भारत सरकार
उत्तर क्षेत्रीय विद्युत समिति
18-ए, श.जीत सिंह मार्ग, कटवरिया सराय
नई दिल्ली- **110016**
Government of India
Northern Regional Power Committee
18-A, S. Jeet Singh Marg, Katwaria Sarai,
New Delhi-110016

सं. उक्षेविस/प्रचालन/107/07/2018/8187-8209 दिनांक: 12.07.2018

सेवा में,
सलग्न सूची के अनुसार

विषय : H.V.D.C. चंपा-कुरुक्षेत्र पोल 1 और 2 में यादृच्छिक विद्युत आदेश के परिवर्तन के मुदे पर और अन्य पश्चिम-उत्तर (डब्ल्यूआर-एनआर) अंतर-क्षेत्रीय लिंक के अविश्वसनीय संचालन के मुद्दों पर चर्चा करने के लिए आयोजित बैठक के मिनट्स ।

उपरोक्त विषय से संबंधित पत्र सूचना और आवश्यक कार्यवाही हेतु संलग्न हे ।

- हस्ताक्षरित-
(भंवर सिंह मीना)
कार्यपालक अभियंता

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सत्यमेव जयते
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नई दिल्ली- 110016
Government of India
Northern Regional Power Committee
18-A, S. Jeet Singh Marg, Katwaria Sarai,
New Delhi-110016

No : NRPC/OPR/107/07/2018/ 8187 - 8209 Dated: 12th July, 2018

Subject : Minutes of meeting held on 25.05.2018 to discuss the issues of Frequent Operation of random power order change in HVDC Champa – Kurukshetra Pole-1 & 2 and unreliable operations of other West – North (WR-NR) inter-regional link

Sir,

A meeting was held on 25.05.2018 at Kurukshetra HVDC Station, POWERGRID to discuss the issues of Frequent Operation of random power order change in HVDC Champa – Kurukshetra Pole-1 & 2 and unreliable operations of other West – North (WR-NR) inter-regional link.

The minutes of the meeting is enclosed as **Annexure** to this letter. Any comments on the minutes may kindly be submitted within a week of issue of the minutes.

Encls: As above

(Bhanwar Singh Meena)
Executive Engineer (P)

To : As per List attached

List of Recipients :

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Minutes of the Meeting held to discuss the issues of Frequent Operation of random power order change in HVDC Champa – Kurukshetra Pole-1 & 2 and unreliable operations of other West – North (WR-NR) inter-regional link

List of Participants is attached as **Annexure – I**.

1. Representative of POWERGRID welcomed Member Secretary, NRPC, Member Secretary, WRPC, Chief Engineer (NPC) and all the officers of NRPC, WRPC, CERC, NLDC, NRLDC, WRLDC and POWERGRID at Kurukshetara HVDC station. He further briefed about the agenda for the meeting.
2. MS, NRPC appreciated warm welcome by POWERGRID and asked representative of NLDC to highlight the issues of HVDC Champa-Kurukshetra through presentation (**Attached as Annexure - II**).
3. Representative of NLDC informed that HVDC Champa- Kurukshetra has tripped no. of times from Oct-17 to May-18 which includes tripping of Pole 1, Pole 2 and Bipole. He further informed that HVDC Vindhyachal Back-back Block-2 (250 MW capacity) was out from 26.11.17 on account of converter transformer failure and HVDC Mundra-Mohendargarh Bipole was operating only up to 25% of its rated capacity on account of less generation at APL Mundra generation plant. He added that there were incidents of random power order change due to TOVC(Transient Overvoltage correction) which has created problems for system operator due to sudden overloading of other inter regional lines. The trippings of the inter-regional lines on the account of thunderstorm, tower collapse, equipment damage was also highlighted. He raised concerns about security and reliability of WR-NR inter-regional power flow considering above scenario.
4. Chief Engineer (NPC), inquired about the relation between temporary higher voltage on AC side and the random power order change in HVDC.
5. Representative of NLDC informed when the voltage at Kurukshetra AC side was higher than 434 kV during winter nights, trippings of filter and random power order change was observed.
6. CE (NPC) told if this was the case then AC lines should have been loaded while keeping the lower power order of HVDC. It was informed that there was constant over voltage at Kurukshtera AC side in winter. Representative of NRLDC informed that the voltage at Kurukshetra in winter was around 430-440kV after opening of around 3-4 lines of 400 kV.
7. Representative of POWERGRID stated that there was minimum requirement of filters to operate the HVDC. It was informed that if the AC side voltage is higher and capacitive MVAr supplied by filters being proportional to the

square of voltage, the cascading effect takes place resulting into further higher voltage on AC side. He stated that it was better to load AC system in peak winter rather than HVDC system. It was also informed that 80 MVAr reactor has been commissioned at Kurukshetra end while another bus reactor of 125 MVAr shifted from Manesar is expected to be commissioned by June, 2018.

8. CE,(NPC) highlighted that dynamics between minimum filter and maximum power order need to be maintain for effective operation of the system. Representative of NLDC informed that MVAr injection by filters was much higher than the MVAr absorption by converters.
9. Representative of POWERGRID informed that M/s GE has introduced minimum switching-in scheme for ensuring the filtering performance was duly met at every power level.
10. SE(O), NRPC highlighted that there is not any large 400kV load center nearby to Kurukshetra which can be explored while strengthening of network and needs to be considered in standing committee.
11. MS, NRPC stated that simulation studies need to be carried to find balance amongst the power order variations and voltage level at the AC side. **(Action : POWERGRID)**
12. MS, WRPC inquired about the settings for the overvoltage and the possibility of filters being used in small chunks. It was informed that AC side setting was 440 kV hence the DC side setting for overvoltage was kept at 434 kV to avoid complete blackout of station in case of over voltage. It was further informed that tripping due to overvoltage settings was instantaneous and it was not possible to use filters in chunks as they aren't designed in that way. It was informed that minimum 2 filters of 125 MVAr were essential for Bi-pole operation at minimum power order of 300 MW.
13. Representative of NLDC informed that complete Kurukshetra station went under blackout due to high voltage on account of MVAR injection from HVDC filters on 10th Nov 2017. Subsequently, a meeting was held on 11th Nov, 2017 between CC-POWERGRID and POSOCO to mitigate the issues of overvoltage at Kurukshetra. It was decided that that HVDC Champa-Kurukshetra Bipole will be operated in RVO (Reduced Voltage Operation) mode of operation i.e 80% of rated voltage at 640 kV. It was found that in RVO mode, converters were observing more MVAR which can help in improving voltage profile.
14. Representative of POWERGRID informed that continuous operation in RVO mode with higher AC voltage was not desirable as the Gamma(extinction angle) needs to be kept at higher to maintain lower DC voltage which puts stress on Thyristor walls and affects the life of equipment.

15. MS, NRPC inquired about the time for which Bi-pole can be operated in RVO mode and cooling off time required in between to again start the operation in RVO mode as the phenomenon of higher voltage will persist in winter.
16. It was informed that 3-4 hours continuous operation in RVO mode was possible. Representative of GE told that studies needs to be carried out to determine the cooling off time required in between to again start the operation in RVO mode. **(Action : POWERGRID/GE)**
17. Representative of NLDC stated that during RVO mode, site personnel informed that due to Gamma(extinction angle) limitations, pole could not be operated on RVO mode. In this regard, it was requested that extinction angle and firing angle telemetry shall be provided from inverter and rectifier stations to RLDCs/NLDC so as to analyze operating margins of Bi-pole.
18. It was highlighted that information of extinction angle shall help in analyzing the flow, voltage variations and improve the knowledge as well as confidence of the operator. It was deliberated that Gamma (extinction angle) information might be provided in 15 min duration at NLDC/RLDC. **(Action : POWERGRID)**
19. Representative of NLDC informed that HVDC Champa – Kurukshetra was designed to operate with Dedicated Metallic Return (DMR). It was informed that there are different modes of operation such as Bipolar with both DMR in operation, Bipolar with one DMR in Operation, Monopolar with both DMR parallel to PMR etc.
20. It was insisted that online telemetry shall be available at NLDC/RLDC to know the real time mode of operation as well as instance of change over from one configuration to another. Representative of POWERGRID agreed for the same and one month time was given to implement it. **(Action : POWERGRID/GE)**
21. Representative of NLDC requested to provide information such as overload settings (MW & time) of healthy pole in case of one pole trips during Bi-pole operation, No. of attempts of auto restart before Pole tripping on DC line fault and Power order variation during Reduced Voltage Operation and a setting curve. **(Action : POWERGRID)**
22. He highlighted that outage of Kurukshetra station 400 kV Bus-2 from 2nd Feb to 5th May 2018 which reduced reliability of Bipole for long duration. It was advised that early restoration of station elements must be ensured.
23. He further informed about various issues due to which trippings happened such as LANE changeover problem, VESDA operation, CLD protection, control mal-operation, External Block, Auxiliary supply failure, Stuck tap position, commutation failure, filter control block operation, CNAP protection etc.

24. He also mentioned about the Bi-pole tripping on 2nd Feb, 2018 due to commutation failure where continuous spikes for 1 minute was observed in voltage profile at Raipur end PMU.
25. Representative of POWERGRID informed that Bi-pole will trip on commutation failure when there are spikes in AC voltage profile continuously for 1.2 secs. It was supposed to operate only after autorecloser for AC line which has the setting of 1 sec.
26. It was clarified that no AC trippings were recorded and only Bi-pole was tripped on that particular day. Representative of POWERGRID stated that there was no tripping recorded due to commutation failure on 2nd Feb, 2018. He also told that the shutdown was taken on 2nd Feb, 2018.
27. Considering the ambiguity about the entire event, it was recommended to investigate and analyze the tripping further in detail and submit the report at the earliest. **(Action: POWERGRID & NLDC)**
28. Representative of NLDC informed that the grid is being operated keeping the margins of power flow in Bi-pole due to unreliable operation and sudden power order changes. It was also informed that it has created stress on other inter-regional lines as well as WR-ER power flow. It was also highlighted about inability of the Grid to reach maximum potential TTC/ATC levels due to unreliable operation.
29. CE (NPC) inquired about the harmonics interchanging between AC & DC voltage. He informed that harmonics are to be monitored as per the CEA, Technical standard and asked if there was possibility to provide data to NLDC/RLDC.
30. Representative of POWERGRID told that providing real time data for the harmonics is difficult but offline/historical data for Harmonics will be made available to CEA/NLDC/RLDC. **(Action : POWERGRID)**
31. MS, WRPC asked if the reliability indices for HVDC was being monitored for the station. Representative of POWERGRID informed that it would be monitored from 6th June for period of 3 years as per contract with M/s GE.
32. It was also inquired why all the deficiencies were not corrected during the commissioning stage. Representative of POWERGRID informed that few of the test in HVDC needs to be done after commissioning and also stated that some issues were encountered only after commissioning.
33. CE(NPC) asked about the list of tests which were done after the commissioning. He asked if COD in this case should be declared after 6 months of operation in grid similar to some Thermal Plants as test in HVDC systems are also done after commissioning.

34. MS,WRPC asked how the equipments were transported and questioned if the methodology for transportation of equipments was certified by OEM. He also enquired about damage if any to the components while transportation.
35. Representative of GE informed that components were transported from Kandla port and sufficient care was taken while packing for the Indian scenario. He also stated that few mechanical components, few filter capacitors were damaged during Pole -1 transportation which were repaired at the site.
36. MS, WRPC emphasized that sufficient care shall be taken for transportation of all the components during Pole -3 and pole -4 projects. **(Action : POWERGRID)**
37. MS, NRPC further asked POWERGRID to highlight the issues through presentation (**Attached as Annexure - III**).
38. Representative of POWERGRID informed about the various configurations of Monopole and Bi-pole operation with PMR and DMR. He also informed that Monopole with PMR and both the DMR and Balance Bi-pole with both the PMR and DMR are best configurations for operation.
39. It was informed that initially there were few problems faced while shifting from one configurations to another but it was resolved and shifting from one configuration to another was smooth.
40. It was informed that to check healthiness of DMR the deliberate unbalancing up to 10% of running power order (+5% in P1 & -5% in P2) is created by control system at every half an hour. In case of fault in DMR, it needs to be identified and S/D has to be taken to clear the fault.
41. Representative of NLDC told that a tripping was observed due to communication failure while checking the healthiness of DMR.
42. MS, NRPC told that philosophy of checking DMR healthiness by unbalancing of poles after every 30 minutes needs to be reviewed as it creates unnecessary disturbance in the Grid. He insisted to carry out experimental studies to find alternative method which will not be affected in communication failure. **(Action : POWERGRID)**
43. Representative of POWERGRID informed that there are main, standby and backup communication and informed that communication failure happened only once due to intermittent failure of telecom over OPGW earth wire. The rectification of faulty hardware was done all along the transmission line including six booster stations and it was ensured that all three communications were healthy.
44. Upon queried about the failure of wall bushing of Pole -1 representative of GE informed that there was moisture content in bushing due to which 2 failures happened in July & October in Pole-1 at Kurukshetra. It was also informed that

bushings were replaced and sensors were being installed for real time monitoring of the moisture content.

45. It was further informed that the representative of OEM of VESDA (Very Early Smoke Detection Apparatus) was called in the month of Oct'17 to attend the issues where the sensitivity was recalibrated and all probable leakage points in entire VESDA pipe line was rectified. It was also told that since then there was no mal-operation of VESDA observed at Kurukshetra end.
46. Representative of POWERGRID told that severe flash over was occurred at two occasions at Kurukshetra due to extremely dense fog /smog during peak winter, in the second week of Dec'17. He further informed that to avoid recurrence of this type of eventuality, M/s GE has carried out the application of RTV (room temperature vulcanisation) coating on the porcelain insulators of all DC disconnector at Kurukshetra.
47. It was further told that M/s GE has upgraded the bi-pole software in the last week of Jan'18 since then most of the repeated mal-operation like tripping of poles due to telecom failure, False CLD of HV and LV cable, filter power limit, VBE major fault, wrong configuration, SYS fail, commutation failure etc. have not repeated.
48. CE (NPC) highlighted the incident on 29th March where overload command was issued and power order was changed from 1200 to 1950 MW. He also mentioned about the similar incidence happened on 9th April where power order was changed from 500 MW and 2000 MW. He asked that the reports regarding problem and remedial actions taken to be provided at the earliest.
49. It was explained that M/s GE has issued operation guidelines to prevent inadvertent overload operations, which is found to be satisfactory till date. It was told that it was a temporary solution and the issue of overload anomaly will be resolved by July, 18.
50. It was further mentioned that reasons behind tripping of pole due to auxiliary AC supply was mal-operation of Defective make/model of C&S make contactor. He told that M/s GE has supplied Schneider make contactors at both the sites for which outage was requested during OCC meeting at NRPC.
51. Representative of POWERGRID stated that 25 no of tripping has been observed, since commissioning period due to defective 5006 cards and all defective cards have been replaced by new make and model of cards by M/s GE at both the sites.
52. MS, WRPC inquired about the earthing used for the electronics circuits. It was informed that there are two type of earthing i.e clean earthing and dirty earthing.
53. Representative of POWERGRID told that the clean earthing is used for electronic circuits which has a separate earth pit not connected to normal earth

mat. MS,WRPC insisted to ensure both earthings are separated as ground potential rise (GPR) due to any fault in earth pit may damage the cards.

