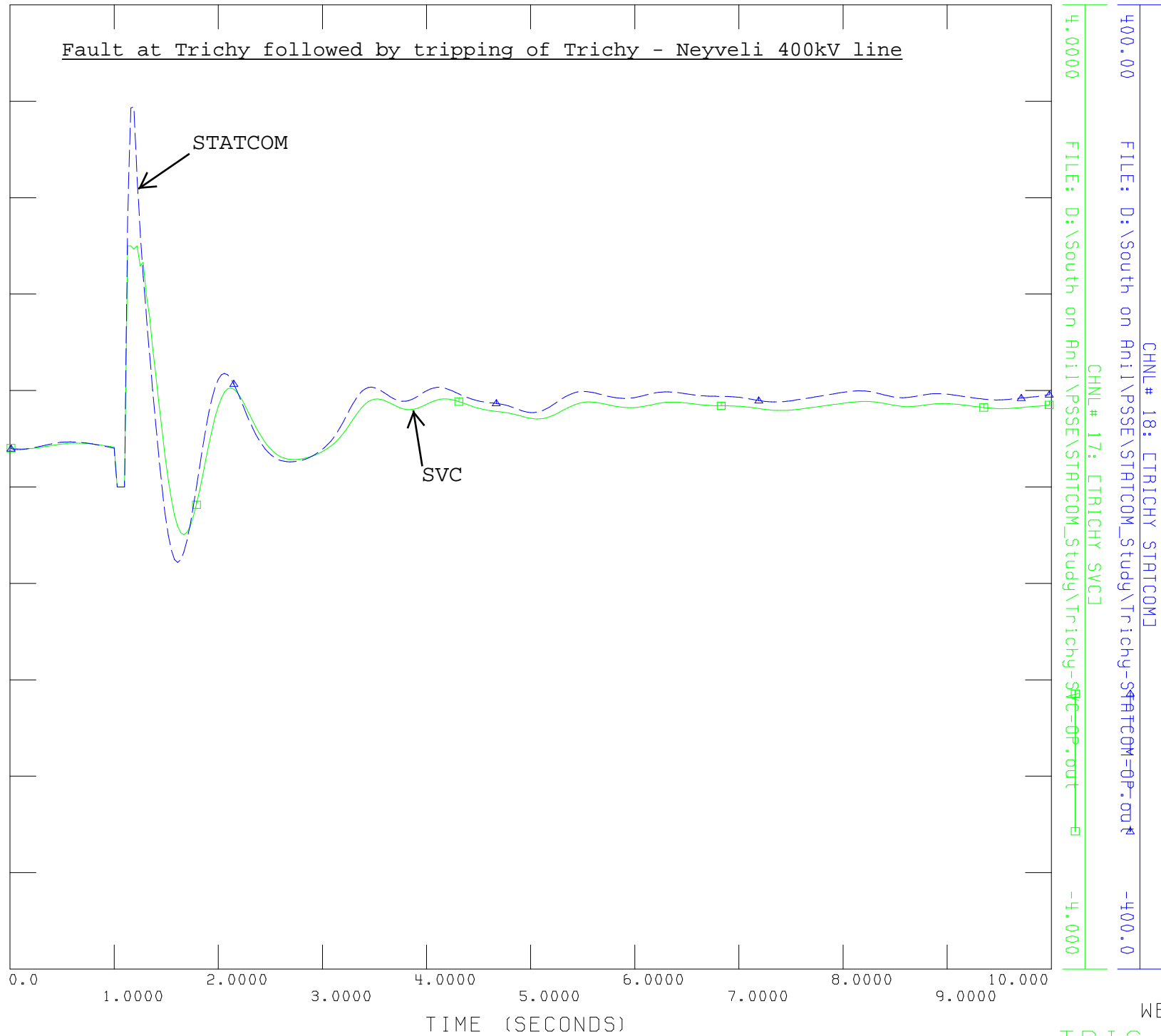
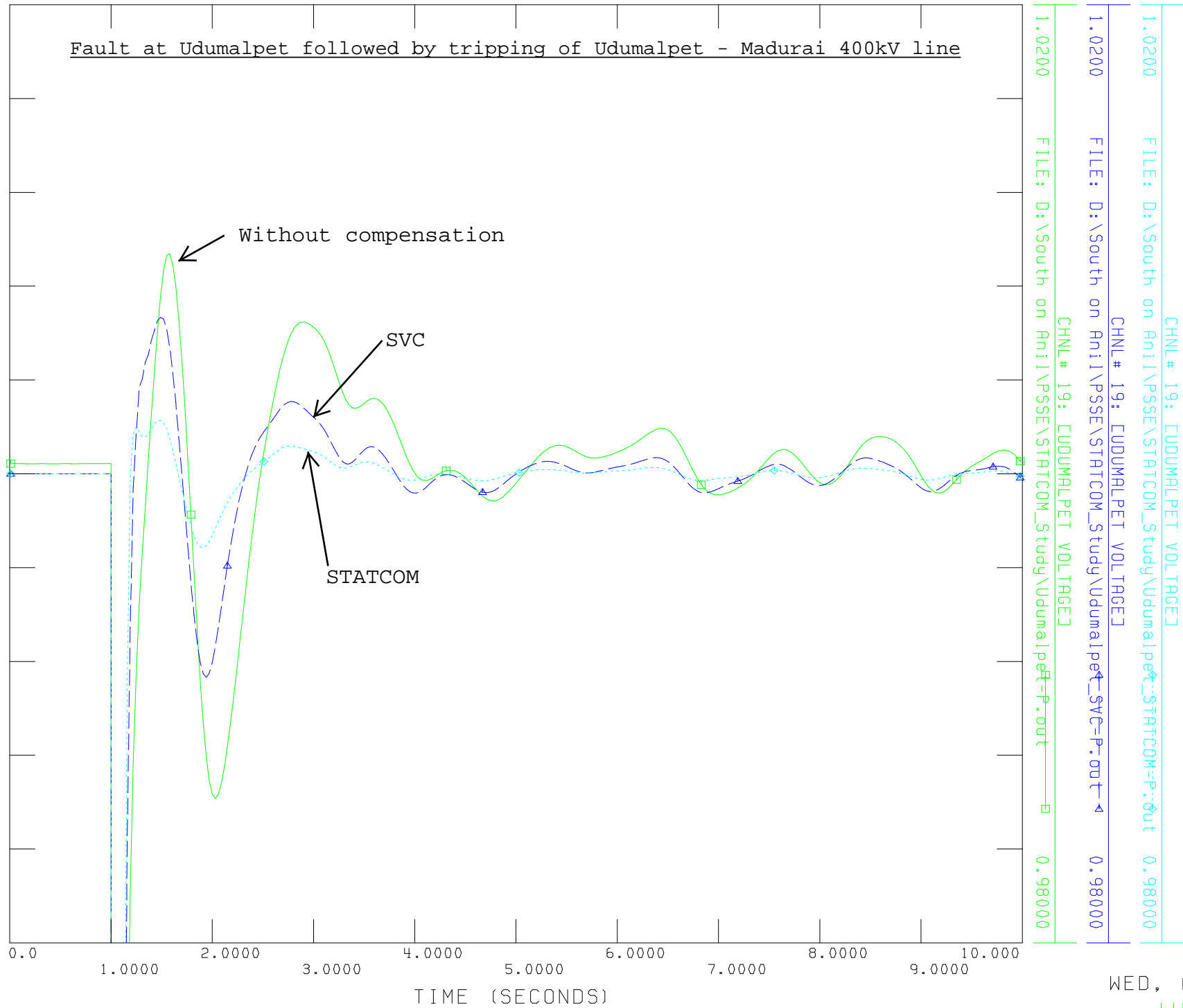


EXHIBIT-8-OP(b)

Fault at Udumalpet followed by tripping of Udumalpet - Madurai 400kV line



1.0200 FILE: D:\South on An11\PSSE\STATIONCOM_Study\Udumalpet\STATCOM=P.out 0.98000
 CHNL# 19: CUDUMALPET VOLTAGE]
 1.0200 FILE: D:\South on An11\PSSE\STATIONCOM_Study\Udumalpet\SVC=P.out 0.98000
 CHNL# 19: CUDUMALPET VOLTAGE]
 1.0200 FILE: D:\South on An11\PSSE\STATIONCOM_Study\Udumalpet-P.out 0.98000
 CHNL# 19: CUDUMALPET VOLTAGE]

EXHIBIT-9-P(a)

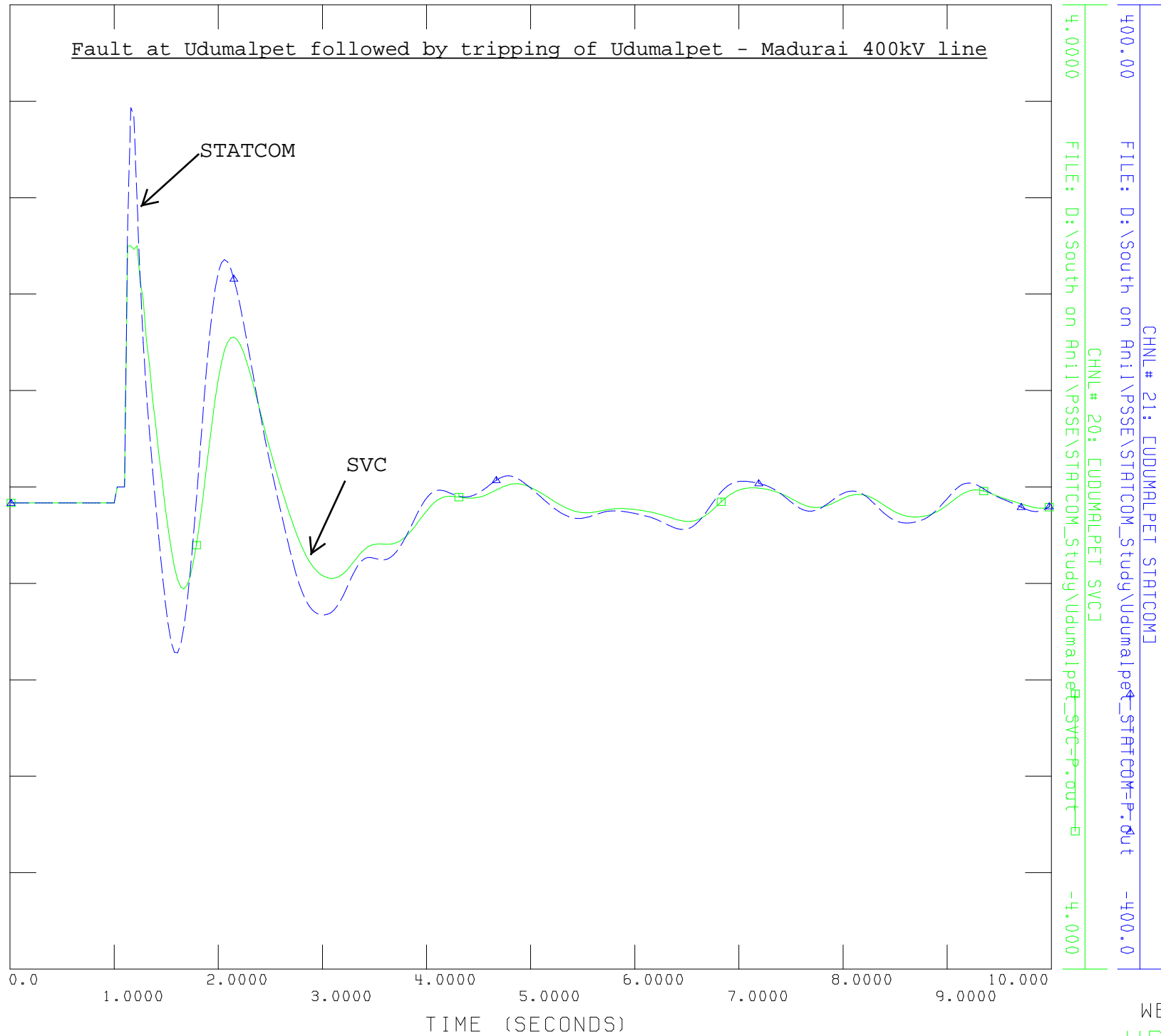
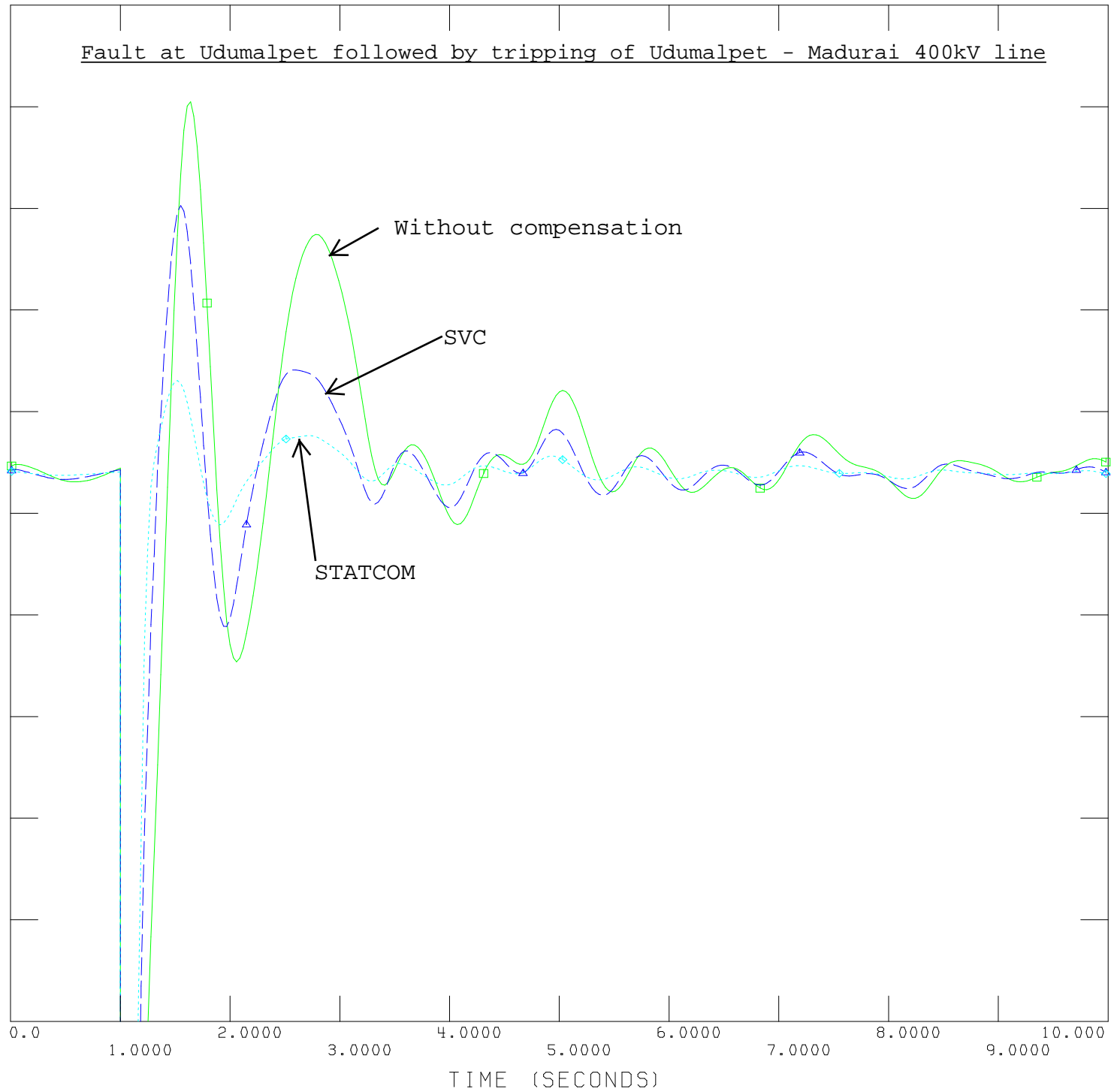


