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विद्युत मंत्रालय / Ministry of Power
केन्द्रीय विद्युत प्राधिकरण / Central Electricity Authority
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No. 26/10/2011-SP&PA/ **Date: 14th Oct., 2011**

To

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Sub: Supplementary Agenda - 33rd meeting of the Standing Committee on Power System Planning of Western Region.

Sir,

In continuation to our letter of even number dated 5th October 2011, it is to intimate that the Supplementary Agenda notes for the 33rd meeting of the Standing Committee on Power System Planning of Western Region is available on CEA website (www.cea.nic.in at the following link: Home page-Wing specific documents-Power Systems-Standing Committee on Power System Planning-Western Region).

Yours faithfully,

K K Arya

(K K Arya)
Chief Engineer (I/C), SP&PA

Additional agenda Note for 33rd Meeting of Standing Committee on Power System Planning in Western Region

1.0 Erection and Commissioning of Interstate line from 132kV Kistampeth S/S (AP) to proposed 132kV Sironcha S/s (MS).

1.1 MSETCL has proposed an interstate line from 132kV Kistampeth S/S (AP) to proposed 132kV Sironcha S/s (MS). At present 66kV S/S at Sironcha is fed from 220kV Gadchandur S/s, which is situated about 240km away. Due to long lines passing through dense forest area, frequent supply interruptions and low voltage problem prevail in this area. MSETCL has already planned new 132kV S/S at Alapalli, Yetapalli and Sironcha. But due to dense forest it is not possible to construct 132kV lines from Alapalli to Sironcha. A 132kV S/s at Kistampeth in AP is 35km away from Sironcha and is fed from 220kV Ramagundam S/s. he load at Sironha S/s will be around 5.0MW & future load growth is also very small.

1.2 Members may discuss.

2.0 High Voltage Studies for Western Region Grid.

2.1 In 32nd SCM on Power System Planning in WR, it was agreed that POWERGRID would carry out High Voltage studies for Western Region.

2.2 POWERGRID had carried out the high voltage studies for off-peak condition for 2013-14 time frame. Demand of Western Region for 2013-14 in off peak period is considered as 35000MW(about 65-70% of peak demand).The details of the high voltage studies are enclosed at Annexure 1.The summary of the studies are as under:

S.No	Section of WR Grid Considered	Name of the 400kV substation	Reactive Compensation suggested
1	Jabalpur-Itarsi-Khandwa -Rajgarh	Jabalpur (PG)	1x125MVAR bus reactor
		Khandwa (PG)	1x125MVAR bus reactor
2	Bina-Shujalpur-Nagda	Shujalpur(PG)	1x125MVAR bus reactor
3	Raigarh-Raipur-Bhatapara/Bhilai	Bhatapara(PG)	1x125MVAR bus reactor
		Raigarh(PG)	1x125MVAR bus reactor
4	Wardha-Aurangabad-Bhusawal	Aurangabad(PG)	1x125MVAR bus reactor
5	Parli-Sholapur-Kolhapur	Parli(PG)	1x150MVAR variable reactor
6	Ranchodpura-Dehgam-Pirana	Ranchodpura(GETCO)	*1x125MVAR bus reactor
		Pirana(PG)	1x150MVAR variable reactor
7	Versana-Rajkot-Jetpur-Amreli	Versana(GETCO)	*1x125MVAR bus reactor
		Rajkot(GETCO)	*1x125MVAR bus reactor
		Amreli(GETCO)	*1x125MVAR bus reactor

* In case of space constraints existing B/R may be replaced.

2.3 Broad estimated cost of the 6 nos of.125 MVAR reactor & 2 nos .Variable reactor and one no.SVC is about: Rs 170Cr (under the scope of POWERGRID) and Broad estimated Cost of the 4 nos .125MVAR reactor: Rs 40 Crs(under the scope of respective STUs)

2.4 Members may discuss

Annexure 1

High Voltage Phenomena in 400kV system of Western Regional Grid

Background

In Western Region, there are various pockets where high voltages in the range of 420 – 435kV are being experienced under different operating conditions especially during off-peak period at 400kV buses. Few additional bus reactors have been/are being installed to control the high voltage conditions. Still the high voltage is persisting in the grid, which results into frequent opening of certain lines affecting the reliability of equipment.

A number of transmission schemes have been proposed as a part of strengthening of grid along with suitable associated reactive compensation. However it was felt that it is necessary to examine whether the proposed reactive compensation shall facilitate in controlling high voltage condition in near future taking into account present power flow scenario as well as high voltage situation.

The matter was also deliberated in 32nd Standing Committee meeting of WR held on 13.05.11 wherein it was decided to study the issues of High Voltages and suggest the remedial measures. Accordingly studies have been carried out for off-peak condition in 2013-14 time frame (as any new reactive compensation proposal may take about 20-22 months for implementation).Demand of Western Region for 2013-14 in off peak period is considered as 35000MW(about 65-70% of peak demand).
In view of the prevailing high voltages being experienced in certain pockets/section of the Western Regional grid, studies have been carried out for following sections.