54. Representative of POWERGRID informed that LANE -1 & 2 are protection systems and replica of each other. He further told that both the LANEs have main –I & II protection due to which there is 100% redundancy.
55. Representative of GE told that there were many trippings in the month of April due to DC differential protection operation while LANE changeover. He explained that this was mainly due to collective effect of three problems which were optical fibre damage, hardware problems with DCCT and issue of defective 5006 card.
56. Upon queried about the condition of optical fibre and hardware failure within 7-8 months of commissioning, representative of GE told that optical fibre used in panel connection is not armoured and told that it was manufacturing defect which was diagnosed at the time of commissioning and replacement of all the cards was in process, hence it was not case of hardware failure in operation. He further stated that all the suspected cards were replaced since then no related issues were observed.
57. CE (NPC) asked representative of GE to provide the write-ups of all the problems encountered, remedial actions taken and measures need to be taken for avoiding such problems in future. **(Action : POWERGRID)**
58. MS, NRPC stated that the capacity building of Engineers at POWERGRID shall be ensured for operating and controlling new HVDC technology. He requested that OEM engineers should be present at both Champa and Kurukshetra end. He further asked that NRPC, CEA, POSOCO shall be associated with FAT (Factory acceptance test)/SAT (Site acceptance test) of Pole-3 and 4 of HVDC. **(Action : POWERGRID)**
59. He told that all the documentation related to modifications/updating of software and the necessity for the same shall be submitted at the earliest. **(Action : POWERGRID)**
60. He insisted that separateness of Clean and Dirty earthing shall be ensured and asked that action plan for providing telemetry signal of real time mode of operation at NLDC control room to be submitted at the earliest. **(Action : POWERGRID)**
61. He requested to have R&D on method of checking healthiness of DMR as it is creating disturbance in the Grid. He asked that reports on recalibration of VESDA, manufacturing defects encountered, remedial actions taken and measures to avoid these issues in future shall be submitted at the earliest. **(Action : POWERGRID)**

62. He told that studies/simulations should be carried out for reduction of AC voltage, operating bi-poles on reduced DC voltage and optimizing filter MVAr & power order for reliable Bi-pole operation. **(Action : POWERGRID)**
63. He insisted that the installation and commissioning of 500 MVAr TCR shall be completed at the earliest and asked to carry out studies for additional requirement of reactors if any to improve voltage levels. Representative of POWERGRID informed that tender for TCR shall be awarded by July, 2018 and it was expected in operation within 2 and half years. **(Action : POWERGRID)**
64. He asked to share the reliability indices which will be monitored from 6th June. He also asked that the report on measure taken to avoid trippings due to fog/smog shall be submitted at the earliest..
65. Representative of NLDC told that there were incidences of miscommunication with both Champa and Kurukshetra end which shall be avoided and also asked to resolve the software issues at the earliest. **(Action : POWERGRID)**
66. He requested to provide the rough assessment about the time duration after which poles might be revived when tripped as TTC/ATC has to be revised. It shall also help in monitoring power flows in other inter-regional lines.
67. MS, WRPC requested that causes, measures taken and further analysis of all the trippings shall be submitted at the earliest. He insisted that these issues must be avoided in Pole-3 and 4 of Champa-Kurukshetra HVDC. He also requested to take cyber security measures to prevent any unwanted events in future.

The meeting ended with vote of thanks to the chair.

Annexure - I

List of participants for the meeting to discuss issues of frequent random power order change in HVDC Champa-Kurukshetra Pole 1&2 and unreliable operation of WR-NR inter regional link

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HVDC Champa-Kurukshetra Operational performance analysis

Contingencies on HVDC links in WR-NR corridor

- **Frequent contingencies in HVDC Champa-Kurukshetra Bipole during October'17 to May'18:**

S.No.	Month 'A'	HVDC Pole-1 No. of trippings 'B'	HVDC Pole-2 No. of trippings 'C'	Bipole trippings included in 'B' and 'C'
1	Oct-17	4	**10**	1
2	Nov-17	**6**	**8**	1
3	Dec-17	3	**6**	1
4	Jan-18	2	4	0
5	Feb-18	4	1	1
6	Mar-18	1	2	0
7	Apr-18	**10**	**13**	3
8	May-18(till 21st May-18)	7	**10**	5

- **HVDC Vindhyachal Back-back Block-2 (250 MW capacity) of is out from 26.11.17 on account of converter transformer failure**
- **HVDC Mundra-Mohendargarh Bipole is operating only upto 25% of its rated capacity on account of less generation at APL Mundra generation plant.**

HVDC Champa-Kurukshetra Pole-I & II random power order change incidents

S. No.	Name of Transmission Element	Runback Date and Time	Power (MW)		Brief Reason/Relay Indication
			Prior to Incident	Post Incident	
1	Champa-Kurushetra pole-I	03/Jan/2018 10:12	1500	250	Commutation failure while deblocking pole-I
2	Champa-Kurushetra pole-II	30/Jan/2018 13:00	1500	1000	Transient Over voltage
3	Champa-Kurushetra pole-I&II	05/Mar/2018 21:27	1500	1100	Over voltage at Kurukshetra
4	Champa-Kurushetra pole-I	29/Mar/2018 15:16	1200	1950	O/L Command Received(Usually received when other pole trips)
5	Champa-Kurushetra pole-I&II	01/Apr/2018 16:00	800	500	Over voltage at Kurukshetra
6	Champa-Kurushetra pole-I&II	09/Apr/2018 06:02	1700	500	Over voltage at Kurukshetra
7	Champa-Kurushetra pole-II	09/Apr/2018 19:38	500	2000	Reason Awaited
8	Champa-Kurushetra pole-I	12/Apr/2018 02:55	1500	1100	Over voltage at Kurukshetra
		12/Apr/2018	1200	1020	Over voltage at Kurukshetra

Bipole tripping during contingencies of thunderstorm in May 2018

Summary of Lines tripped on thunderstorm of 2nd May 2018

Region	765 kV line	400 kV line	220 kV line	HVDC Line	Total
Northern Region	8	47	5	0	60
Western Region	3	6	1	0	10
Eastern region	0	7	0	0	7
Inter-regional lines	4	2	1	**3**	10
Total	15	62	7	3	87

Summary of Lines tripped on thunderstorm of 14th May 2018

Region	765 kV line	400 kV line	220 kV line	HVDC Line	Total
Northern Region	7	35	0	1	43
Western Region	0	4	1	0	5
Eastern region	0	5	1	1	7
Inter-regional lines	1	0	0	**2**	3
Total	8	44	2	4	58

** Bipole tripping included in red and bold

HVDC Pole Availability

- As per CERC (Terms and Conditions of Tariff) Regulations, 2014:

Normative Annual Transmission System Availability Factor (NATAF) For recovery of Annual Fixed Charges:

(1) AC system: 98%

(2) HVDC bi-pole links and HVDC back-to-back stations: 95%

For incentive consideration:

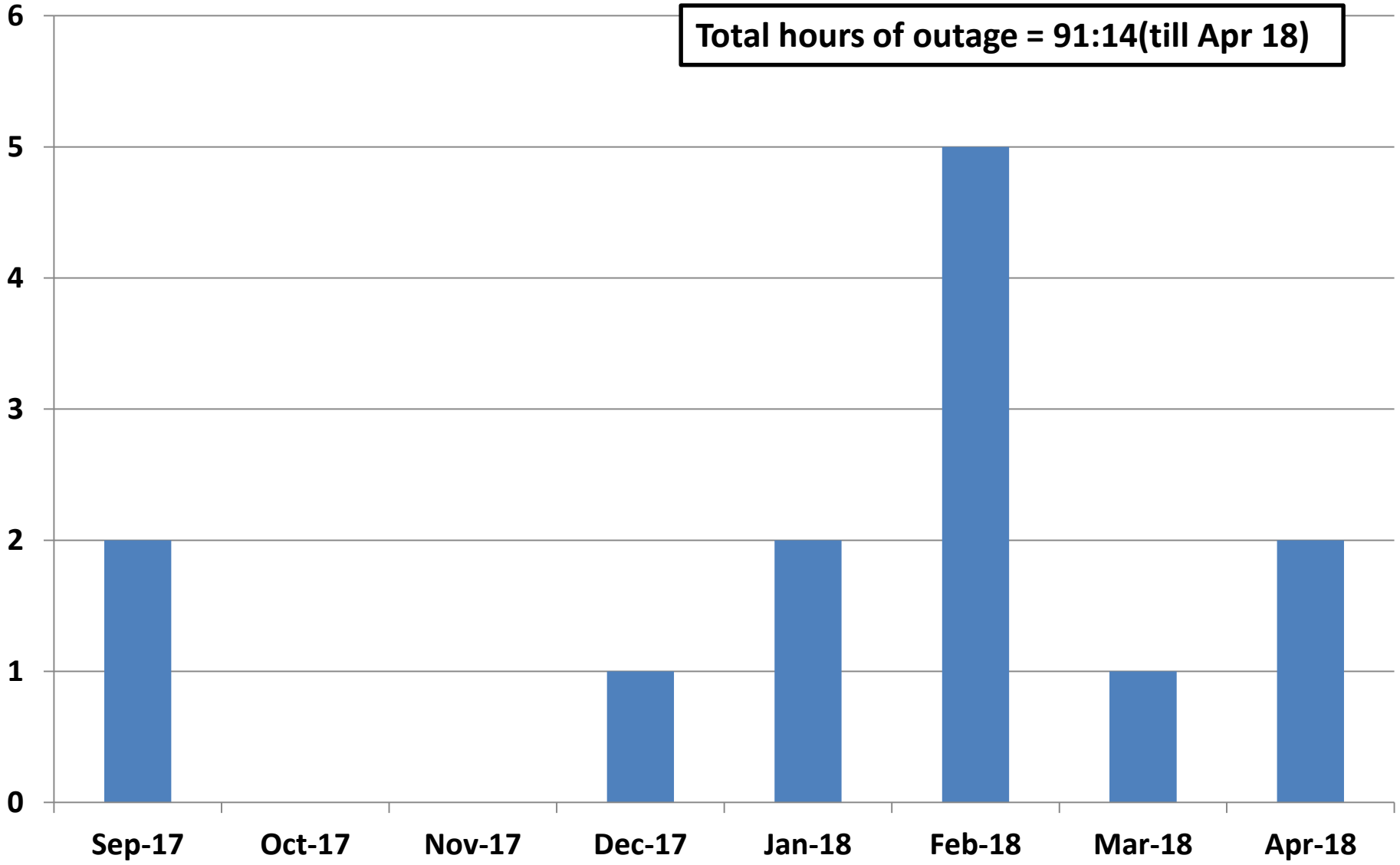
(1) AC system: 98.50%

(2) HVDC bi-pole links and HVDC back-to-back Stations: 96%

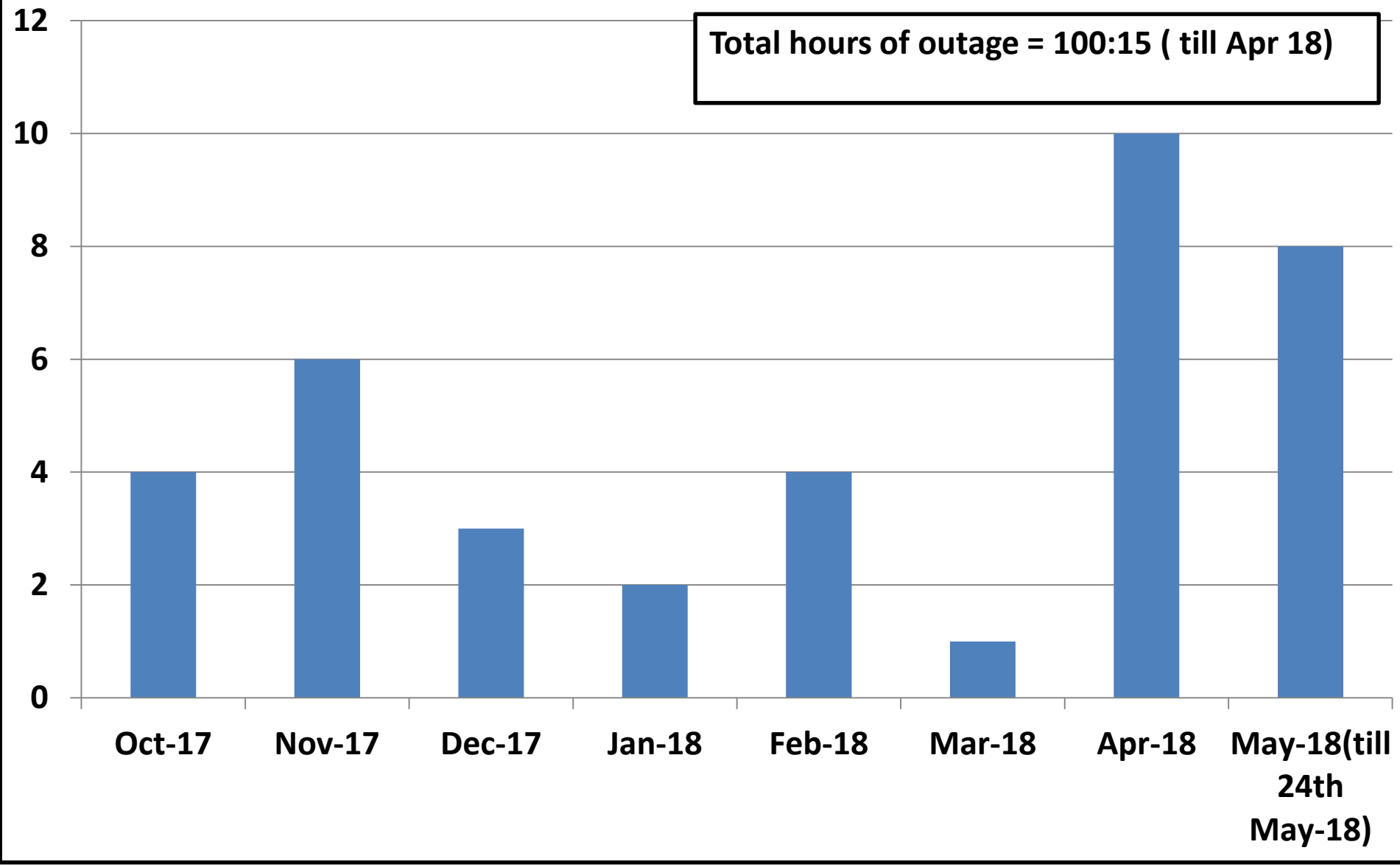
Provided that for new HVDC stations, NATAF shall be considered as 95% for first three years.