EXHIBIT-9-P(b)

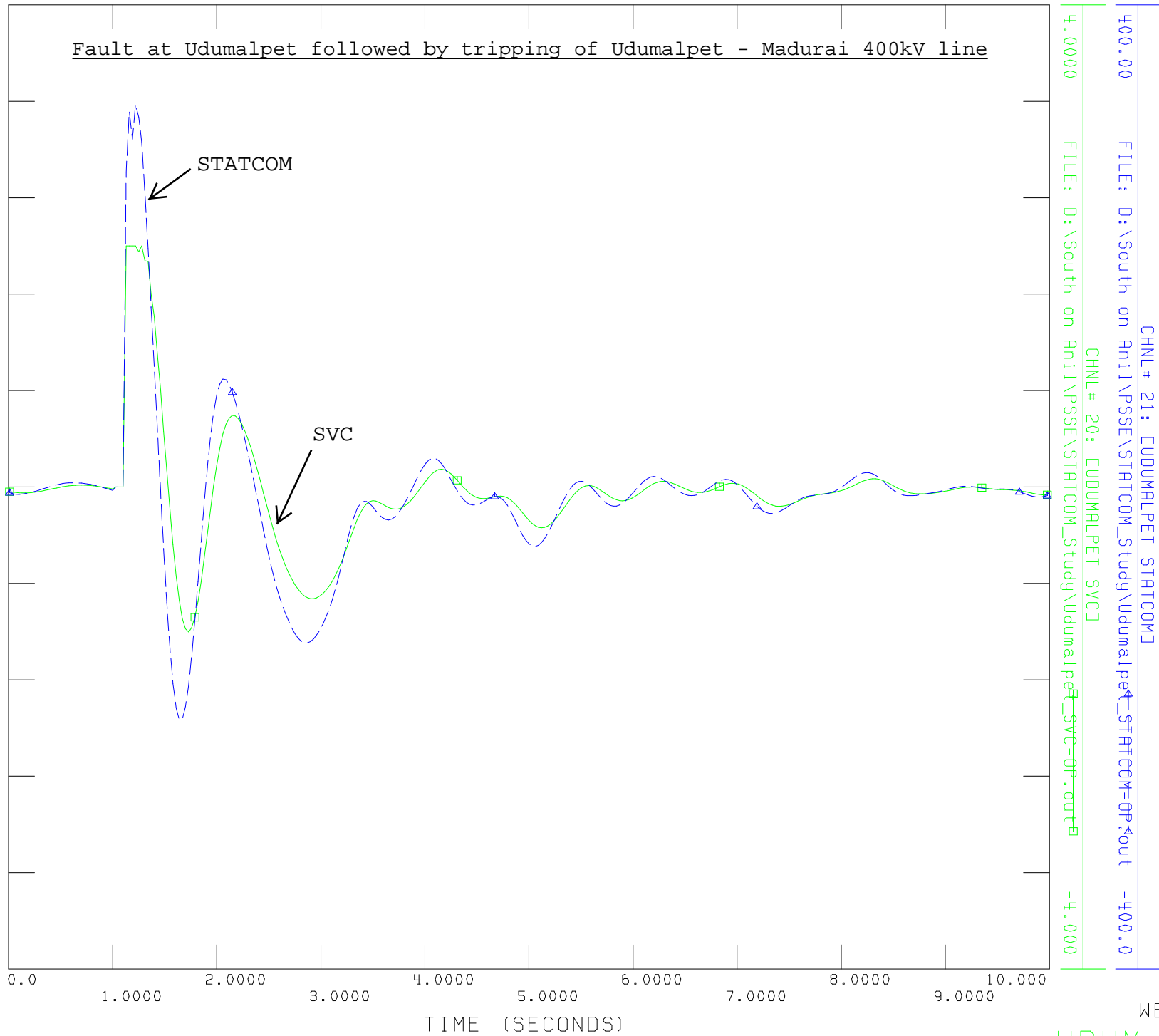


1.0200 FILE: D:\South on Ani1\PSSE\STATCOM_Study\Udumalpet\STATCOM=OP.out 0.98000
CHNL # 19: CUDUMALPET VOLTAGE]

1.0200 FILE: D:\South on Ani1\PSSE\STATCOM_Study\Udumalpet\SVC=OP.out 0.98000
CHNL # 19: CUDUMALPET VOLTAGE]

1.0200 FILE: D:\South on Ani1\PSSE\STATCOM_Study\Udumalpet-OP.out 0.98000
CHNL # 19: CUDUMALPET VOLTAGE]

EXHIBIT-9-OP(a)



Fault at Udumalpet followed by tripping of Udumalpet - Madurai 400kV line

STATCOM

SVC

EXHIBIT-9-OP(b)



FAULT AT JEYPORE FOLLOWED BY TRIPPING OF JEYPORE INDRAVATI 400kV S/c

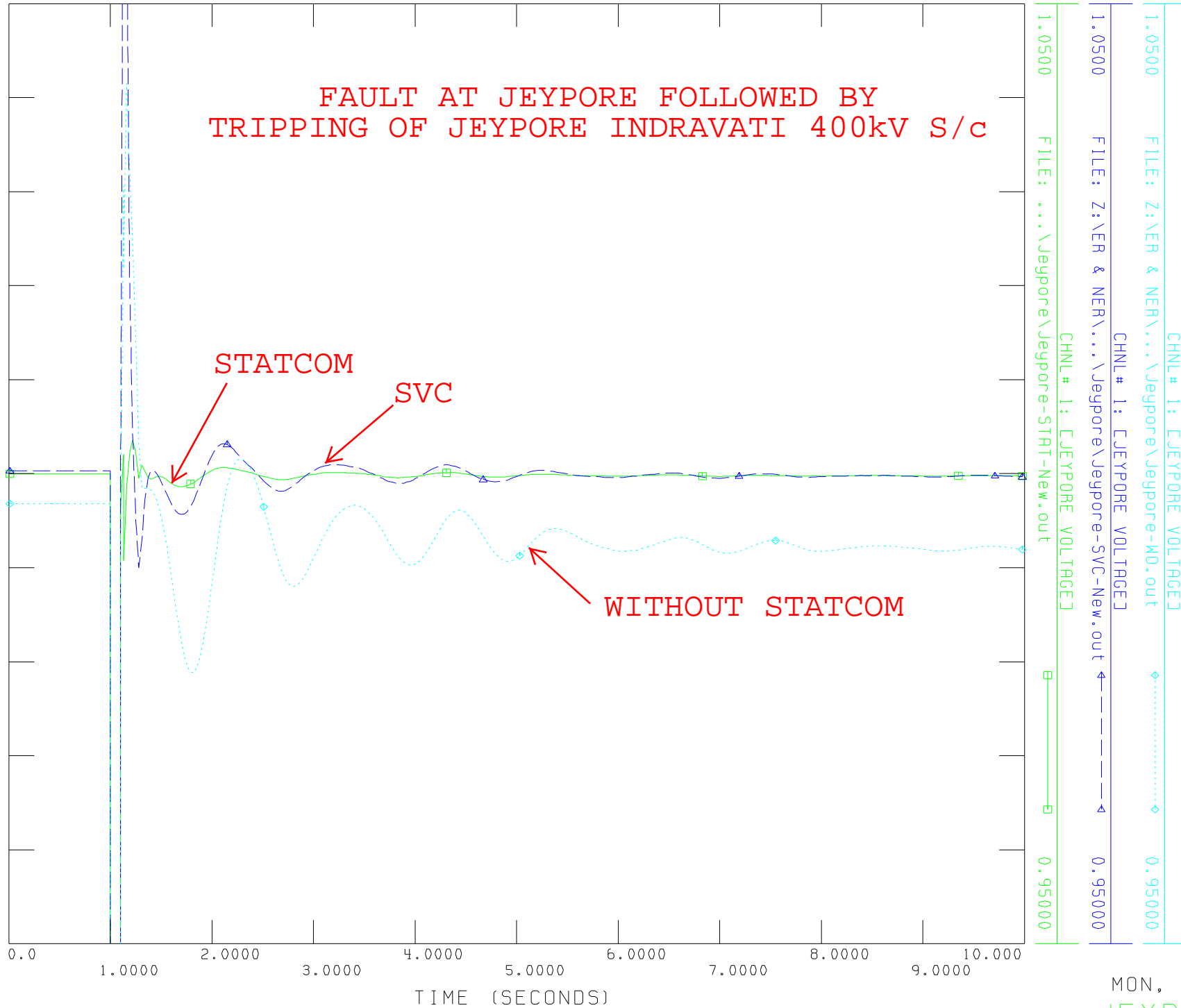
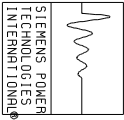


EXHIBIT-10-P(a)

MON, AUG 05 2013 18:01
JEYPORE VOLTAGES



FAULT AT JEYPORE FOLLOWED BY
TRIPPING OF JEYPORE INDRAVATI 400kV S/c

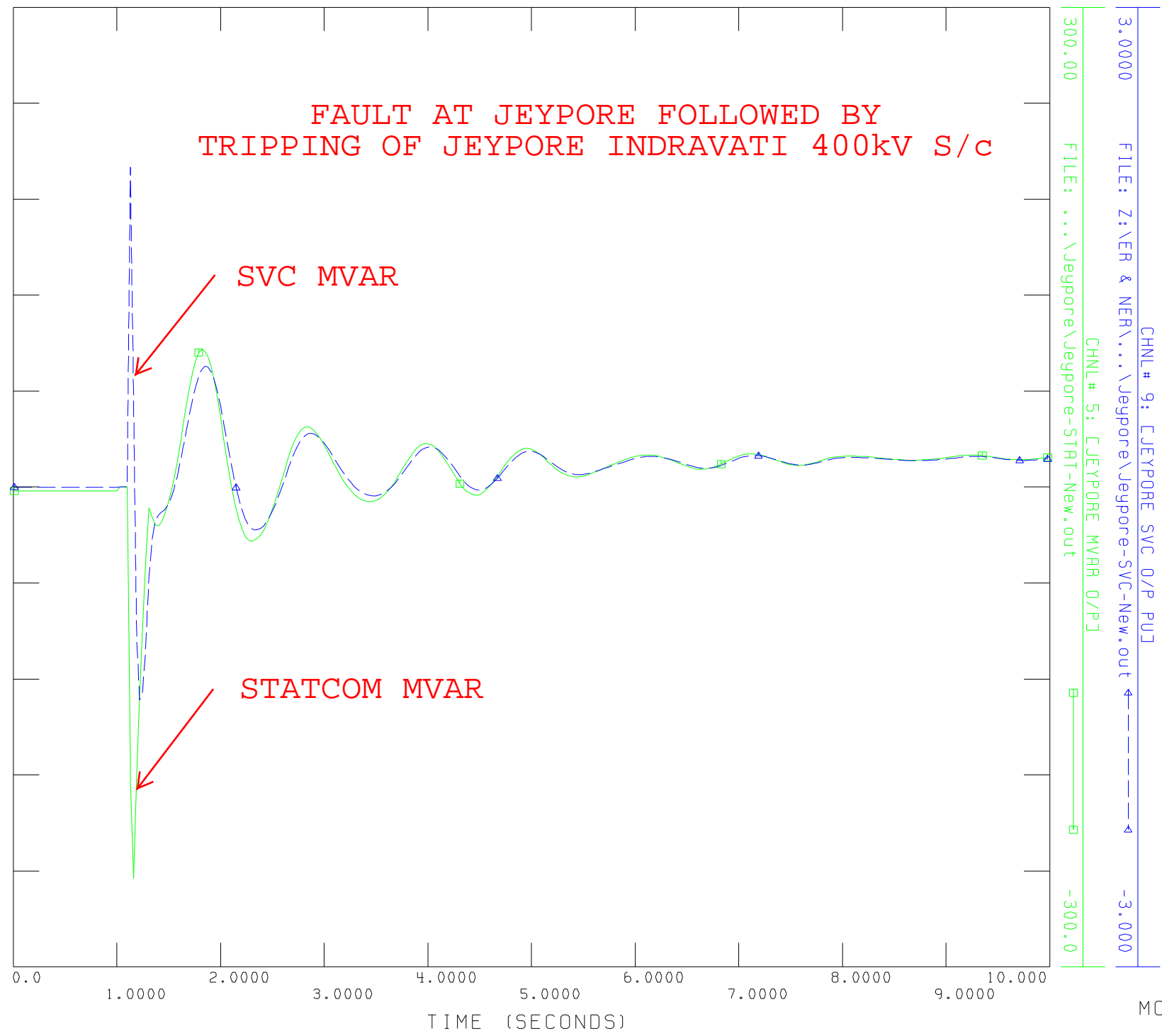


EXHIBIT-10-P(b)

MON, AUG 05 2013 18:15

JEYPORE MVAR

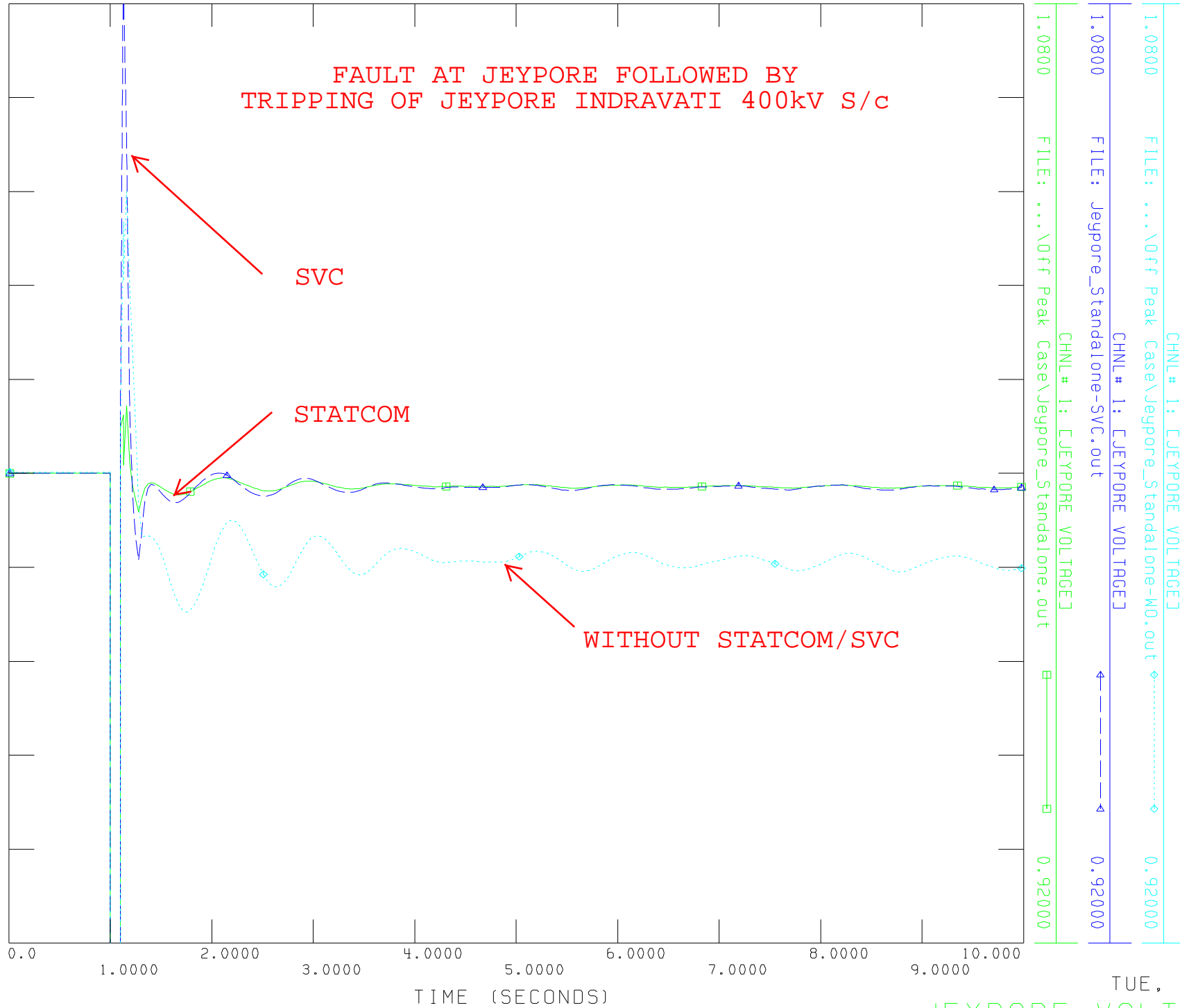
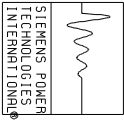


EXHIBIT 10-O(a)

TUE, AUG 06 2013 14:39

JEYPORE VOLTAGES OFFPEAK



FAULT AT JEYPORE FOLLOWED BY
TRIPPING OF JEYPORE INDRAVATI 400kV S/c

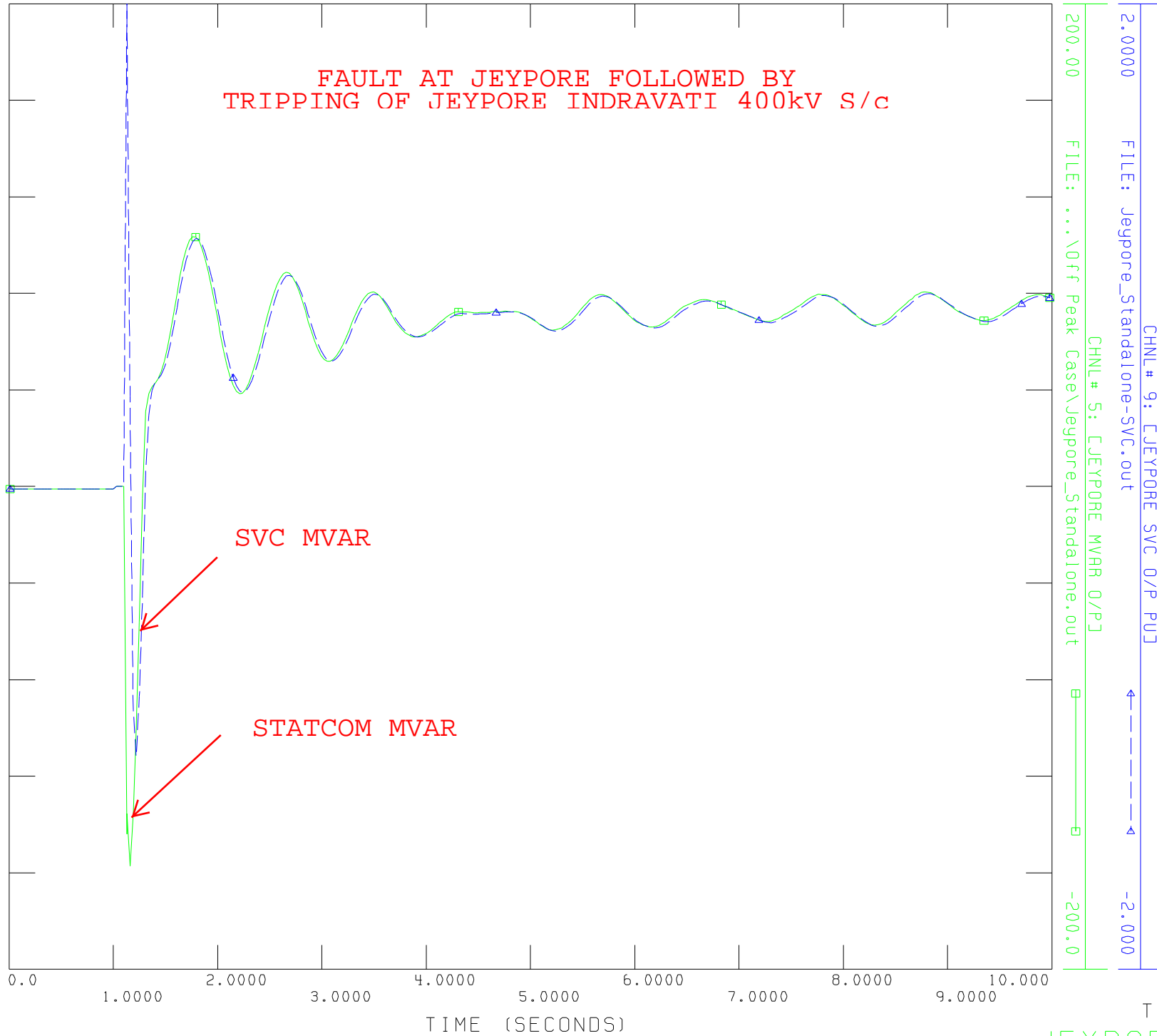


EXHIBIT 10-O(b)



FAULT AT KISHENGANJ FOLLOWED BY TRIPPING OF KISHENGANJ PATNA 400kV S/c

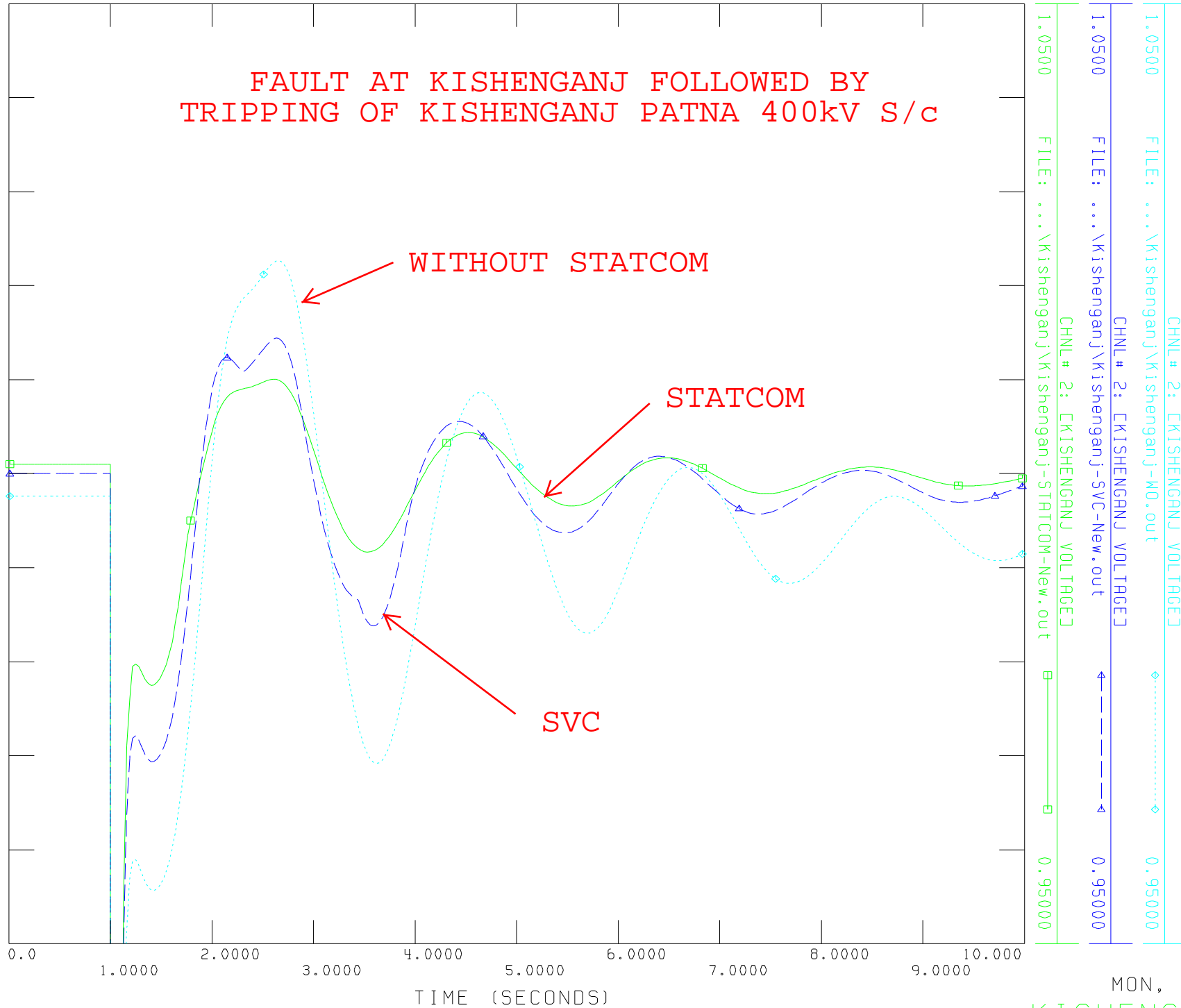


EXHIBIT-11-P(a)

MON, AUG 05 2013 18:04

KISHENGANJ VOLTAGES

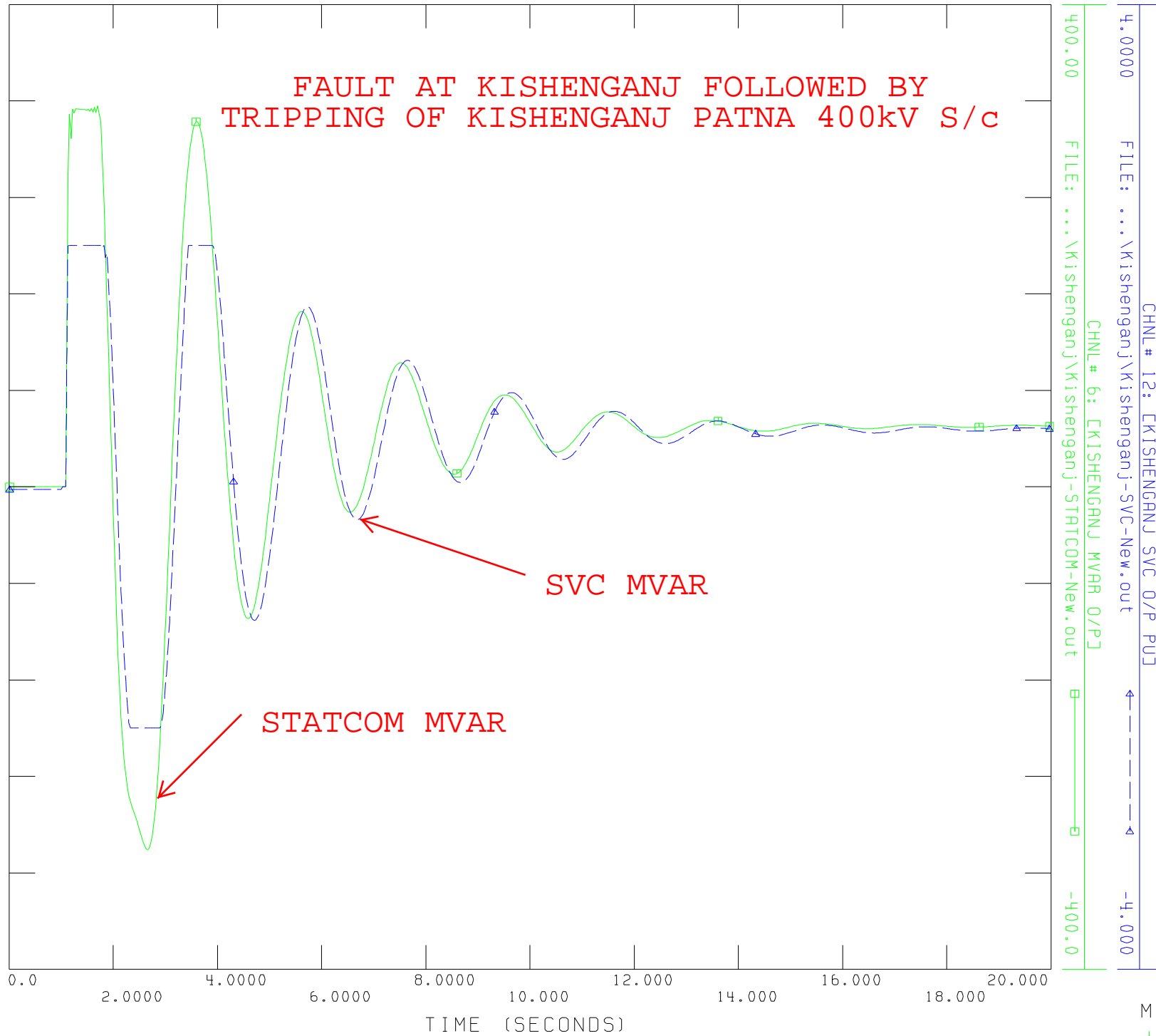


EXHIBIT-11-P(b)