- As per letter dated 15th May 2018 from POWERGRID-CC(AM), it is provided that availability is above MoU target however operational availability and reliability is not standard.
- The availability plots is given in next slides, it can be observed that though the number of shutdowns are very low in comparison to no. of trippings, there outage hours are not so less than outage on account of trippings.
- The frequency of disruption in service is not brought out by figures of availability.

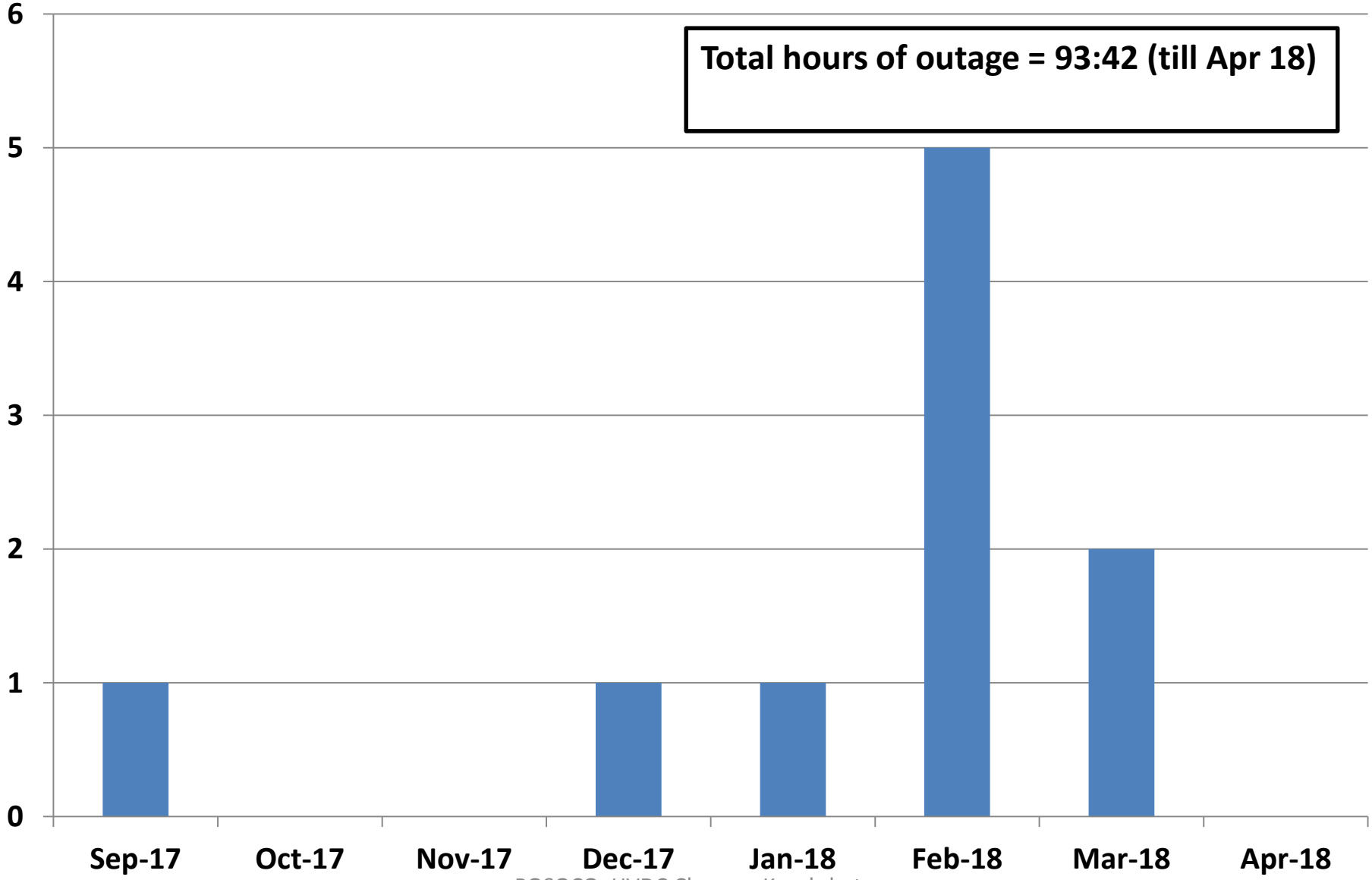
No. of Shutdowns of HVDC Champa-Kurukshetra Pole-1



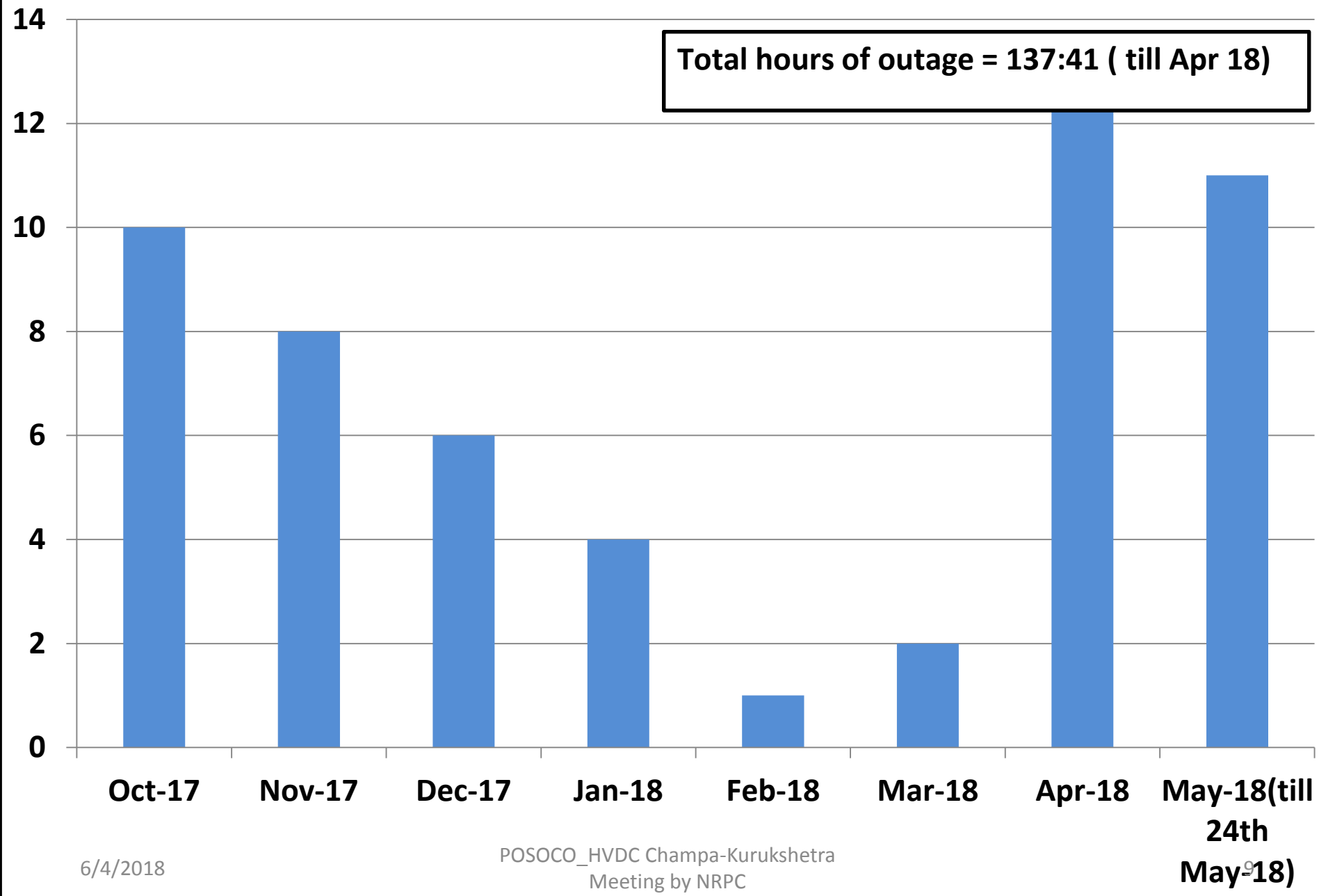
No. of Trippings of HVDC Champa-Kurukshetra Pole-1



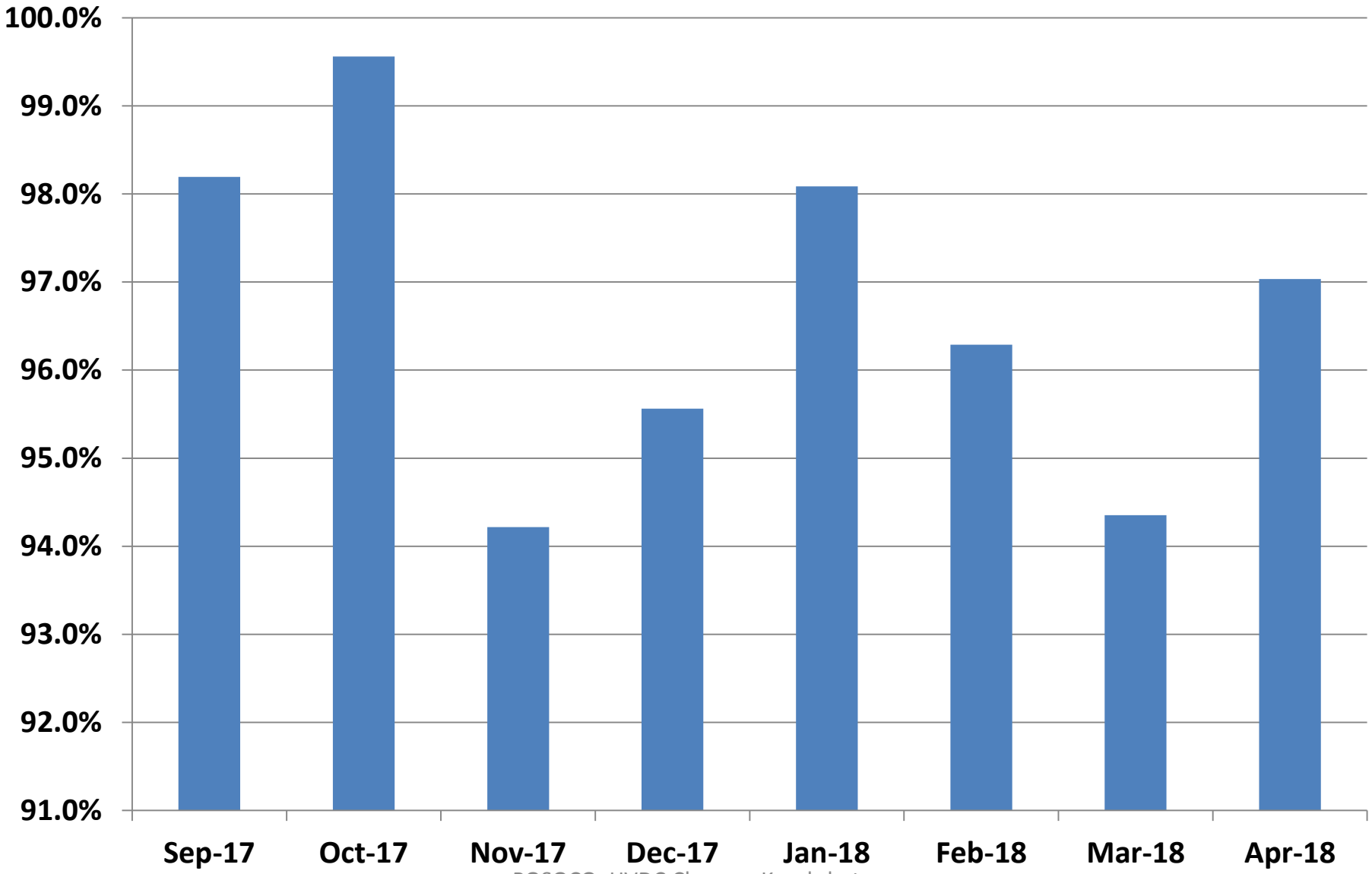
No. of Shutdown of HVDC Champa-Kurukshetra Pole-2



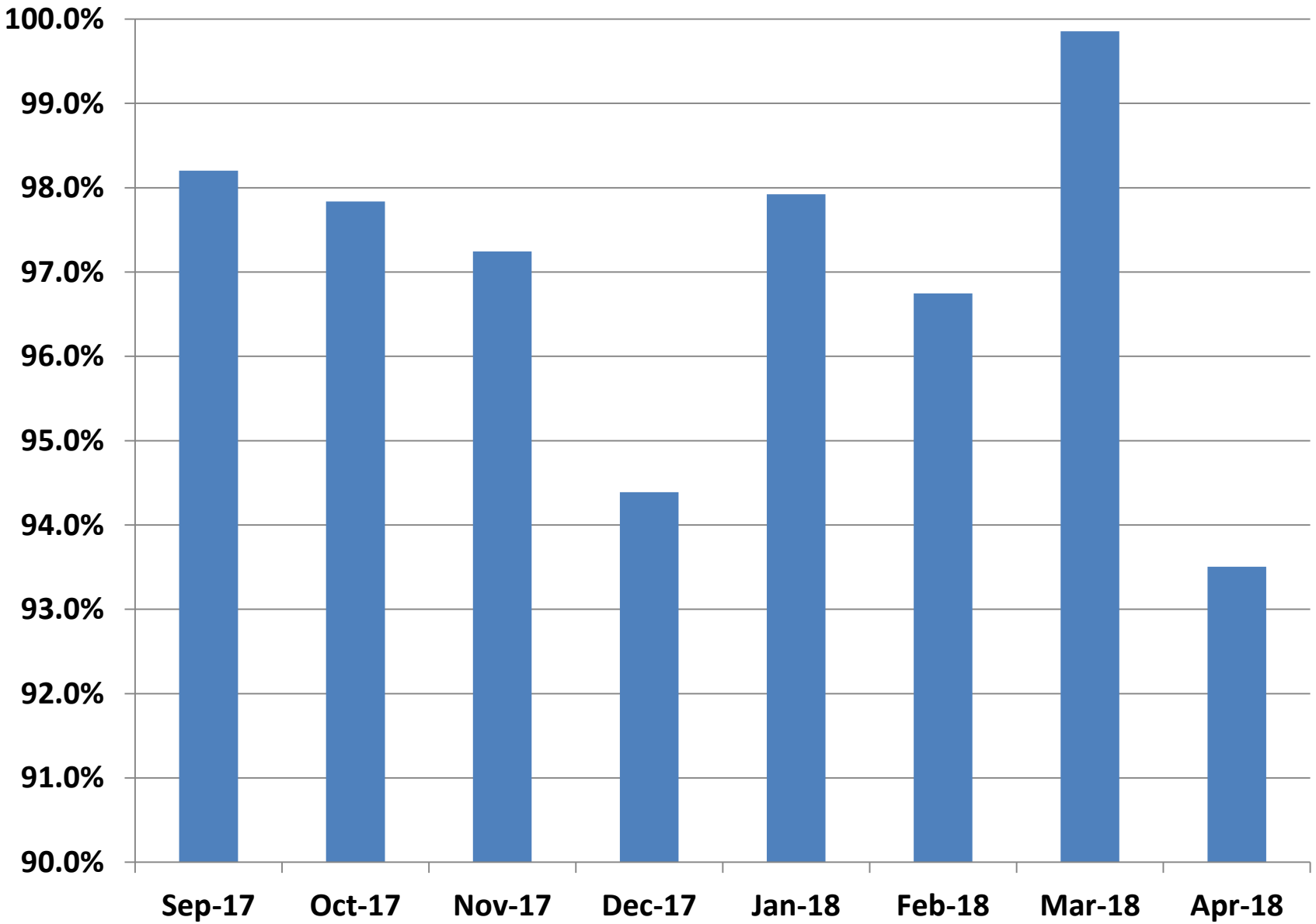
No. of Trippings of HVDC Champa-Kurukshetra Pole-2