MON, AUG 05 2013 18:13

KISHENGANJ MVAR



FAULT AT KISHENGANJ FOLLOWED BY TRIPPING OF KISHENGANJ-PATNA 400kV S/c

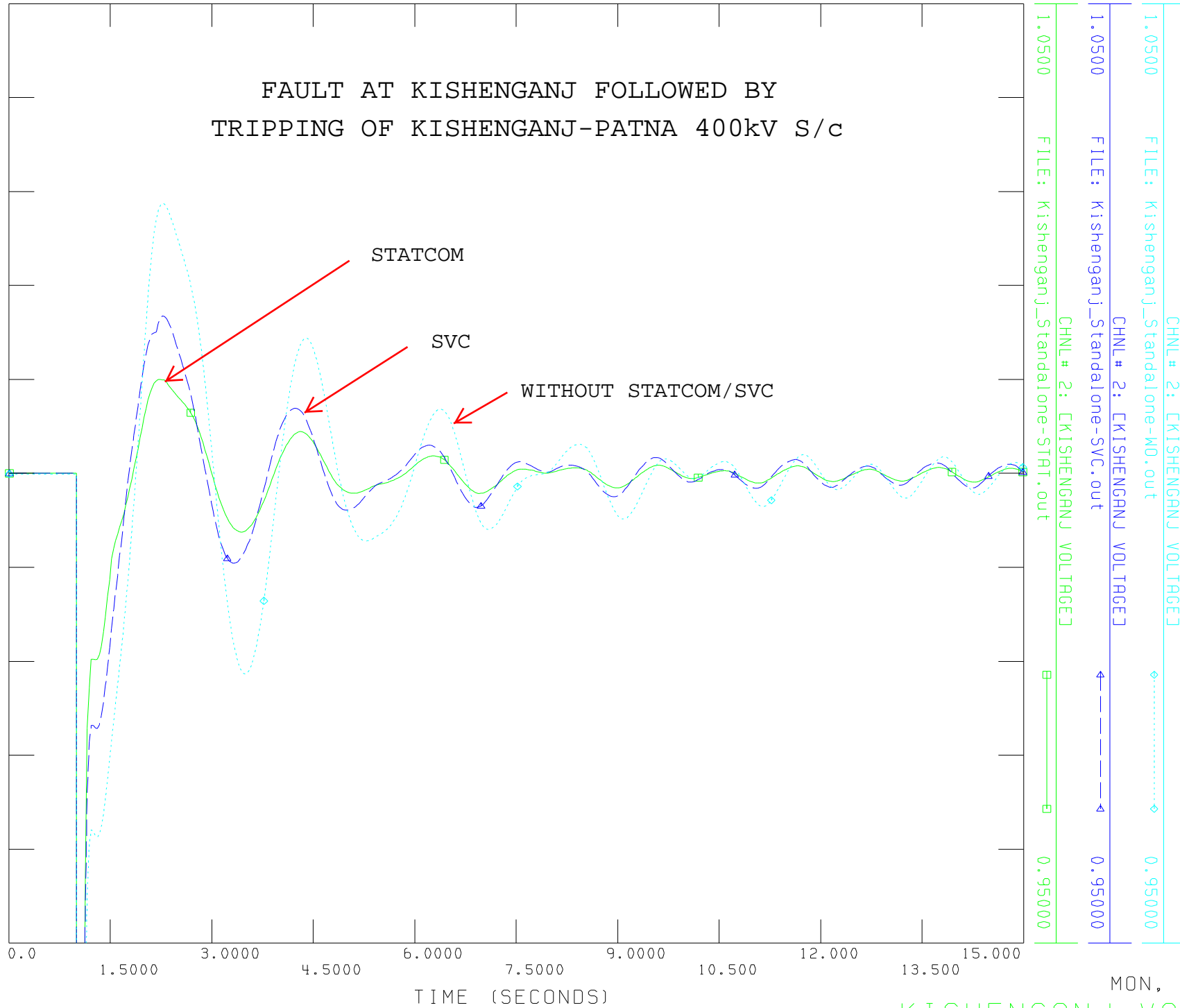


EXHIBIT-11-O(a)

MON, AUG 05 2013 18:23

KISHENGANJ VOLTAGES OFFPE



FAULT AT KISHENGANJ FOLLOWED BY
TRIPPING OF KISHENGANJ-PATNA 400kV S/c

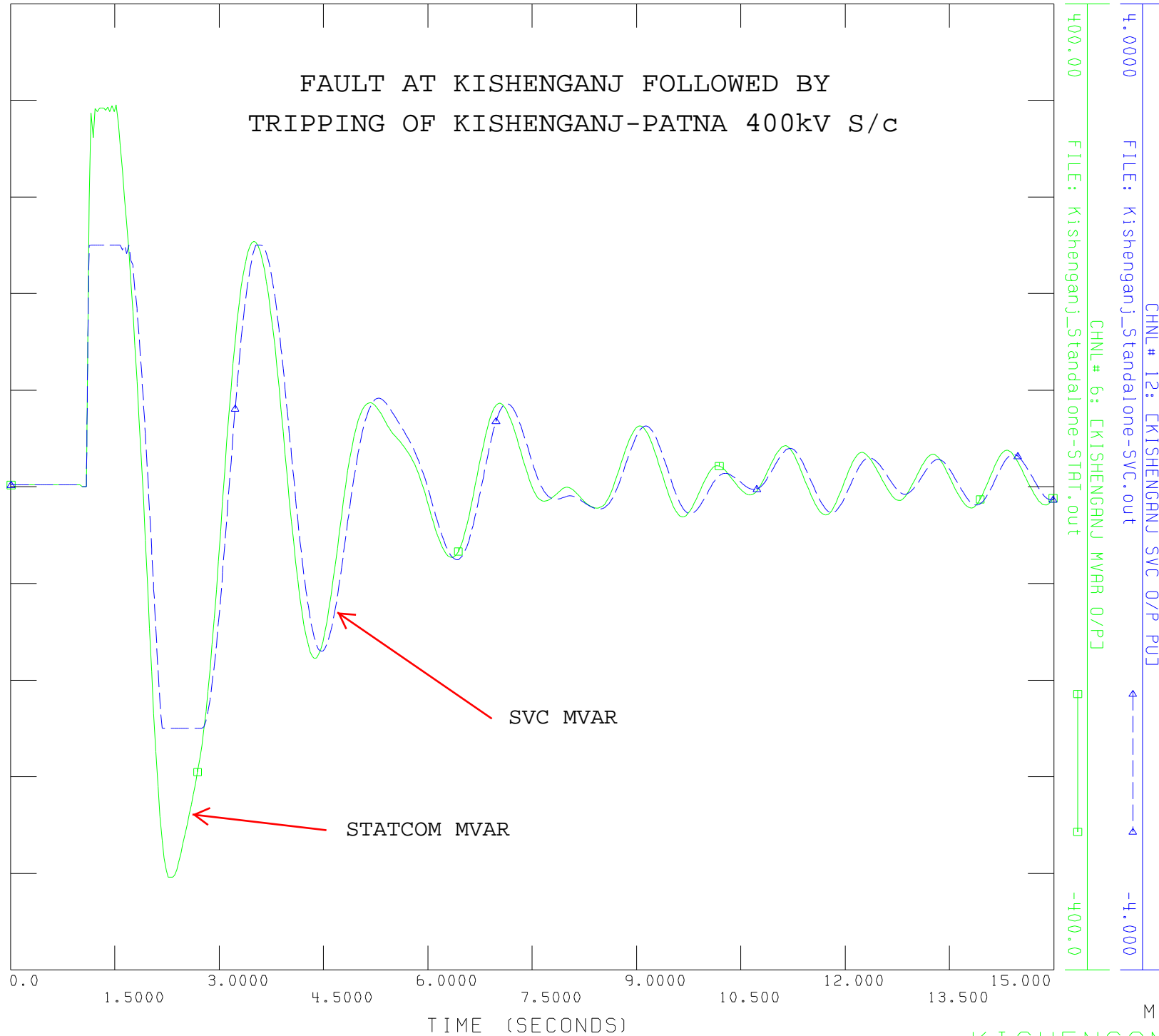


EXHIBIT-11-O(b)

MON, AUG 05 2013 18:33

KISHENGANJ MVAR OFFPEAK



FAULT AT RANCHI FOLLOWED BY
TRIPPING OF RANCHI JHARSUGUDA 765kV S/c

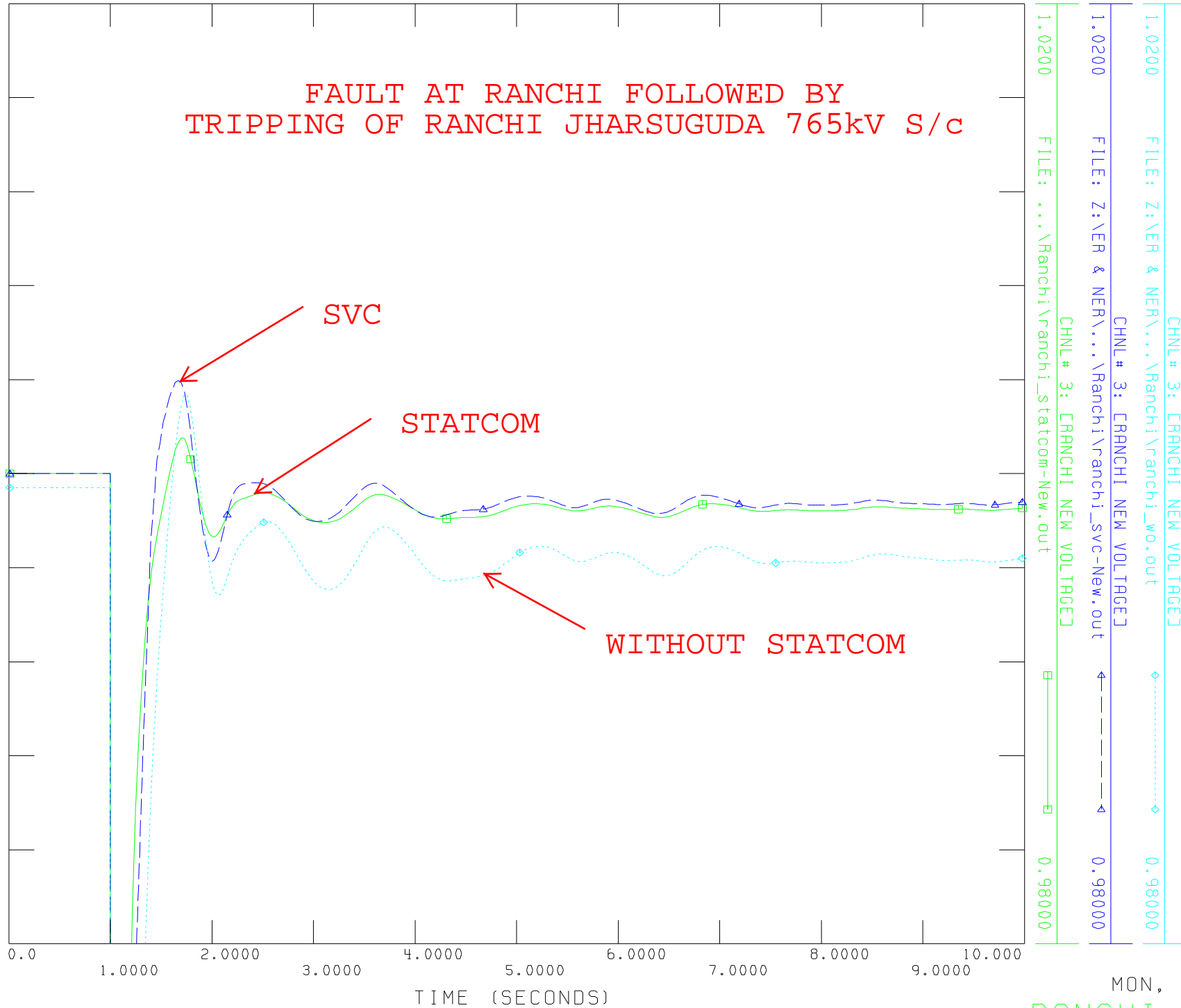


EXHIBIT-12-P(a)