Percentage Operational Availability of HVDC Champa-Kurukshetra Pole-1 Monthwise

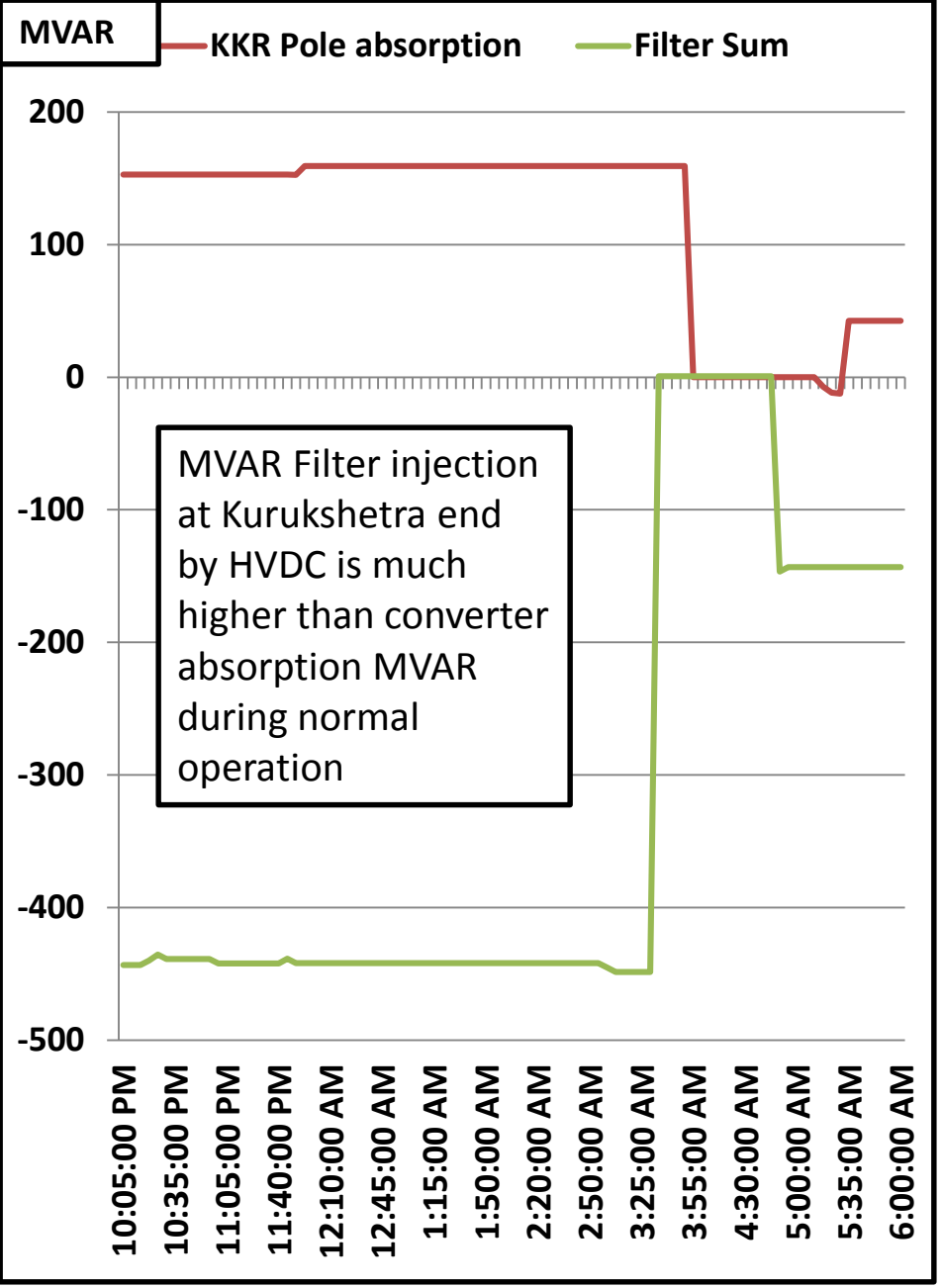


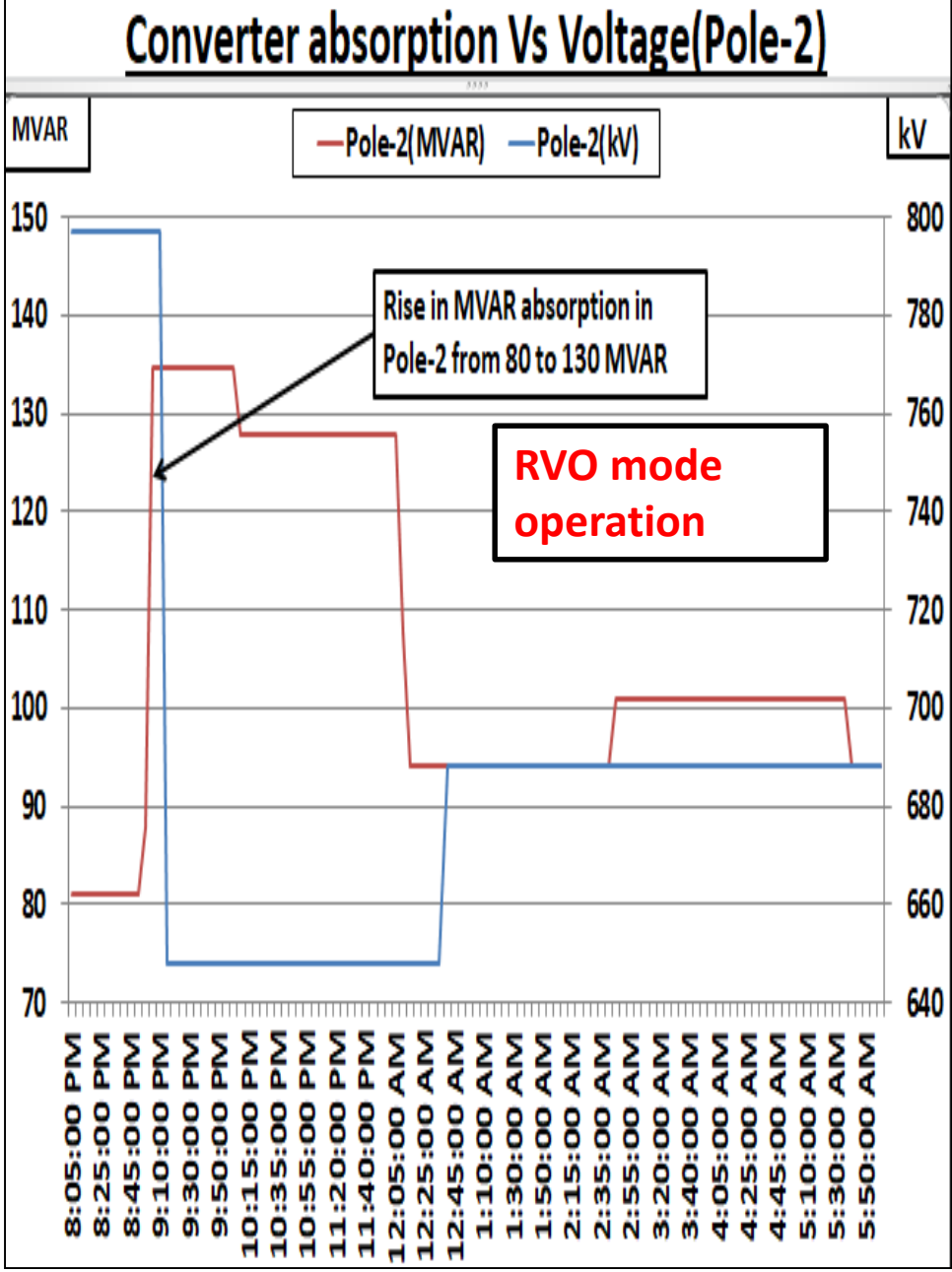
Percentage Operational Availability of HVDC Champa-Kurukshetra Pole-2 Monthwise



High Voltage problem at Kurukshetra end after commissioning of HVDC Champa-Kurukshetra

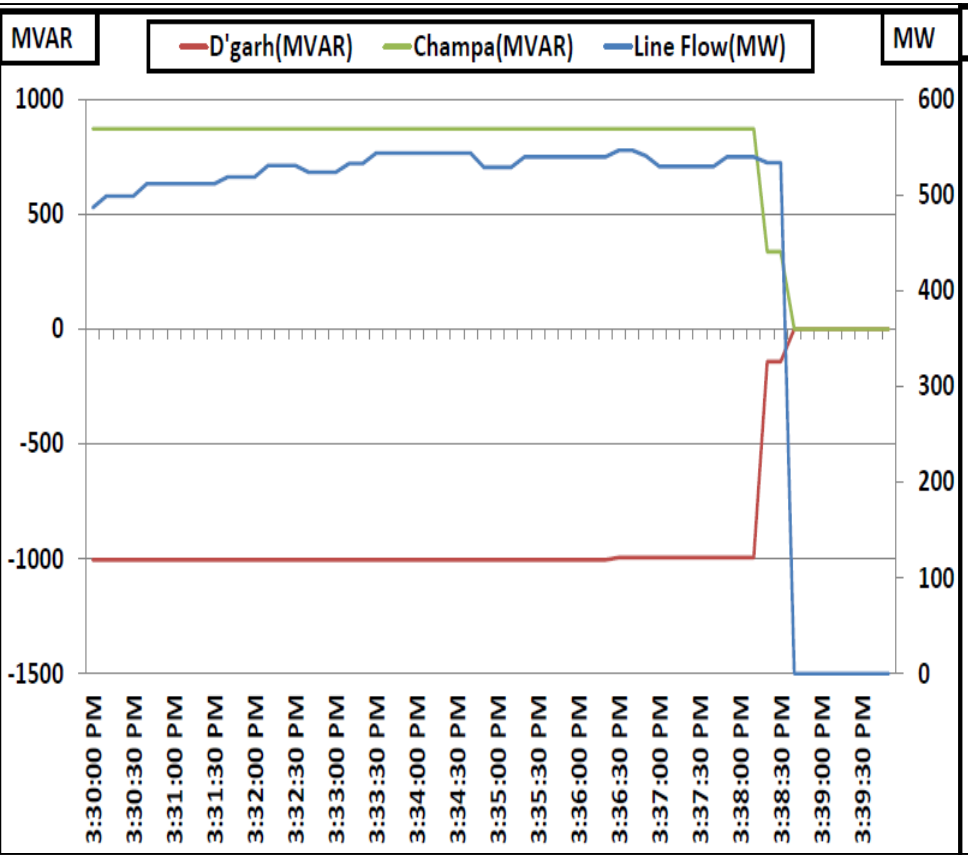
- Due to high voltage scenario during low demand periods , complete outage of Kurukshetra station has been observed on two to three occasions.
- Expected date of commissioning of Bus reactor at Kurukshetra (125 MVAR)may be discussed
- On 10th Nov 2017, complete Kurukshetra station went under blackout due to high voltage on account of MVAR injection from HVDC filters.
- The opening of lines from Kurukshetra station do not provide much relief to overvoltage conditions arising out of MVAR injection by filters.
- The feasibility of optimizing filter bank for the same power order need to be discussed, one sample plot of random day(2200 hrs to 0600 hrs,low demand period) MVAR absorption by converters and filter injection at Kurukshetra is given in next slide
- To mitigate the issue of overvoltage at Kurukshetra, it was decided in meeting with CC-POWERGRID on 11th Nov 2017 that HVDC Champa-Kurukshetra Bipole will be operated in RVO mode of operation.
- It was found that in RVO mode, converters were observing more MVAR, a sample plot of such operation is given in next slide
- During RVO mode, site personnel informed that due to Gamma(extinction angle) limitations, pole can not be operated on RVO mode.
- In this regard it is requested that extinction angle and firing angle telemetry be provided from inverter and rectifier stations to RLDCs/NLDC

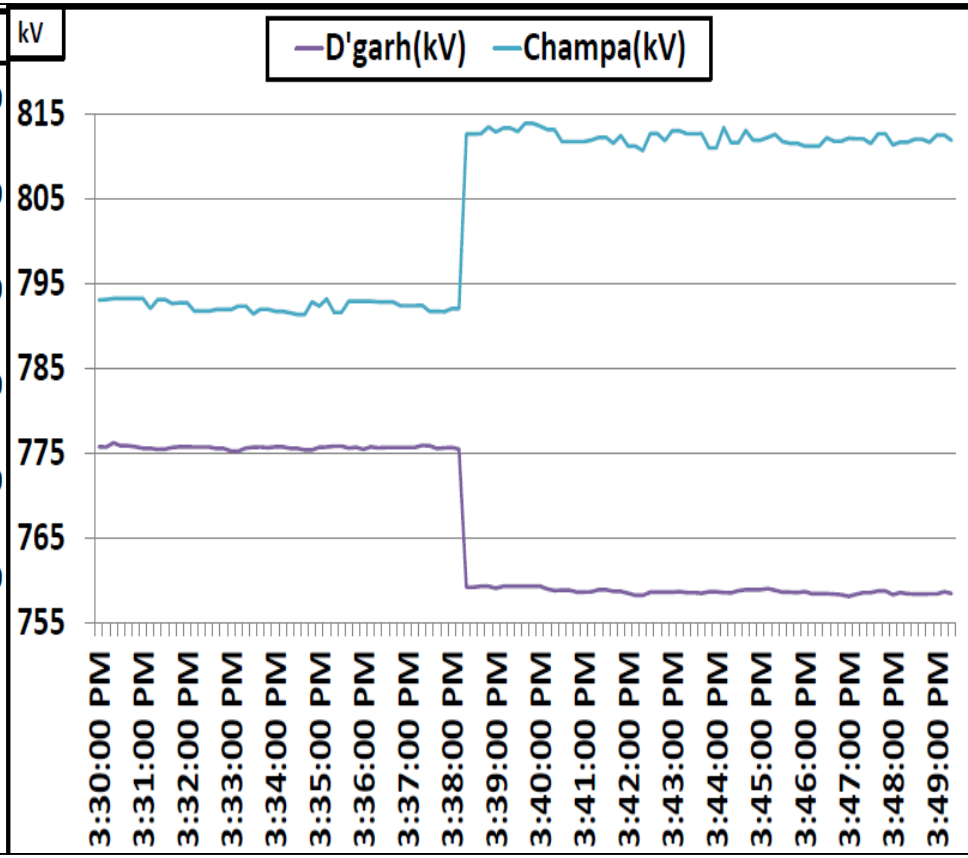

MVAR
KKR Pole absorption
Filter Sum
200
100
0
-100
-200
-300
-400
-500
MVAR Filter injection at Kurukshetra end by HVDC is much higher than converter absorption MVAR during normal operation
10:05:00 PM
10:35:00 PM
11:05:00 PM
11:40:00 PM
12:10:00 AM
12:45:00 AM
1:15:00 AM
1:50:00 AM
2:20:00 AM
2:50:00 AM
3:25:00 AM
3:55:00 AM
4:30:00 AM
5:00:00 AM
5:35:00 AM
6:00:00 AM


Converter absorption Vs Voltage(Pole-2)
MVAR
kV
Pole-2(MVAR)
Pole-2(kV)
150
140
130
120
110
100
90
80
70
800
780
760
740
720
700
680
660
640
Rise in MVAR absorption in Pole-2 from 80 to 130 MVAR
RVO mode operation
8:05:00 PM
8:25:00 PM
8:45:00 PM
9:10:00 PM
9:30:00 PM
9:50:00 PM
10:15:00 PM
10:35:00 PM
10:55:00 PM
11:20:00 PM
11:40:00 PM
12:05:00 AM
12:25:00 AM
12:45:00 AM
1:10:00 AM
1:30:00 AM
1:50:00 AM
2:15:00 AM
2:35:00 AM
2:55:00 AM
3:20:00 AM
3:40:00 AM
4:05:00 AM
4:25:00 AM
4:45:00 AM
5:10:00 AM
5:30:00 AM
5:50:00 AM

High Voltage problem at Champa

- In 765 kV Champa-Dharamjaigarh is observed that Champa end is injecting heavy reactive power into the line and during outage of line high voltage rise is observed. SCADA voltage and reactive power at both ends observed during one such incident given:





DMR feature in HVDC Champa-Kurukshetra

- The scheme is designed to operate with Dedicated Metallic Return (DMR).The HVDC line is designed for 6000 MW to carry additional power of 3000 MW from a future bipole working in parallel with the converter scheme presented in this report.(Design Document)
- The following modes need to be detailed as in design document and telemetry *available to validate the real time mode* as well as *repercussion of the specific mode on system operation is needed*:

1. Bipolar with both DMR in operation
2. Bipolar with one DMR in Operation
3. Monopolar with both DMR parallel to PMR
4. Monopolar with one DMR parallel to PMR
5. Monopolar with both DMR
6. Monopolar with one DMR
7. Monopolar with PMR

Queries on Operation philosophy of HVDC Champa-Kurukshetra

1. Overload settings(MW as well as time) on healthy pole in case one pole trips during bipole operation
2. No. of attempts of autorestart before Pole tripping on DC line fault
3. Power order variation during Reduced Voltage Operation i.e. power associated with reduced voltage, a setting curve will be needed.
4. Kurukshetra station 400 kV Bus-2 was under outage from 2nd Feb to 5th May 2018 reducing reliability of the system for such long duration. Early restoration of station elements be ensured for Champa and Kurukshetra stations.
5. The HVDC mode of operation is Constant Extinction Angle control as reported however settings for minimum extinction angle be shared as problems reported during RVO operation periods.
6. The procedure of data exchange between the HVDC terminal stations in case of communication failure may be elaborated
7. The failure modes of HVDC with physical status/interruption and possible implications may be tabulated and shared so that the nature of fault, its possible implications and options available for best operation in real time can be appreciated.
8. Steps taken for stabilisation and reliable operation of existing Bipole is required before commissioning of Pole – 3 & 4.

9. Incident of 17th Nov 2018, may be explained(annexure attached for plots)

Transient Overvoltage Correction(TOVC) settings in HVDC Champa-Kurukshetra

- TOVC feature trips the filter banks whenever voltage crosses set threshold value and reduces the power order so as to match the corresponding filter banks in service.
- Frequent operations of TOVC has been reported in the link
- The TOVC is set at 434 kV, in view of persistent overvoltage at Kurushetra end in low demand periods.
- The settings change should be intimated by site personnel to NLDC through proper message.
- The details about the operation may be explained by Kurukshetra.

Tripping of HVDC under various heads(Oct 2017-May 2018)

S.No.	Reason	Pole-1	Pole-2
1	Control mal-operation	4	7
2	Failure of lane change over	2	6
3	VESDA protection	0	1
4	CLD protection	1	4
5	Tap-changer stuck of the converter transformer	1	2
6	Under/Over voltage protection	4	5
7	Auxiliary supply failure	4	1
8	Pole DC Differential protection	3	7
9	Filter switch out	4	4
10	External Block	5	5
11	DMR short circuit fault	1	0
12	Abnormal firing angle	0	1
13	Miscellaneous(e.g. power order change,valve cooling)	3	4
14	Converter Differential operated	4	1
15	Commutation failure	1	4

Reason of Outages in HVDC Champa-Kurukshetra

1. LANE changeover problem at both ends:

- Frequent problem during leading to blocking of pole
- Lane Changeover fail protection happens at both ends:
  LANE-1(SystemA)
  LANE-2(SystemB)
- If one system already in unhealthy condition so that LANE-1 kept under maintenance.
- Another healthy system continuously try to change LANE-2 to LANE-1 which results tripping of Pole-2 frequently.
- The detailed scheme of LANE may be elaborated and proper maintenance be done in this regard
- The schematic diagram be shared for understanding the logic.

Reason of Outages(Contd.)

2. VESDA(Very Early Smoke Detection Alarm) operation:

- VESDA has caused blocking of poles on several occasions
- It is reported that any kind of dust and repair work near the sensor operates VESDA and cause blocking.
- Repetition is really a cause of concern and details be shared about steps taken to resolve the issue

3. CLD protection(Cable longitudinal protection):

- Backup protection for line differential
- Maloperation observed in many cases
- Steps taken to resolve the issue of maloperation may be discussed.

Reason of Outages(Contd.)

4. External Block:

- One of the most frequent reasons mentioned for pole blocking
- Under which all conditions external block is generated need to be analysed.
- Gas leakage in voltage divider and polymer insulator as well as valve cooling have been reported as few causes of external block.
- During Kotra incident of 23rd Apr 2018 same reason was mentioned.

5. Auxilliary Supply Failure:

- The issue has been observed 6-7 times at both the ends
- Auxiliary supply status at both ends need to be furnished
- Maloperation of auxilliary BCU reported on 7th Feb 2018,0958 hrs as reason.
- Steps to avoid the recurrence be discussed.

Reason of Outages(Contd.)

6. Control maloperation:

- There have been approx. 10 instants of trippings reported on this account.
- During master control transfer to other end this maloperation is very frequent e.g 3rd Jan 2018,1706 hrs.
- Steps taken to avoid the same may be explained.

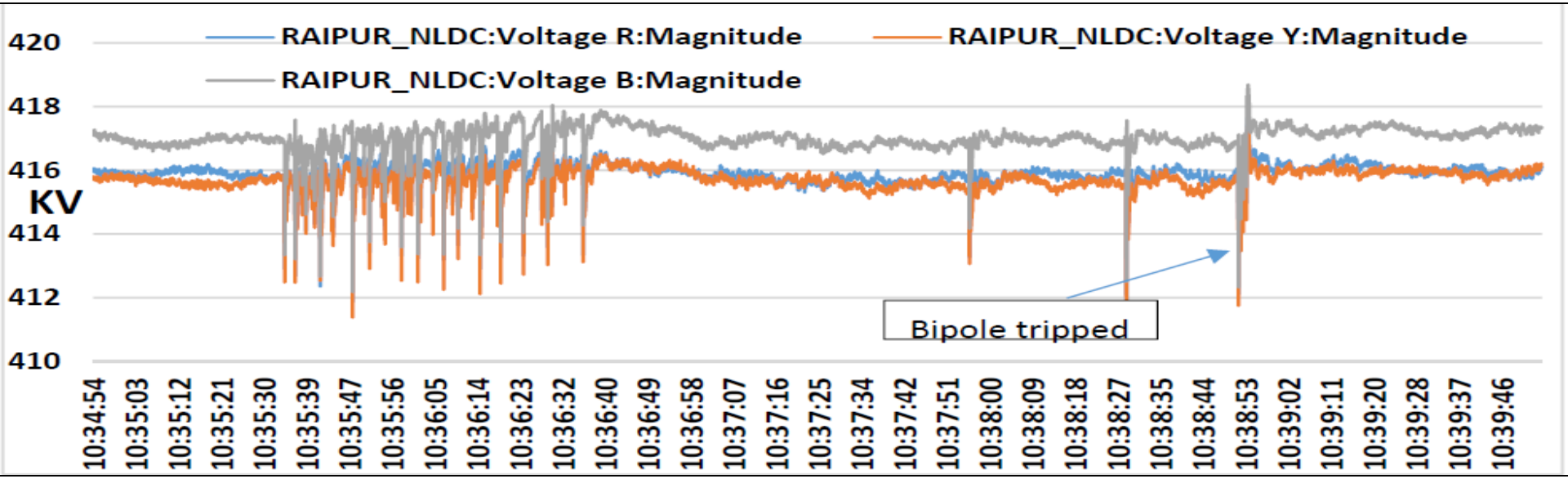
7. Stuck Tap Position:

- The tap changer of converter transformer gets stuck during deblocking operation in Poles.
- It occurs reportedly on account of telecom non availability.
- On 31st Jan 2018,19:02 hrs, the operation took place where block tripped on this account.

Reason of Outages(Contd.)

8. Commutation Failure :

- Pole-II has more cases of tripping on this account
- On 2nd Feb 2018,both poles tripped and resulted in oscillation, the PMU voltage plot is given below indicating 10-15 spikes before tripping
- The settings for commutation failure may be shared



10. Filter Control Block operation

11. Line Winding Undervoltage and CNAP protection

Thank You..