MON, AUG 05 2013 18:05

RANCHI NEW VOLTAGES



FAULT AT RANCHI FOLLOWED BY TRIPPING OF RANCHI JHARSUGUDA 765kV S/c

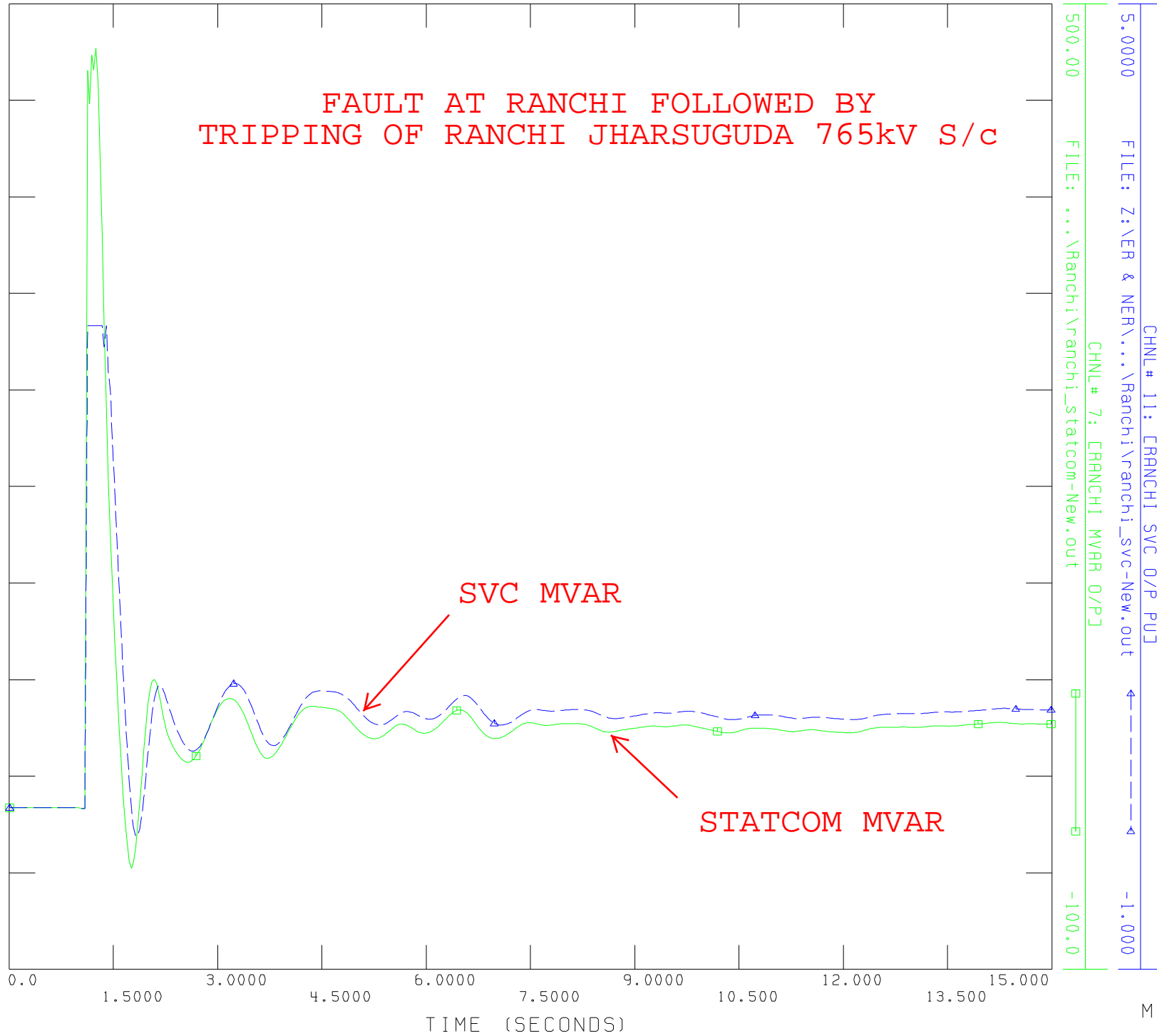


EXHIBIT-12-P(b)

MON, AUG 05 2013 18:12

RANCHI MVAR



FAULT AT RANCHI FOLLOWED BY TRIPPING OF RANCHI-SUNDERGARH 765kV S/c

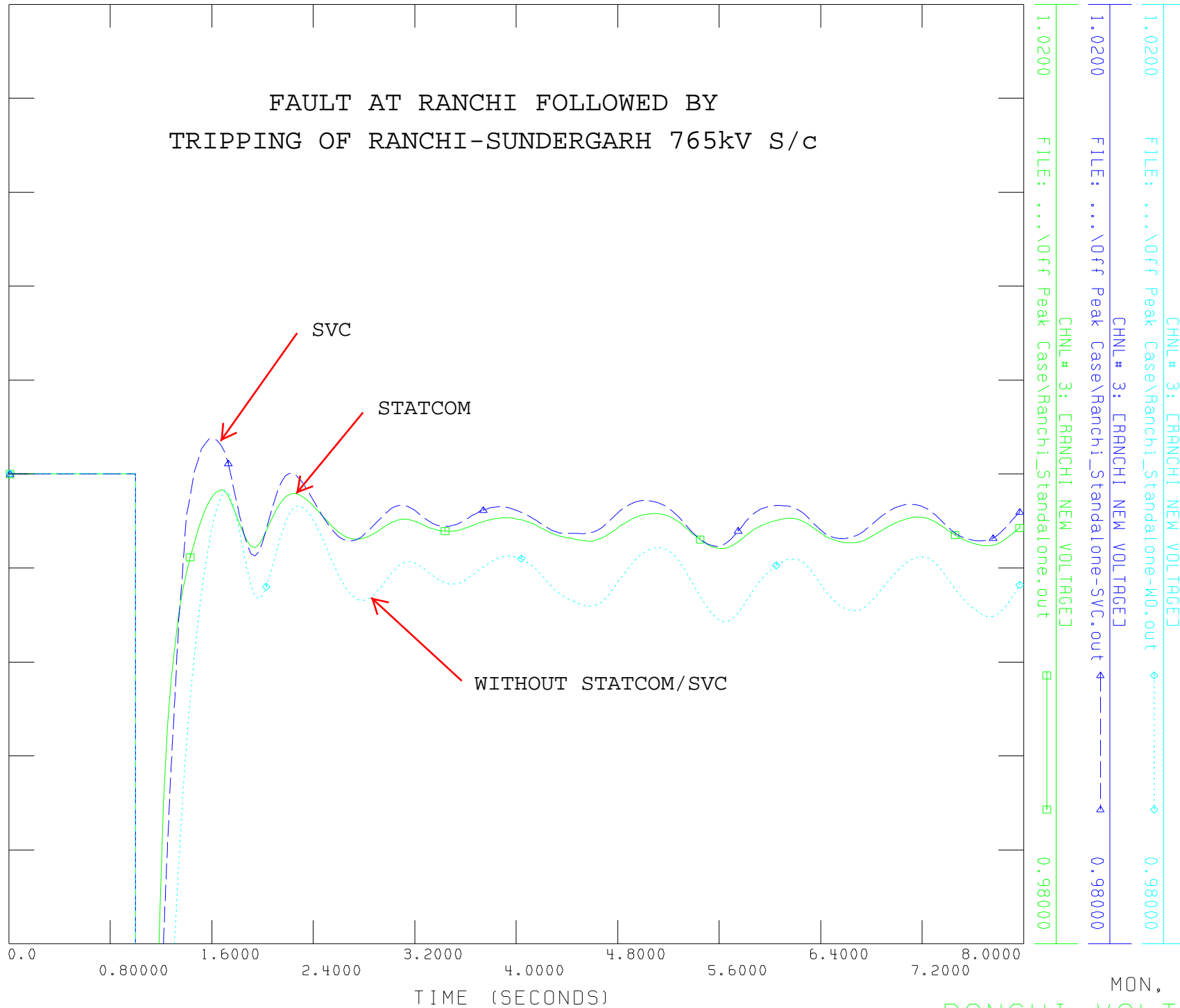
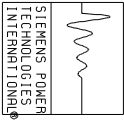


EXHIBIT-12-O(a)

MON, AUG 05 2013 18:25

RANCHI VOLTAGES OFFPEAK



FAULT AT RANCHI FOLLOWED BY
TRIPPING OF RANCHI-SUNDERGARH 765kV S/c

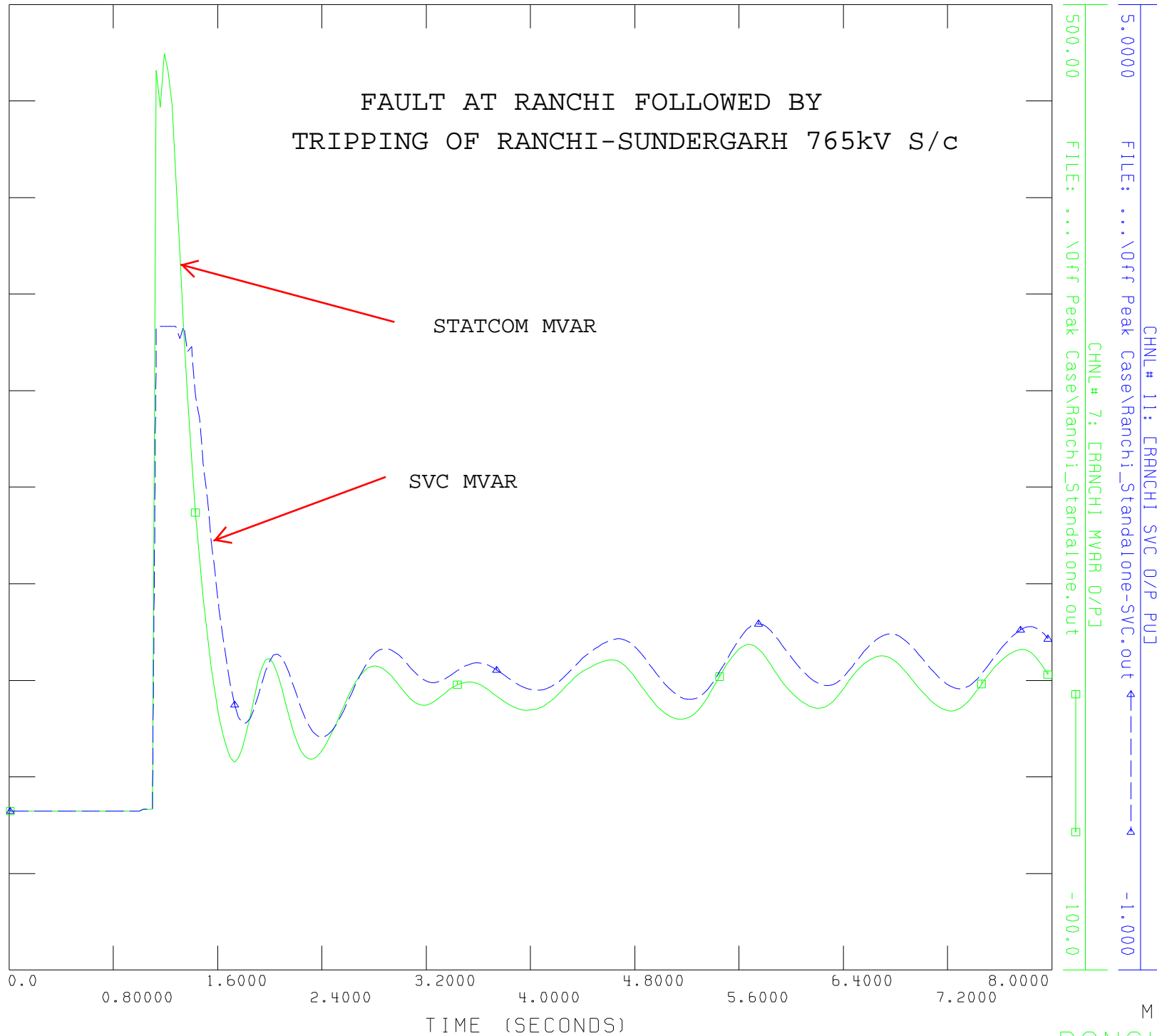


EXHIBIT-12-O(b)

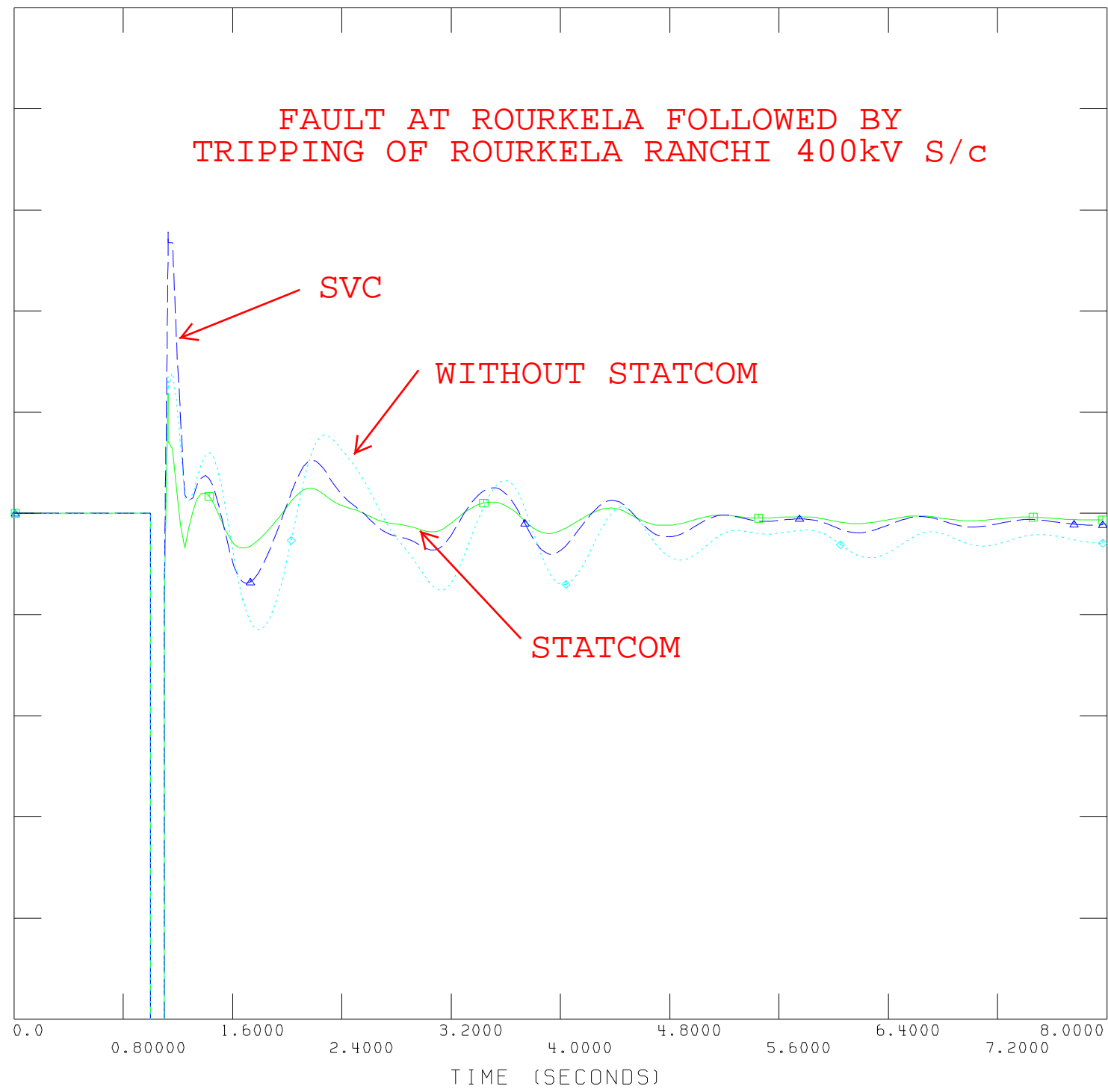


FAULT AT ROURKELA FOLLOWED BY
TRIPPING OF ROURKELA RANCHI 400kV S/c

SVC

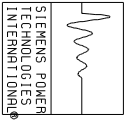
WITHOUT STATCOM

STATCOM



1.0500 FILE: ...\Rourkela\Rourkela-MD-New.out CHNL # 4: [ROURKELA VOLTAGE] 0.95000
1.0500 FILE: Z:\ER & NER\...\Rourkela\rour_svc-New.out CHNL # 4: [ROURKELA VOLTAGE] 0.95000
1.0500 FILE: Z:\ER & NER\...\Rourkela\rour_stat-New.out CHNL # 4: [ROURKELA VOLTAGE] 0.95000

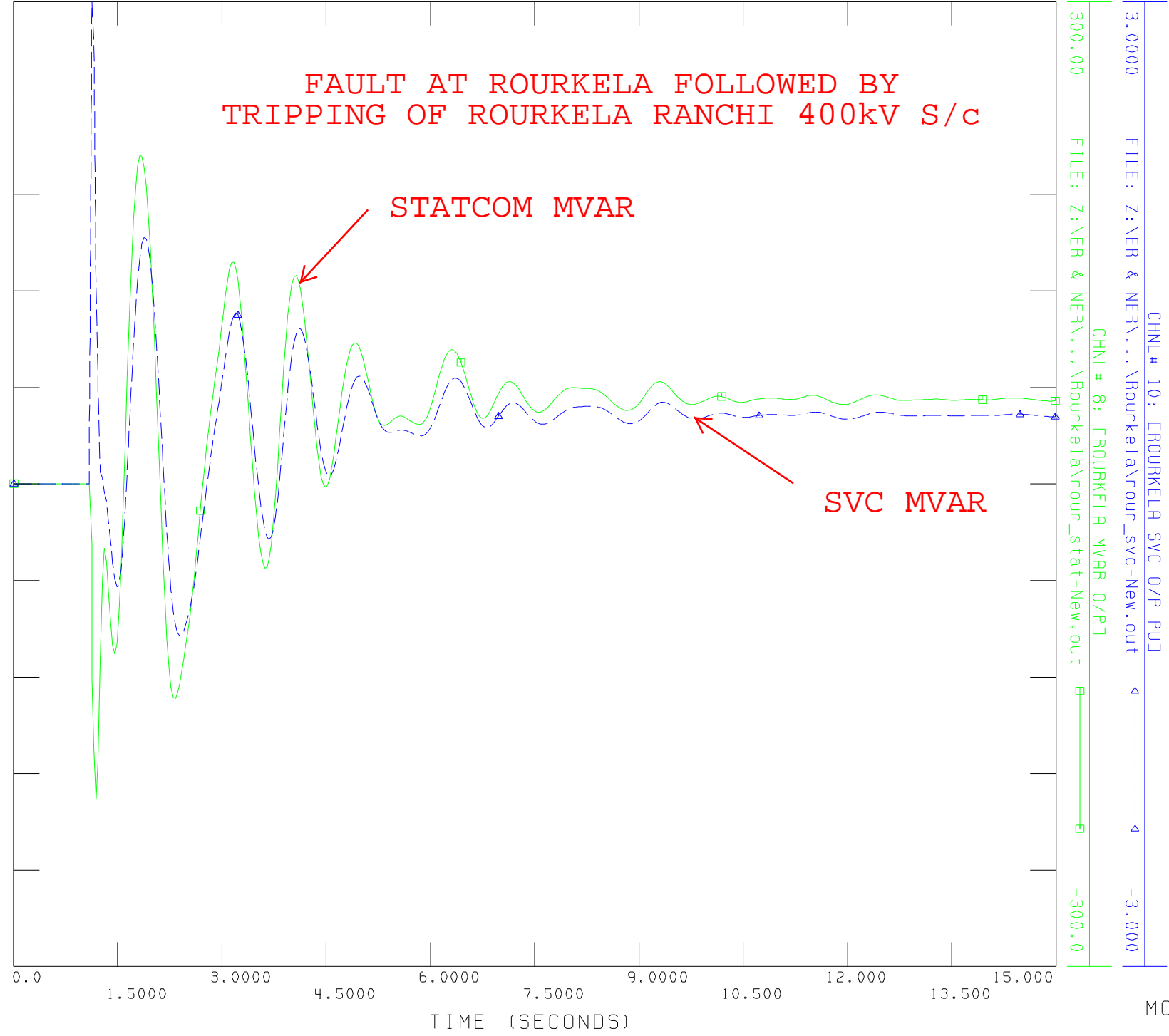
EXHIBIT-13-P(a)



FAULT AT ROURKELA FOLLOWED BY
TRIPPING OF ROURKELA RANCHI 400kV S/c

STATCOM MVAR

SVC MVAR



CHNL # 10: EROURKELA SVC O/P PUJ
FILE: Z:VER & NER\...\Rourkela\rour_svc-New.out
CHNL # 8: [ROURKELA MVAR O/P]
FILE: Z:VER & NER\...\Rourkela\rour_stat-New.out

EXHIBIT-13-P(b)

MON, AUG 05 2013 18:10

ROURKELA MVAR



FAULT AT ROURKELA FOLLOWED BY TRIPPING OF RANCHI-ROURKELA 400kV S/c

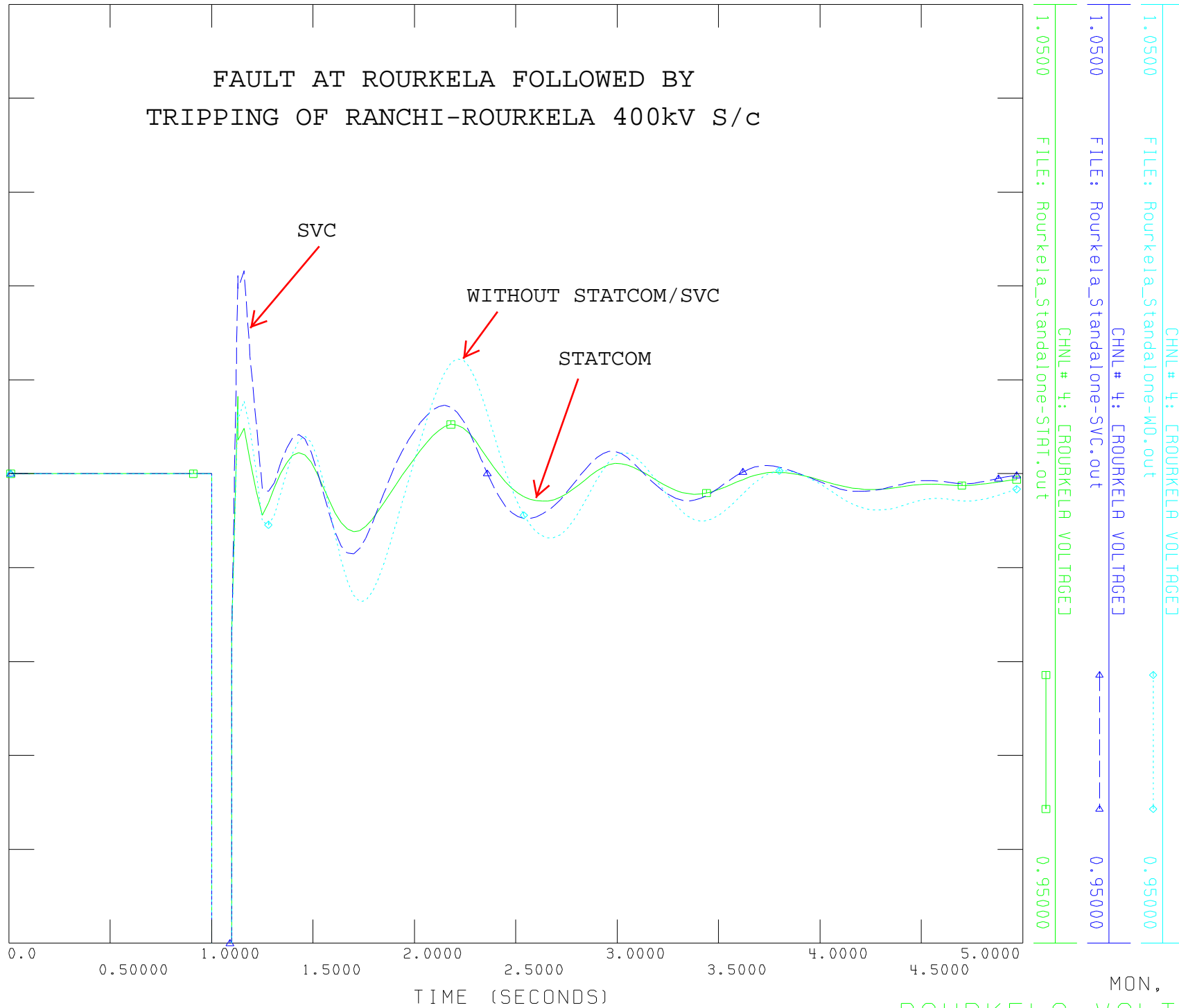
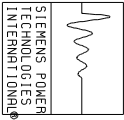


EXHIBIT-13-O(a)

MON, AUG 05 2013 18:28

ROURKELA VOLTAGES OFFPEAK



FAULT AT ROURKELA FOLLOWED BY
TRIPPING OF RANCHI-ROURKELA 400kV S/c

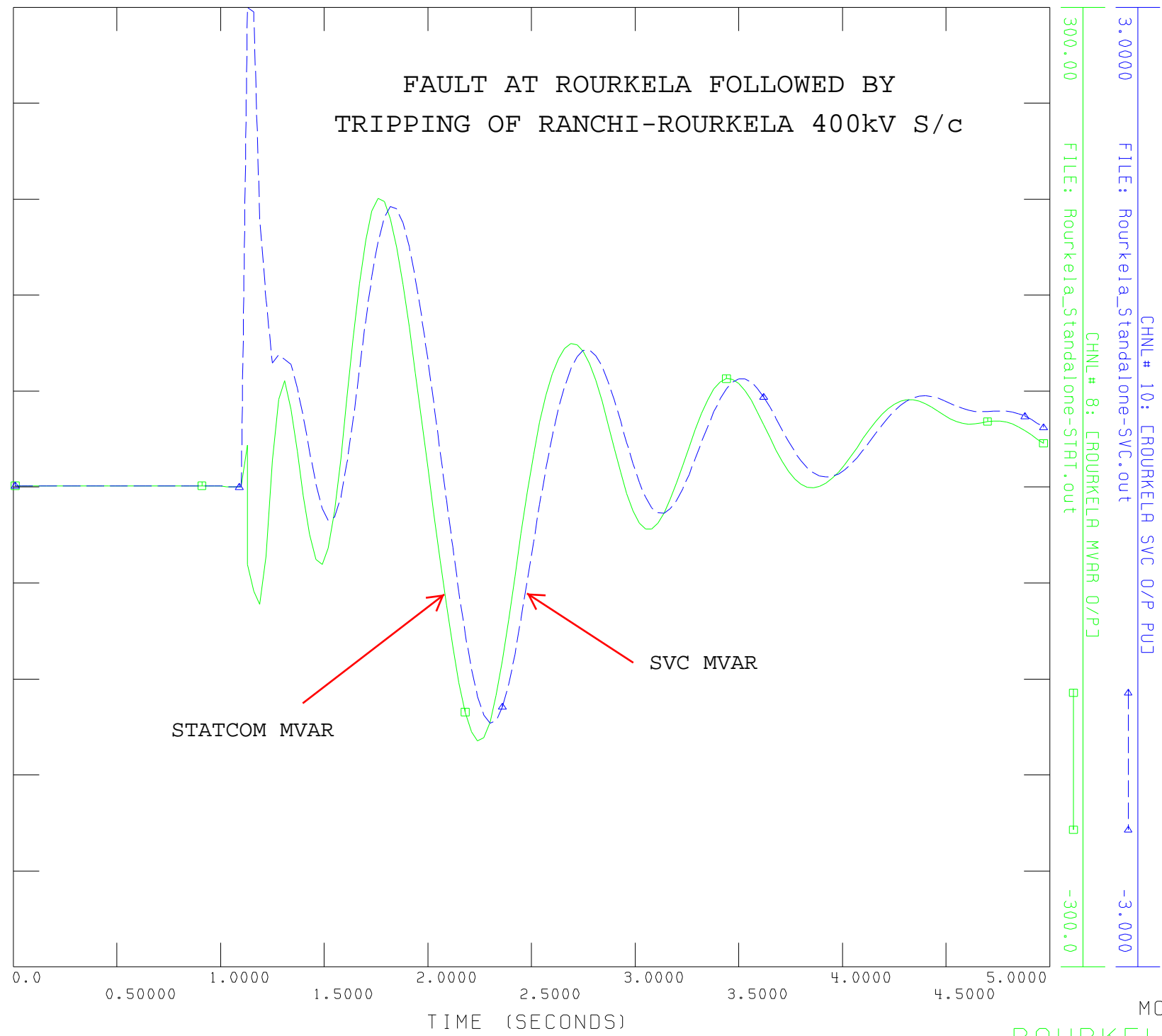


EXHIBIT-13-O(b)

765kV System Strengthening Scheme in Eastern Region

It has been observed from the future load generation scenario of ER (13th Plan end) that there would be a steady growth in the load all over ER, but major generation projects are envisaged in the central and western part of ER (Odisha, Jharkhand and Bihar), whereas no major generation addition is expected in the eastern part (West Bengal).

The 765kV inter-state substations of ER at Ranchi, Gaya, Angul and Jharsuguda/Sundergarh have been implemented by POWERGRID to mainly enable export of power outside the region. In order to provide reliable and secure power supply within the region from various future generation projects and also to facilitate power exchange with the neighbouring regions under various operating conditions, it is proposed to build high capacity transmission network in ER which would optimize RoW requirements by creating a 765kV ring/corridor, as mentioned below:

1. Ranchi (New)-Medinipur-Jeerat (New)-Gokarna (New)-Banka (New)-Gaya-Ranchi (New) 765kV D/c line along with establishment of 765/400kV new substations at Banka (New), Gokarna (New), Medinipur and Jeerat (New).
2. Angul-Jajpur Road-Medinipur 765kV D/c line, forming a ring line Angul-Jajpur Rd-Medinipur-Ranchi-Dharamjayagarh-Jharsuguda-Angul with establishment of new 765/400kV substation at Jajpur Road.

The above 765/400kV sub-stations would be interconnected with the nearby 400kV substations through 400kV high capacity D/c lines.

The said proposal was discussed and approved in the Standing Committee Meeting of ER held on 02nd May 2014 by all the constituents. However, certain modifications in the proposed scheme were incorporated based on subsequent discussion with the constituents.