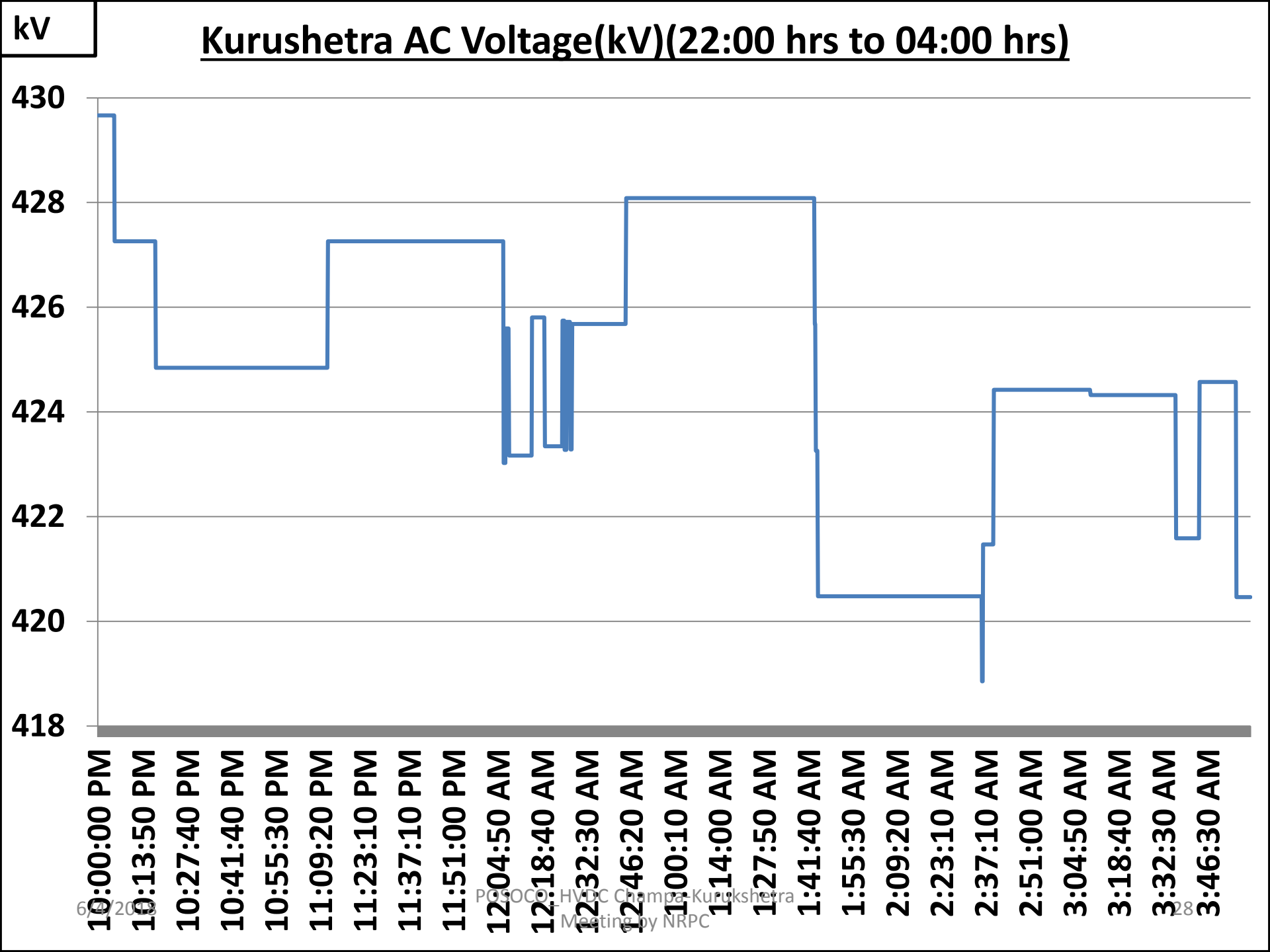
Annexure

Labelled Plots for HVDC Champa-Kurukshetra Operation_17.11.17

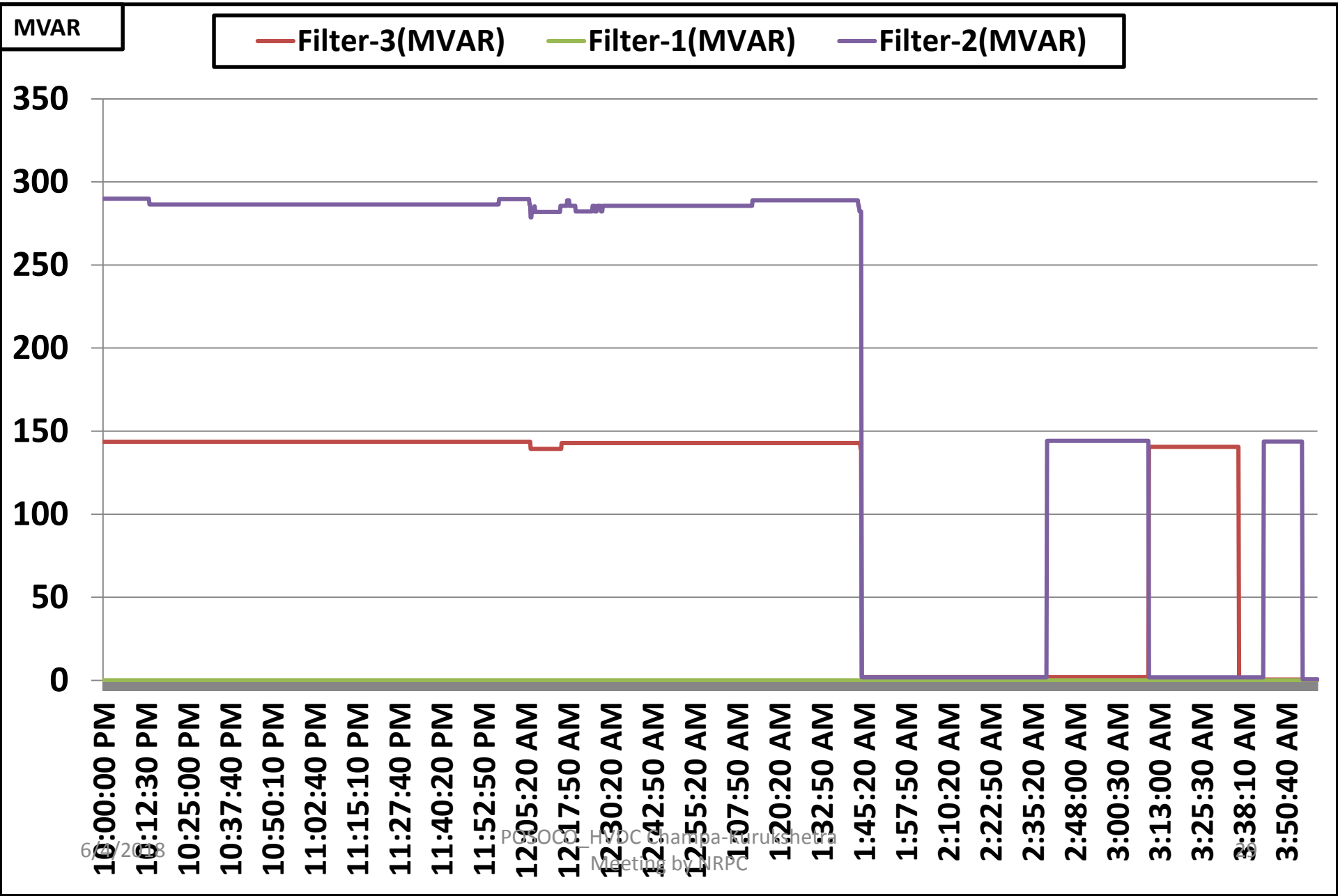
Incident

- HVDC Champa – Kurukshetra Pole – II (250 MW) was blocked at 00:06 Hrs to control high voltage at Kurukshetra end.
- Bipole was carrying 500 MW at the time of blocking of Pole – II. While transfer of power to Pole – I due to blocking of Pole – II, Pole – I automatically went into RVO mode at 00:06 Hrs and power of Pole – I started fluctuating between 321 MW to 436 MW.
- Due to fluctuation in power, HVDC Kurukshetra requested to take Pole – I in normal mode and same was done at 00:27 Hrs.
- Later, to control over-voltage at Kurukshetra, Pole – I tripped at 01:41 Hrs while taking it into RVO mode due to abnormal gamma angle issue.
- As intimated by HVDC Kurukshetra, Pole – I could not be deblocked due to issue in control and protection lanes of Pole- I.
- Further, Pole – II could not be deblocked till 04:23 Hrs as HVDC software control got stuck in Bipole mode and was not switching to dual monopole mode..

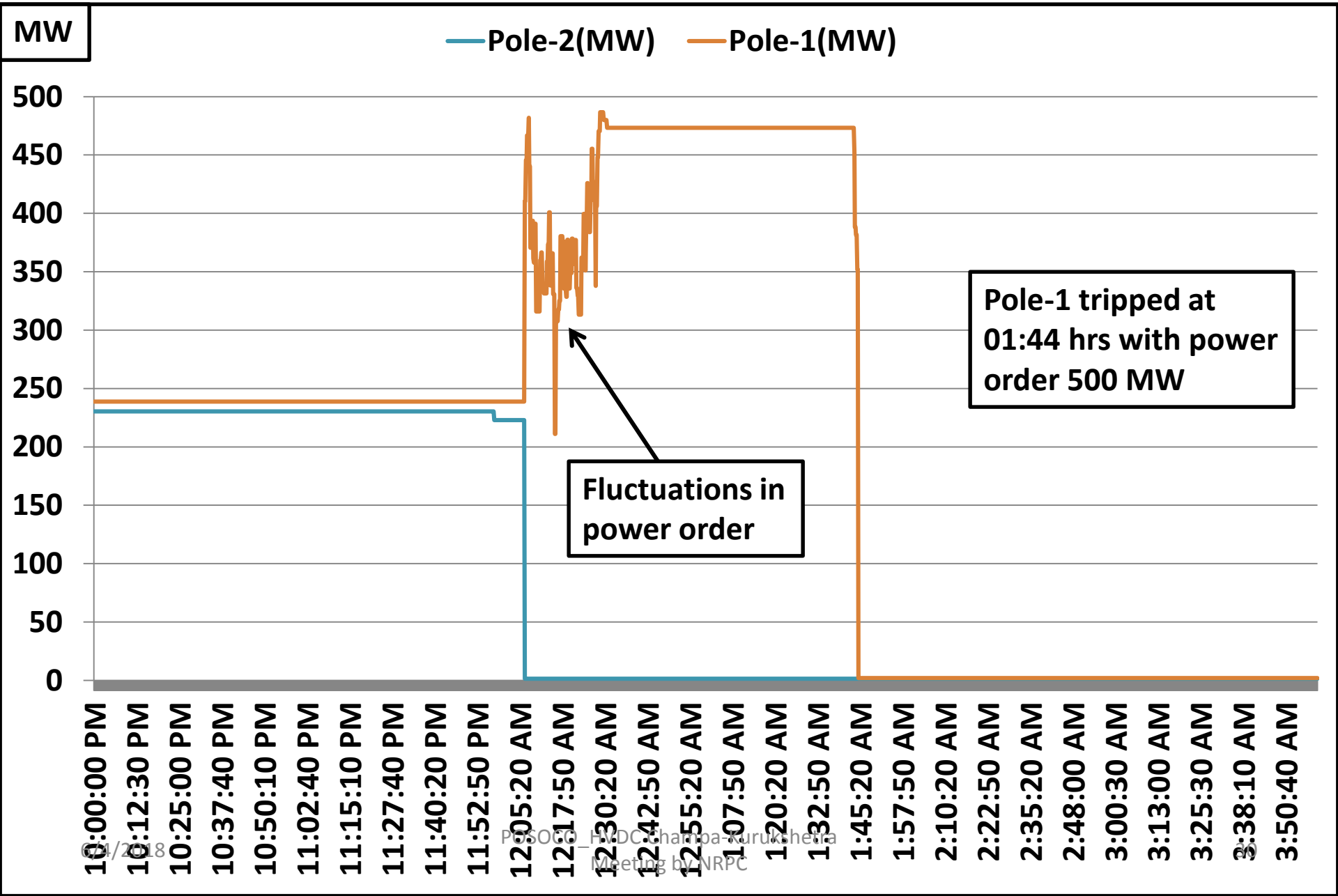
Kurushetra AC Voltage(kV)(22:00 hrs to 04:00 hrs)



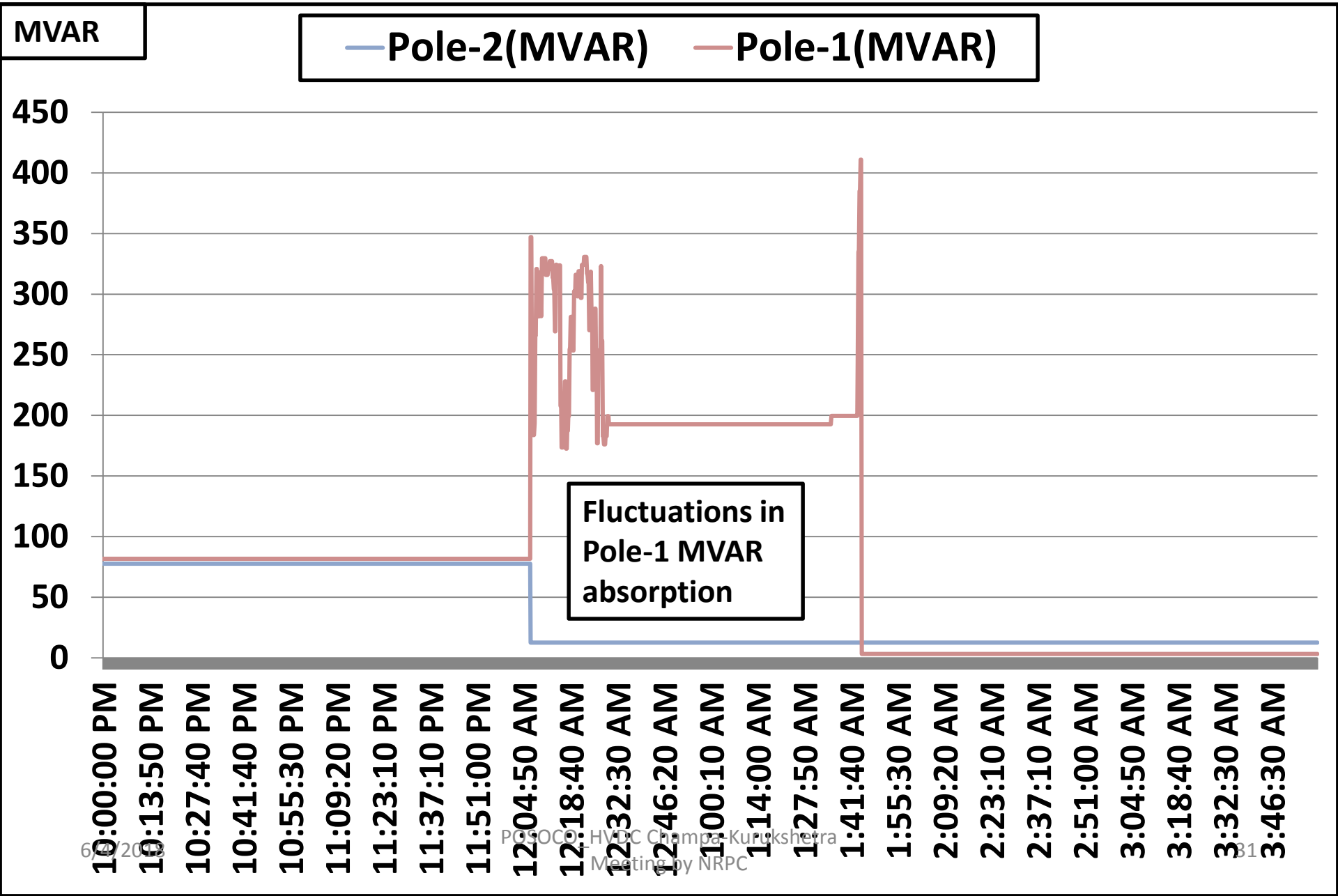
Filter MVAR Injection)(22:00 hrs to 04:00 hrs)



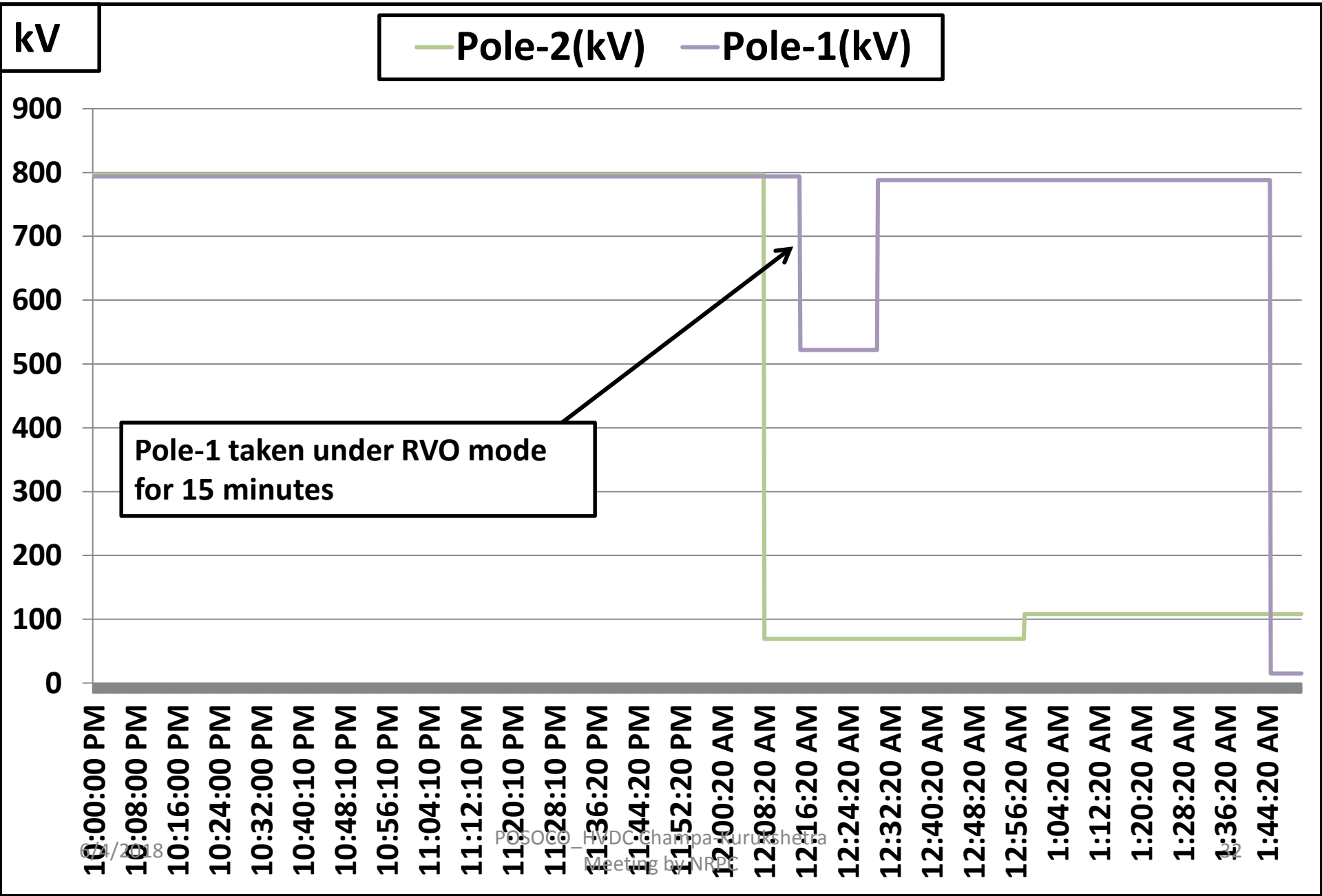
Power Order)(22:00 hrs to 04:00 hrs)