The schematic diagram of the scheme is as mentioned below:

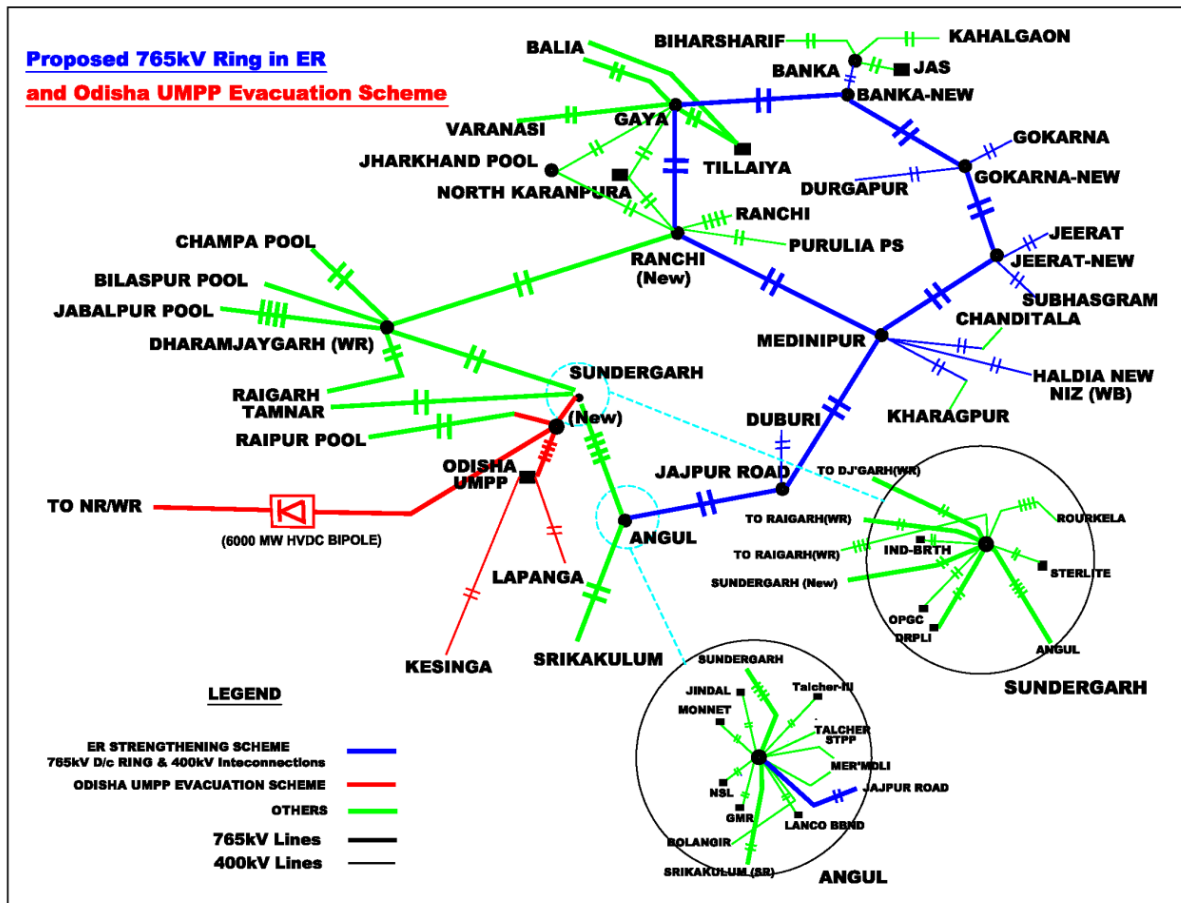


Figure: 765kV Strengthening in ER and the associated 400kV interconnections

Further, the scheme has been reviewed due to delay in the implementation of Orissa UMPP and other generation projects, and it has been observed that most of the 765kV corridors are not getting adequately loaded in the study result for 2018-19 time period. Accordingly, the requirement of 765kV ring may be postponed for some time. However, a strong East-West connection in the Eastern Region is found to be necessary. So to begin with, the middle path of the ring i.e. Ranchi – Medinipur – Jeerat 765kV D/c line may be taken up for implementation, wherein following transmission system is proposed:

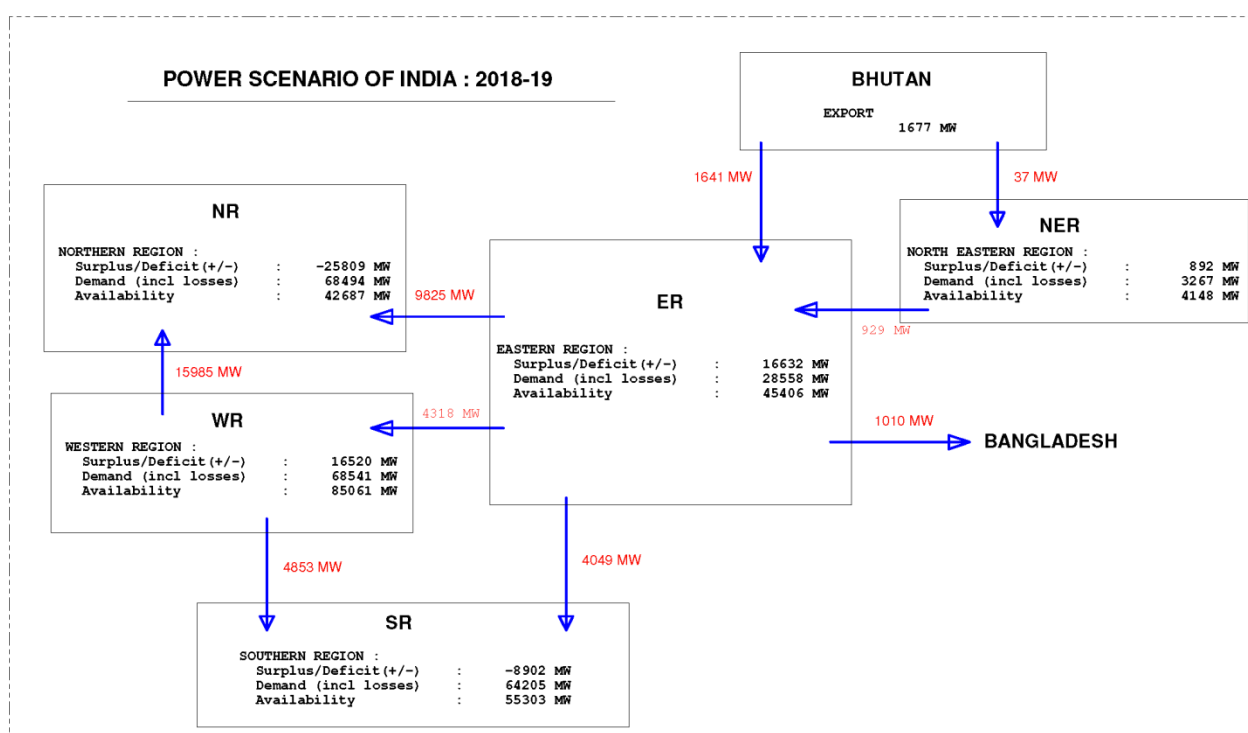
- (a) Establishment of 765/400kV, 2x1500MVA substations at Medinipur and Jeerat (New)
- (b) Ranchi (New) – Medinipur 765kV D/c line
- (c) Medinipur – Jeerat (New) 765kV D/c line
- (d) Medinipur – Haldia New (NIZ) (WBSETCL) 400kV D/c line (quad/HTLS)
- (e) LILO of Chandithala – Kharagpur 400kV D/c line at Medinipur

- (f) Jeerat (New) – Subhasgram 400kV D/c line(quad/HTLS)
- (g) Jeerat (New) – Jeerat 400kV D/c line (quad/HTLS)
- (h) LILO of Jeerat (WB) – Subhasgram 400kV S/c section at Rajarhat

Revised system studies have been carried out for 2018-19 time-frame for two scenarios namely – (i) Expected LGB of Eastern Region and (ii) With reduced self-generation of West Bengal. The LGBs considered for study are as given below:

➤ **LGB: 2018-19**

- **All India**



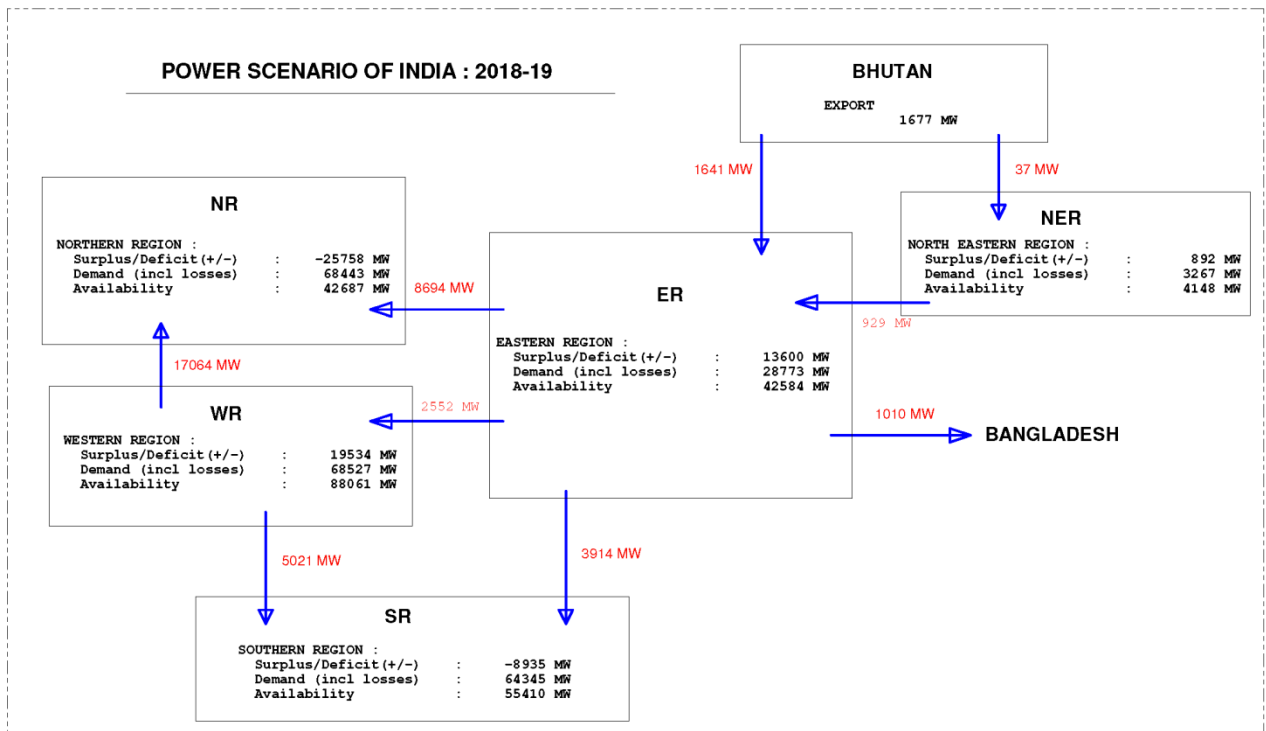
- **Eastern Region**

State	Generation (in MW)	Load + Loss (in MW)	(+) Surplus/ (-) Deficit (in MW)
Bihar	9177	5754.2	3422.8
Odisha	14897	5770.9	9126.1
DVC	5845	4264.4	1580.6
West Bengal	8791.9	11161.2	-2369.3
Jharkhand	5216	1669.1	3546.9
Sikkim	1479	154.4	1324.6
Total	45405.9	28774.2	16631.7

Study Results for this scenario Without Strengthening and With 765kV Strengthening is at **Exhibit-1** and **Exhibit-2** respectively.

➤ **LGB: 2018-19 (Reduced West Bengal Self-Generation)**

- All India



- Eastern Region

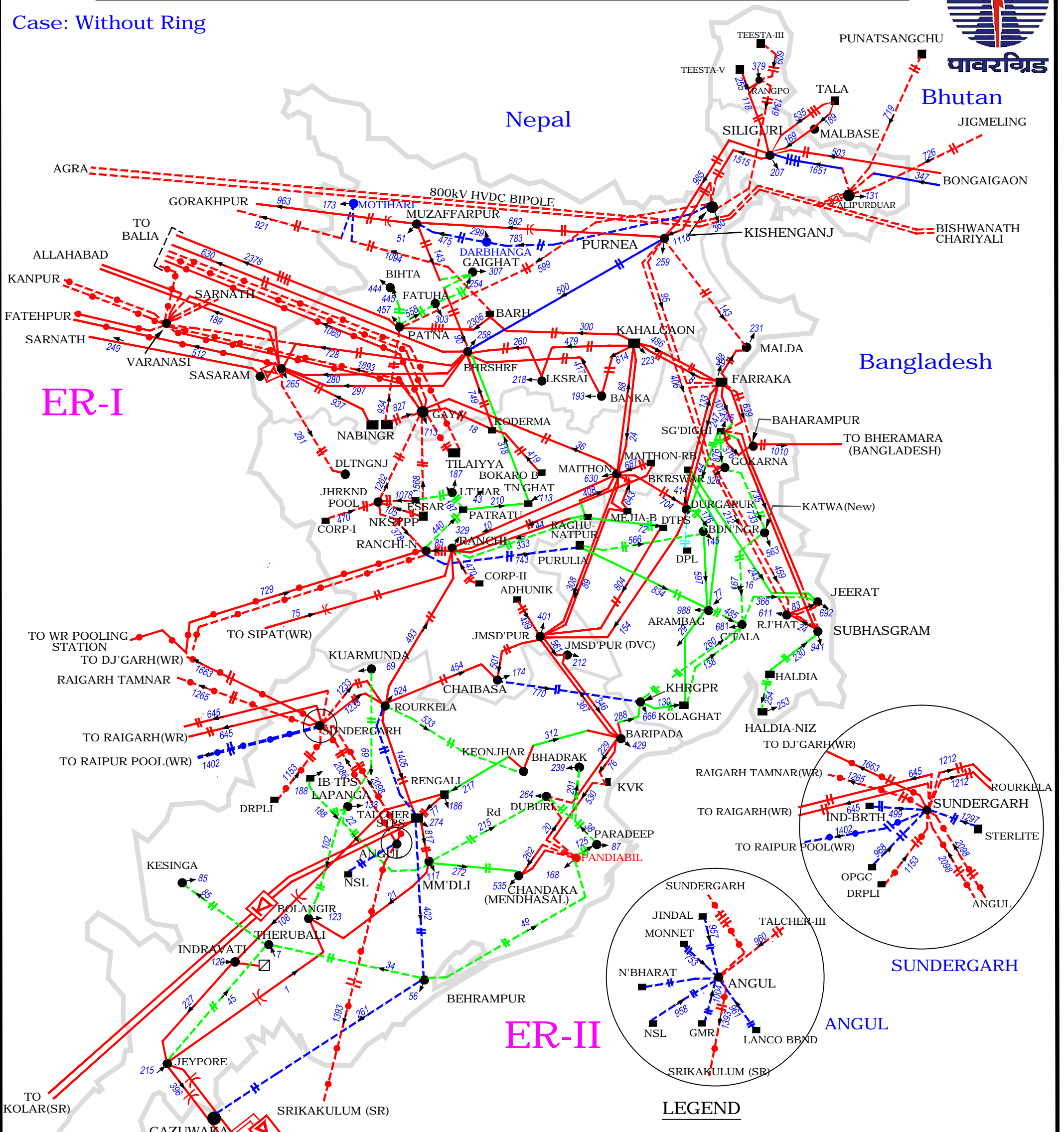
State	Generation (in MW)	Load + Loss (in MW)	(+) Surplus/ (-) Deficit (in MW)
Bihar	9177	5740.2	3436.8
Odisha	14897	5846.8	9050.2
DVC	5845	4295.4	1549.6
West Bengal	5970	11248.4	-5278.4
Jharkhand	5216	1698.8	3517.2
Sikkim	1479	154.5	1324.5
Total	42584	28984.1	13599.9

Study Results for this scenario Without Strengthening and With 765kV Strengthening is at **Exhibit-3** and **Exhibit-4** respectively.

POWER MAP OF EASTERN REGION



Case: Without Ring



ER-I

ER-II

LEGEND

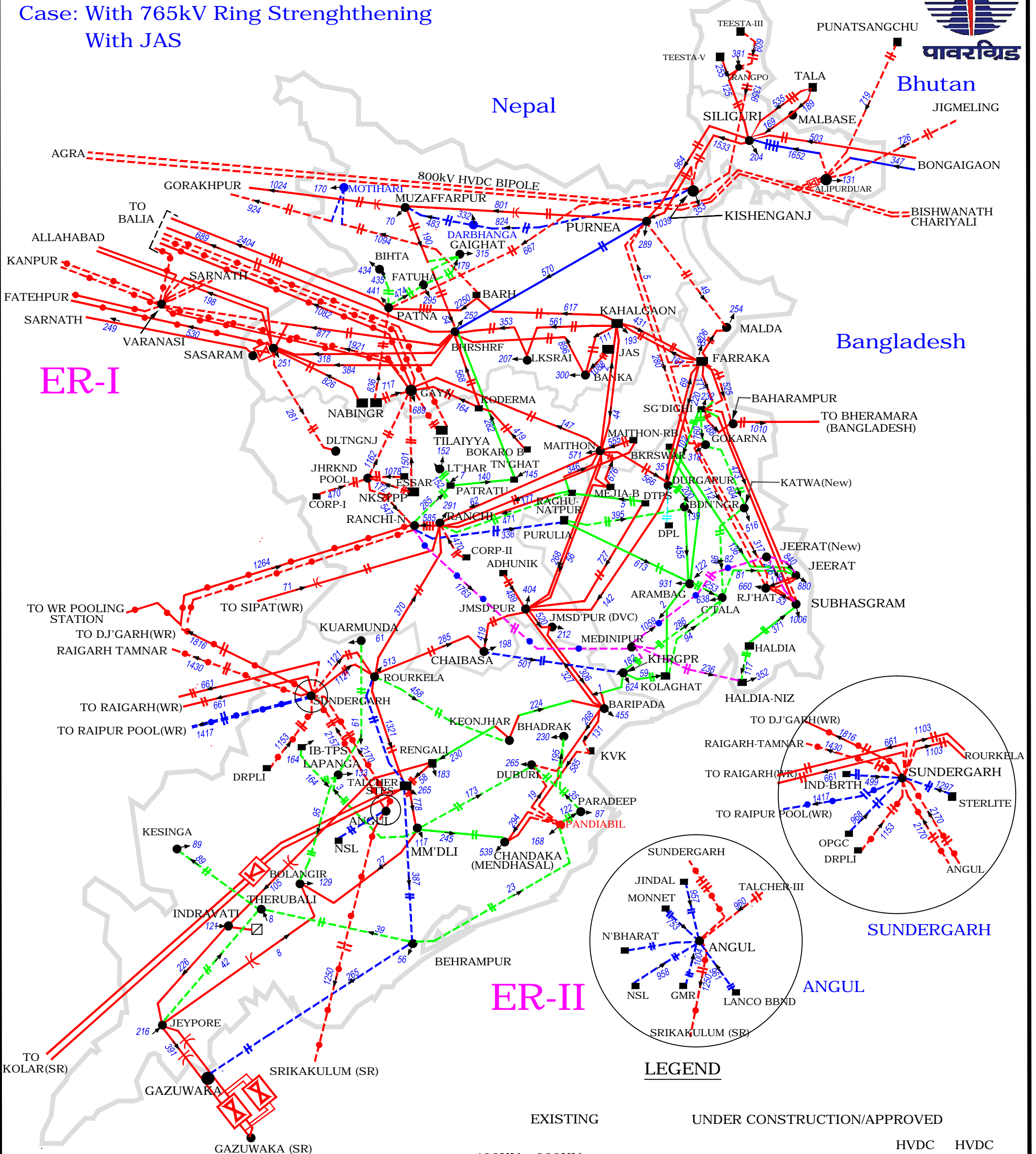
	EXISTING			UNDER CONSTRUCTION/APPROVED			HVDC BTB	HVDC BIPOLE
POWERGRID	400KV	220KV	132KV	765 KV	400 KV	220 KV		
TBCB								
SEB								

Time Frame: 2018-19

Last Updated
17 Feb 2015

POWER MAP OF EASTERN REGION

Case: With 765kV Ring Strengthening
With JAS



ER-I

ER-II

LEGEND

	EXISTING			UNDER CONSTRUCTION/APPROVED			HVDC BTB	HVDC BIPOLE
POWERGRID	400KV	220KV	132KV	765 KV	400 KV	220 KV		
TBCB								
SEB								

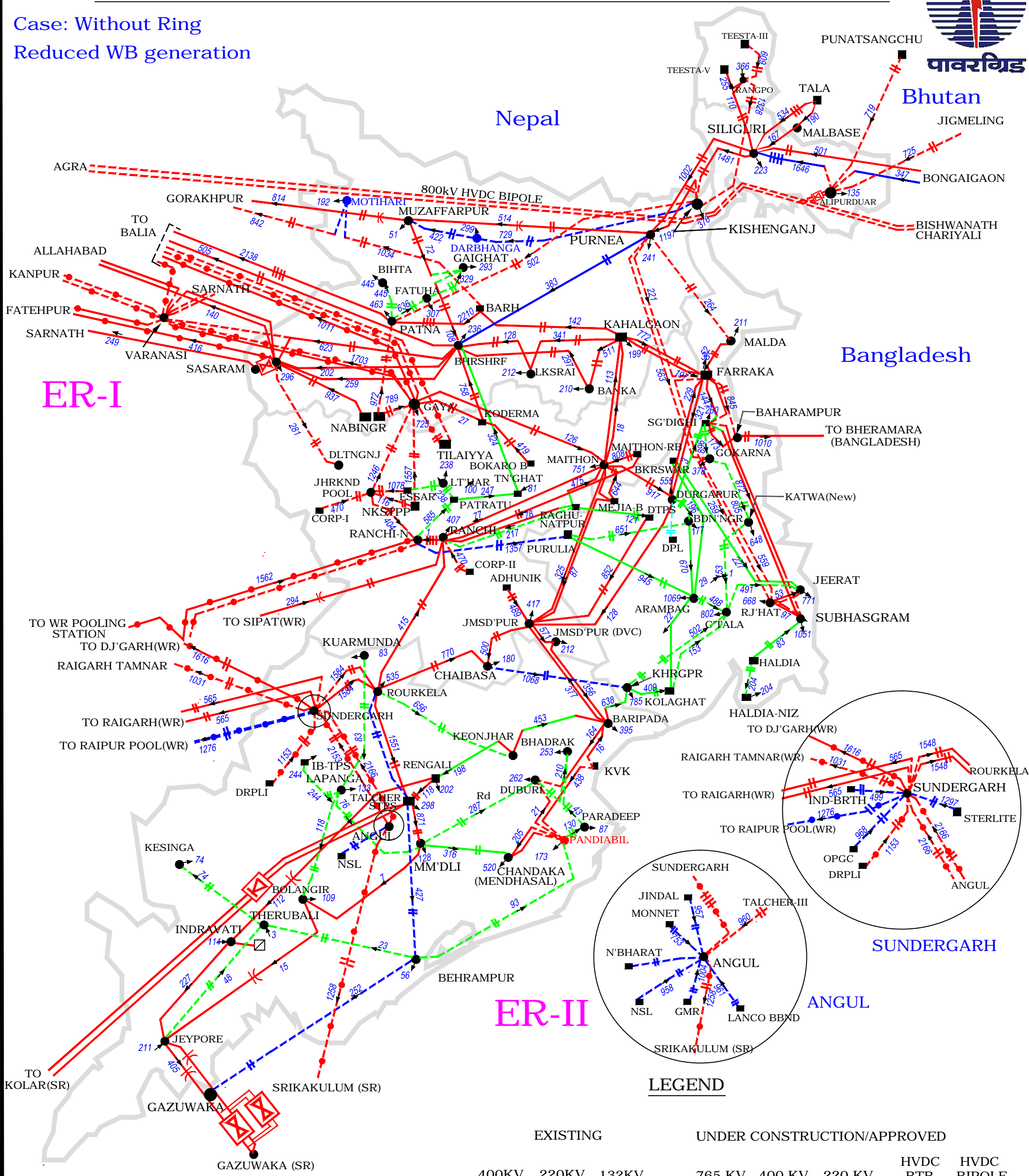
Timeframe: 2018-19

Last Updated
17 Feb 2015

POWER MAP OF EASTERN REGION



Case: Without Ring
Reduced WB generation



ER-I

ER-II

LEGEND

	EXISTING			UNDER CONSTRUCTION/APPROVED			HVDC BTB	HVDC BIPOLE
POWERGRID	400KV	220KV	132KV	765 KV	400 KV	220 KV		
TBCB								
SEB								

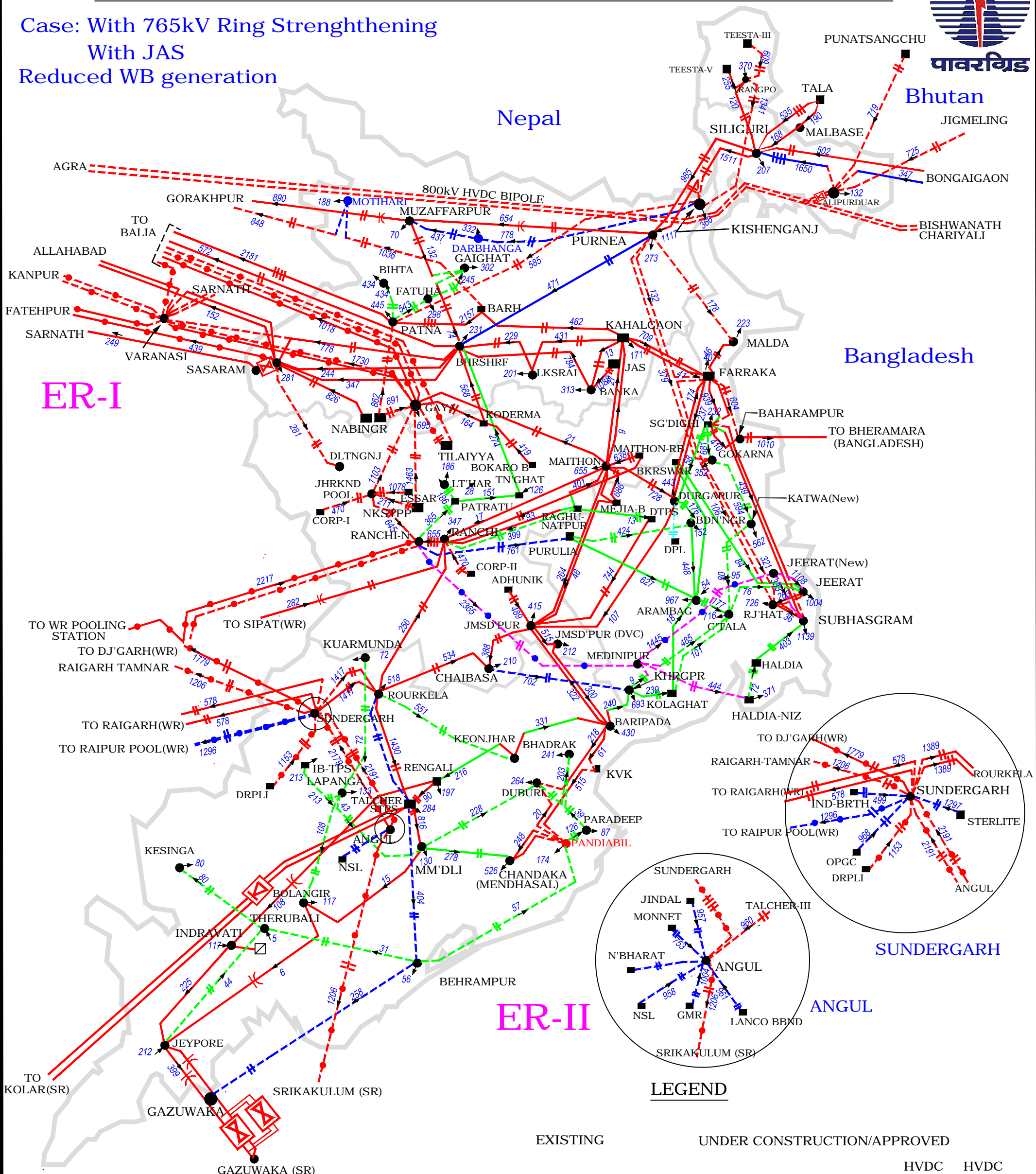
Time Frame: 2018-19

Last Updated
17 Feb 2015

POWER MAP OF EASTERN REGION



Case: With 765kV Ring Strengthening
With JAS
Reduced WB generation



ER-I

ER-II

LEGEND

	EXISTING			UNDER CONSTRUCTION/APPROVED			HVDC BTB	HVDC BIPOLE
POWERGRID	400KV	220KV	132KV	765 KV	400 KV	220 KV		
TBCB								
SEB								

Timeframe: 2018-19

Last Updated
17 Feb 2015