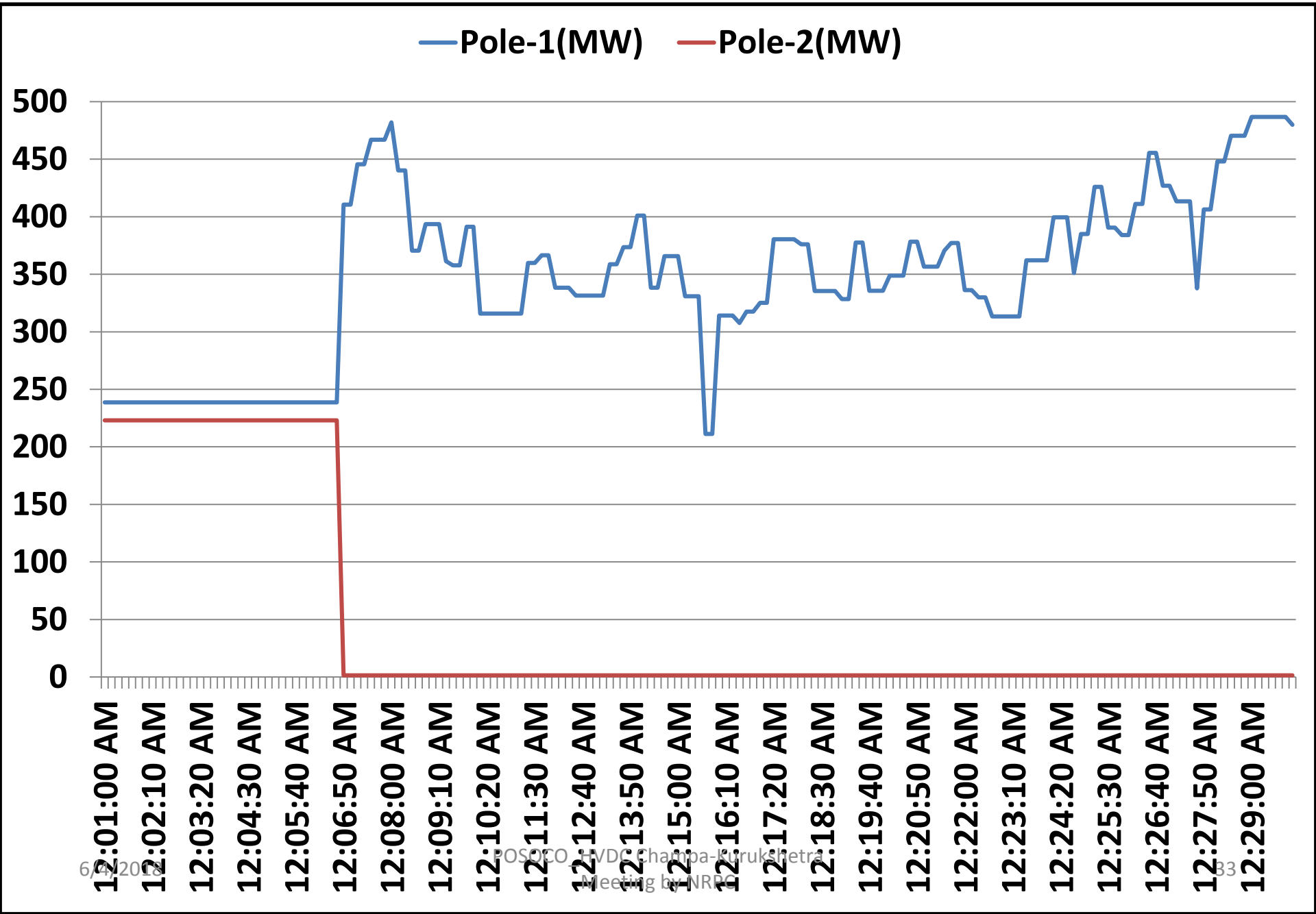
Reactive Power Absorption)(22:00 hrs to 04:00 hrs)



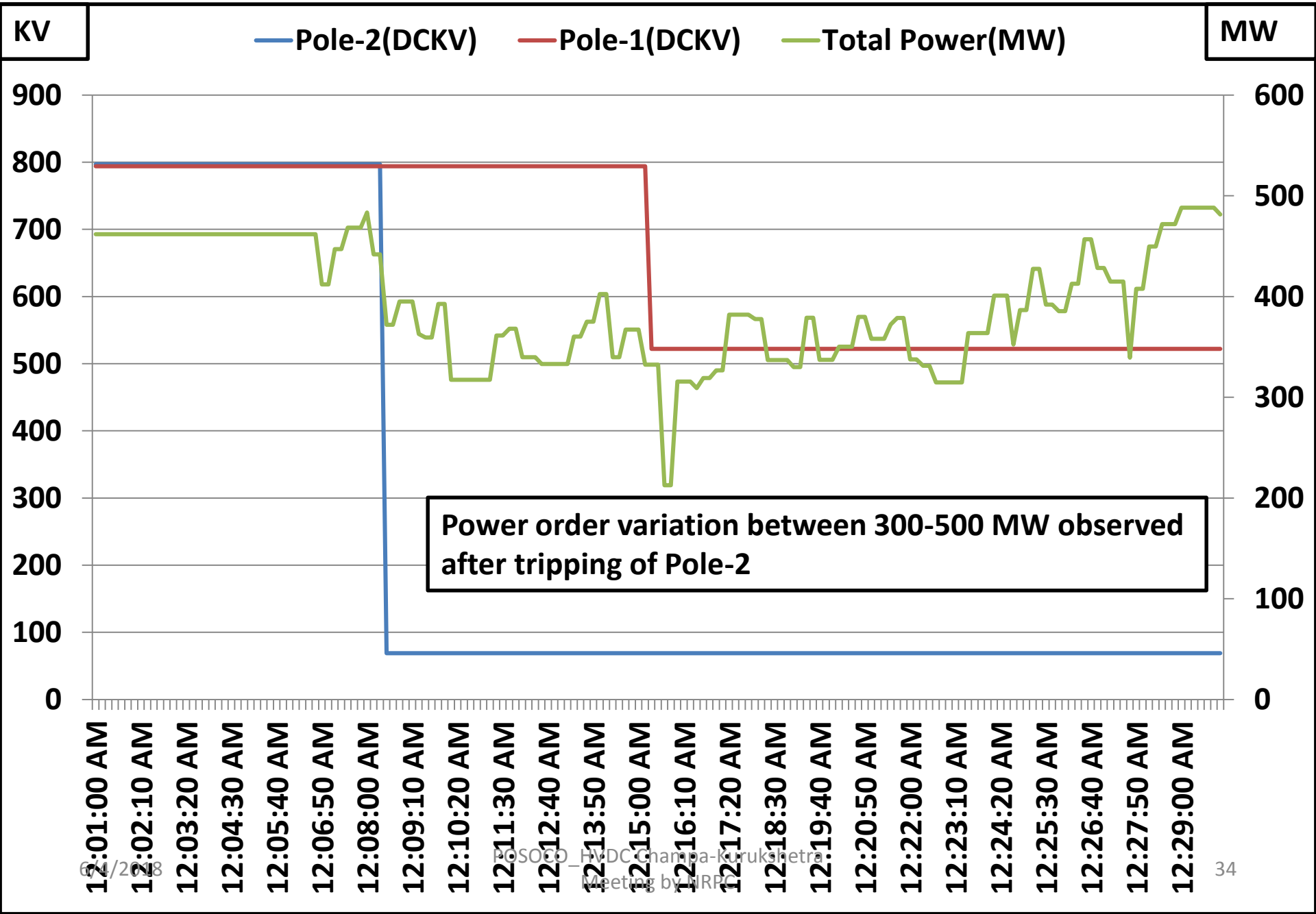
DC Voltage of Pole)(22:00 hrs to 04:00 hrs)

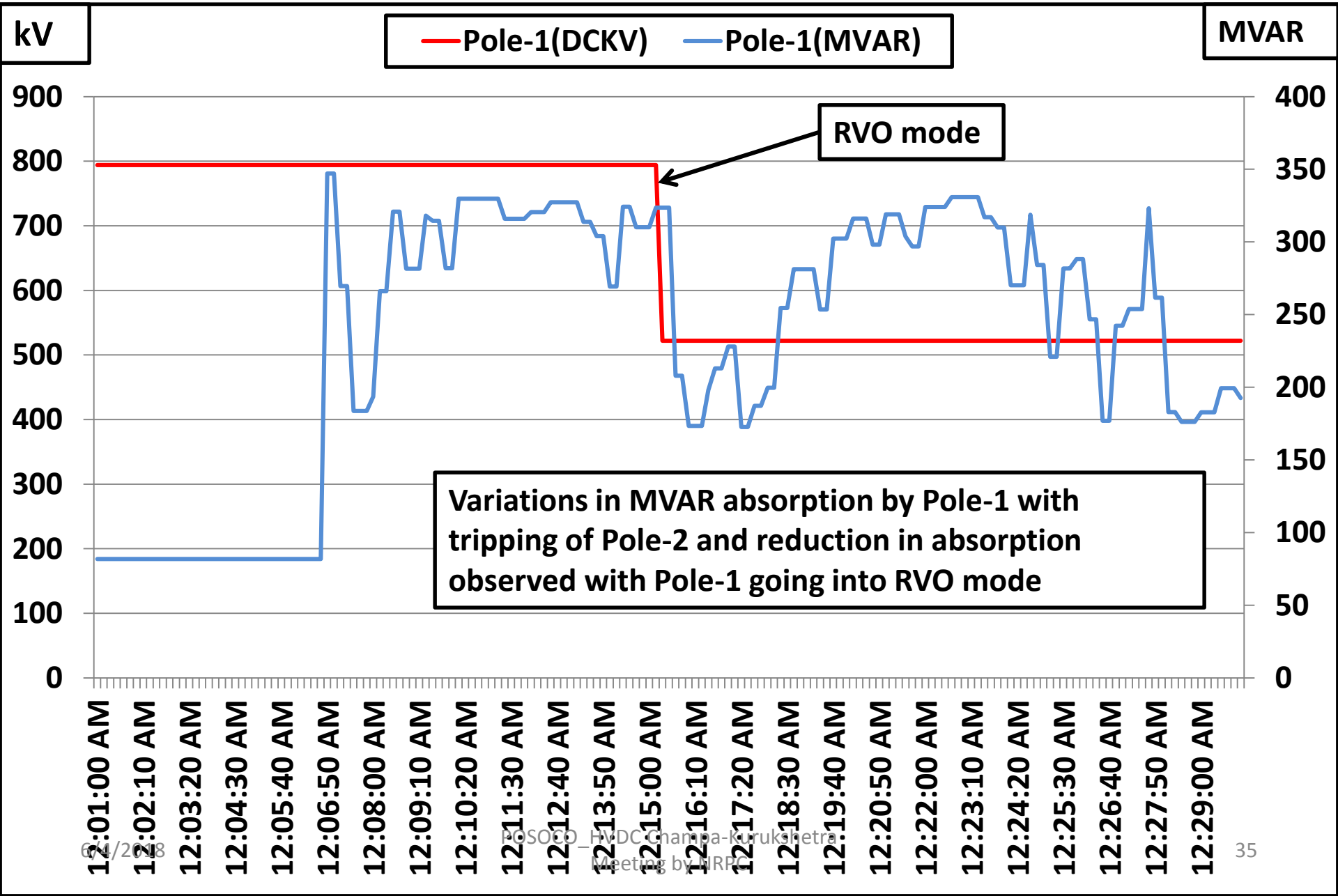


Power Order(00:00 hrs to 00:30 hrs)

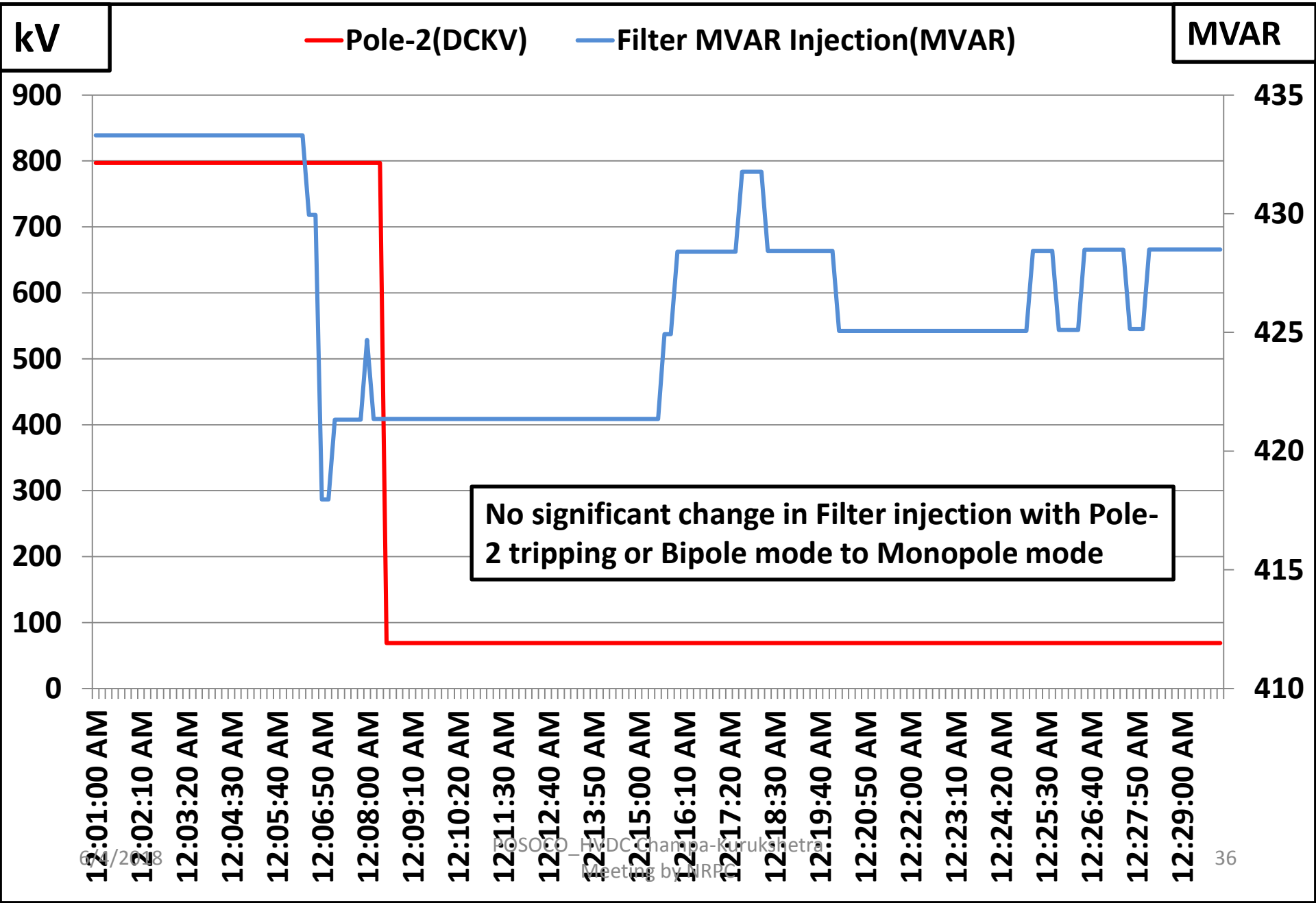


DC Voltage on Poles Vs Power Order




kV
MVAR
Pole-1(DCKV)
Pole-1(MVAR)
900
800
700
600
500
400
300
200
100
0
400
350
300
250
200
150
100
50
0
RVO mode
Variations in MVAR absorption by Pole-1 with tripping of Pole-2 and reduction in absorption observed with Pole-1 going into RVO mode
12:01:00 AM
12:02:10 AM
12:03:20 AM
12:04:30 AM
12:05:40 AM
12:06:50 AM
12:08:00 AM
12:09:10 AM
12:10:20 AM
12:11:30 AM
12:12:40 AM
12:13:50 AM
12:15:00 AM
12:16:10 AM
12:17:20 AM
12:18:30 AM
12:19:40 AM
12:20:50 AM
12:22:00 AM
12:23:10 AM
12:24:20 AM
12:25:30 AM
12:26:40 AM
12:27:50 AM
12:29:00 AM

Pole-2(kV) Vs Total Filter Injection



Annexure - III

POWERGRID KURUKSHETRA

Welcomes

Mr M.A.K.P. Singh
MS, NRPC

Mr A. Balan
MS, WRPC

OVERVIEW OF HVDC CHAMPA-KURUKSHETRA LINK

- **±800kV, 6000 MW HVDC Champa-Kurukshetra Bi-pole :-**

  - CK-I – 3000 MW commissioned in Sep-2017
  - CK-II, Link to be upgraded up to 6000 MW
  - Rectifier station at Champa
  - Inverter station at Kurukshetra
  - Line Length- 1287 Km
  - Dedicated metallic return conductor in place of Conventional Ground Electrode (***first in the World***)

Availability summary of Champa-Kurukshetra HVDC Link

Month	Pole-1	Pole-2
Sep-17	99.34%	98.88%
Oct-17	76.21%	97.71%
Nov-17	94.43%	93.80%
Dec-17	96.03%	95.23%
Jan-18	98.08%	98.05%
Feb-18	96.33%	96.75%
Mar-18	99.63%	99.81%
Apr-18	98.78%	93.80%

Service Building

HVDC Station Control Room

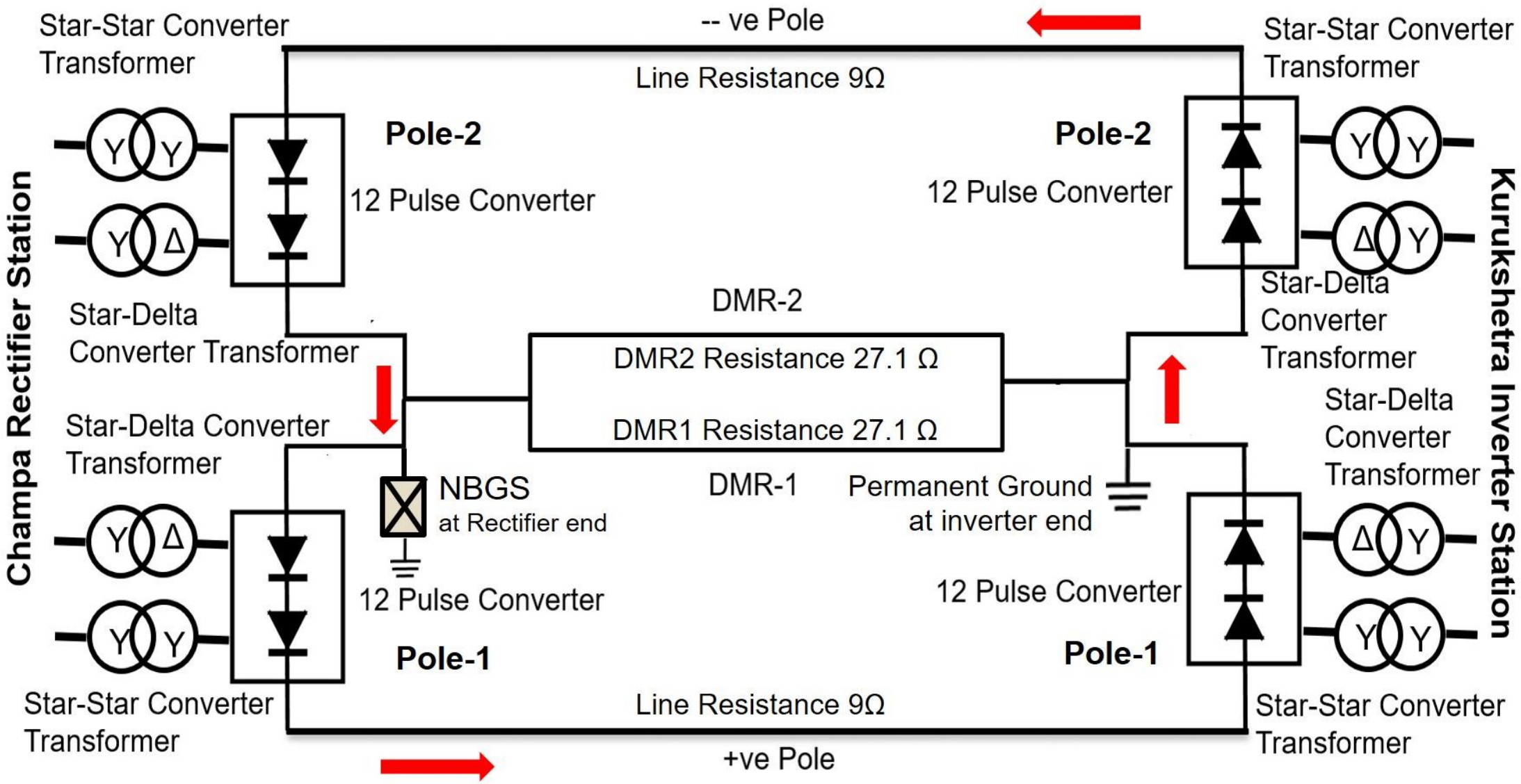
AC Filter Yard consisting 14 nos Filter Sub-bank

400kV GIS Kurukshetra consisting 29 bays

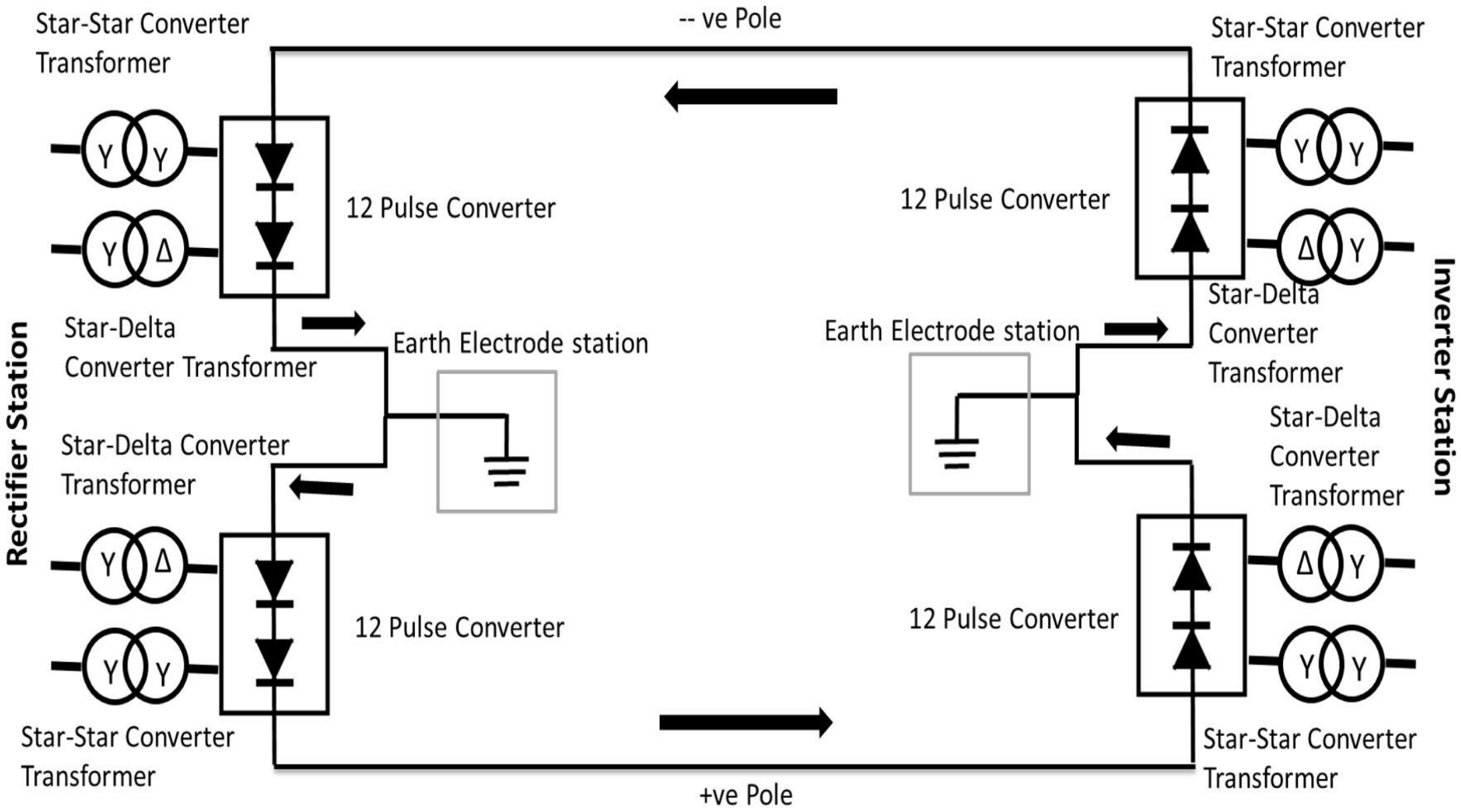
HVDC Switchyard

HVDC Double Valve

Champa-Kurukshetra HVDC Link with DMR Key SLD for Bipole-I



Conventional HVDC Scheme with Electrode Line



Major advantage of DMR

- DMR runs on same transmission line instead of separate towers / line for electrode line and therefore saves additional ROW.
- Separate land area (about 90 Acre land for each electrode station) for two no electrode stations is also avoided.
- Environment friendly.
- Major draw back of surface currents created by electrode station is also overcome.
- The performance of the link with DMR also utilize the link optimally even in Monopolar mode.

Operating Configuration of Champa-Kurukshetra HVDC Bipole Link

Modes of Monopolar Operation :

a. P1 / P2 on HV Line-1/2 with PMR//DMR1//DMR2 (Return path resistance value 5.4Ω)

b. P1 / P2 on HV Line-1/2 with PMR//DMR1 or DMR2 (Return path resistance value 6.8Ω)

c. P1 / P2 on HV Line-1/2 with DMR1//DMR2 (Return path resistance value 13.6Ω)

d. P1 / P2 on HV Line-1/2 with DMR1 or DMR2 only (Return path resistance value 27.1Ω)

e. P1 / P2 on HV Line-1/2 with PMR only (Return path resistance value 9Ω)

Operating Configuration of Champa-Kurukshetra HVDC Bipole Link

Modes of Bipolar Operation :

a. Balanced Bipole with DMR1 or DMR2 or DMR1//DMR2 for negligible unbalance current return

b. Dual Monopole/Unbalanced Bipole with DMR1 or DMR2 or DMR1//DMR2 for unbalance current return as per operating condition

NOTE:

Additional Operating Configurations with Bipole-2 along with Bipole-I

Healthiness of DMR during Balance Bipole Operation

- **DMR healthiness cannot be ensured during balanced Bipole operation.**
- **During protection trip of either pole, total current automatically shifts to the DMR for remaining pole and if some permanent fault exists in DMR, the remaining pole may also get blocked.**
- **Therefore, the ensuring the healthiness of DMR during balanced Bipole mode is essentially required.**
- **Deliberate unbalancing up to 10% of running power order (+5% in P1 & -5% in P2) is created by control system at every half an hour to check the healthiness of DMR.**
- **Upon detection of DMR fault only alarm flashes to operator for its further course of action.**

Problems observed during O&M of Bipole-I

1. Failure of Bushing in July 2017 and October 2017

2. External Block due to VESDA Mal-operation

3. Challenges of HVDC operation with High Bus voltage in Lightly Loaded AC Grid

4. Damaging of fibres by rodents

5. Flashover along the porcelain insulators in DC Yard during extreme fog condition at Kurukshetra

6. Repeated Tripping of poles due to software mal-operations

7. Failure of Telecom

Problems observed during O&M of Bipole-I

8. Tripping of pole due to mal-operation of contactor of C&S make in auxiliary AC supply

9. Failure of Back Plane 5006 Cards in VBE panels

10. Failure of LFL (GPS synch issue)

11. Failure of DC Voltage Divider

12. Pole-1 LANE-1 in maintenance mode at Kurukshetra.

THANK YOU