(A) Jabalpur – Itarsi - Khandwa – Rajgarh Section
(B) Bina – Shujalpur – Nagda Section
(C) Raigarh – Raipur – Bhatapara/Bhilai Section
(D) Wardha – Aurangabad – Bhusawal Section
(E) Parli – Solapur – Kolhapur Section
(F) Kutch / Saurashtra region

- Ranchodpura (Vadavi)–Dehgam-Pirana Section (Kutch region)
- Versana – Rajkot (Hadala) – Jetpur – Amreli Section (Saurashtra region)

(A) Jabalpur –Itarsi – Khandwa – Rajgarh Section

- Presently Jabalpur – Itarasi – Khandwa – Rajgarh section faces significantly high voltage condition in the off-peak hours. During off-peak period, the loading remains much less than Surge Impedance Loading of the line, and the 400kV lines generate MVAR to make bus voltage significantly high. To contain bus voltages within stipulated limits, opening of

Jabalpur – Itrarsi, Itarsi - Khandwa and Khandwa - Rajgarh 400kV one circuit is carried out as an operational measure.

- To solve the high voltage problem in this area, installation of 1 no. 125MVAR bus reactor at Rajgarh is already under implementation and 1x125MVAR bus reactor at Khandwa is already installed. With the installation of bus reactor at Rajgarh, voltages in this section shall be reduced, but may still remain outside acceptable limits. Therefore installation of additional reactors at suitable locations like Jabalpur & Khandwa are also examined and results are tabulated as below:

Table-1: Jabalpur – Itarsi – Khandwa – Rajgarh Section

S No	Case	Power Flow/ckt (MW)	Voltage(kV)			
			Jabalpur	Itarsi	Khandwa	Rajgarh
C1	Base Case with 1x125MVAR bus reactor at Rajgarh	Jabalpur – Itarsi :154 Itarsi – Khandwa :123 Khandwa - Rajgarh: 274	423	423	421	418
C2	C1+80 MVAR B/R at Jabalpur		420	422	420	418
C3	C1+125 MVAR B/R at Jabalpur		418	420	419	418
C4	C3+125 MVAR B/R at Khandwa		417	419	416	416

- From the above results, it can be observed that installation of additional 1x125MVAR bus reactor at Jabalpur & Khandwa is adequate to control the voltages within acceptable limits.
- It has been observed that due to high short-ckt strength of most of the substations, 80MVAR bus reactor does not have much impact on voltage. Therefore, bus reactor of higher size (125MVAR) has been considered for all further studies.
- Keeping above in view, following is proposed to limit voltages in Jabalpur - Itarasi–Khandwa – Rajgarh section:
  - i) Installation of 1x125 MVAR bus reactor at 400kV Jabalpur
  - ii) Installation of 1x125 MVAR bus reactor at 400kV Khandwa
  - iii) Adjustment of transformer taps at suitable locations

(B) Bina –Shujalpur – Nagda Section

- This section observes high voltage condition especially during off-peak hours mainly due to following reasons:
  - Light loading on Bina – Shujalpur - Nagda 400 kV line
  - Light loading on Jabalpur Pool –Bina – Gwalior –Agra 765kV line
- Presently, 1x 63MVAR bus reactor is existing each at 400kV Bina (PG) & Shujalpur as well as 2x50MVAR bus reactor at Nagda(MPPTCL) substations.

- In present situation also above section experiences high voltage situation, therefore to contain bus voltages within stipulated limits, opening of Seoni – Bina and 400kV Satna - Bina - Nagda one ckt is carried out as an operational measure.
- To solve the high voltage problem in this area, installation of 1 no. 125MVAR bus reactor at Shujalpur is examined and results are tabulated as below:

Table-2: Bina – Shujalpur – Nagda Section

S No	Case	Power Flow/ ckt (MW)	Voltage(kV)		
			Bina	Shujalpur	Nagda
C5	Base Case (C4)	Bina-Shujalpur:276 Shujalpur – Nagda:239	417	424	424
C6	C5+125 MVAR B/R at Shujalpur		415	419	420

- From the above results, it can be observed that installation of 1x125MVAR bus reactor at Shujalpur shall facilitate in controlling the voltages within acceptable limits. Proposed 125 MVAR Bus reactor along with 1x63 MVAR reactor at Shujalpur shall facilitate reactive compensation in four steps of 0, 63, 125 & 188 (125+63) MVAR ratings.
- Keeping above in view, following is proposed to limit voltages in Bina – Shujalpur - Nagda section:
  i) Installation of 1x125 MVAR bus reactor at 400kV Shujalpur
  ii) Adjustment of transformer taps at suitable locations

(C) Raigarh – Raipur – Bhatapara / Bhilai Section

- Presently, 400kV Raigarh – Raipur – Bhatapara/Bhilai Section in Chhattisgarh faces significantly high voltage condition during off-peak hours as well as light load conditions on East-West interconnections. During above, line loadings remains much less and the 400 kV lines generate MVAR to make bus voltage significantly high. To contain bus voltages within stipulated limits, presently opening of 400kV Raigarh – Raipur, 400kV Rourkela- Raigarh, 400kV Raipur - Sipat, 400kV Bhilai- Bhadravati one circuit is being carried out as an operational measure.
- 400kV Raipur and Raigarh have 80 MVAR & 63 MVAR bus reactor respectively. In view of the space constraints at 400kV Raipur S/s, installation of additional reactors near 400kV Raigarh area is examined for 2013-14 time frame.
- Study results with above additional Bus reactor at Raigarh & Bhatapara has been examined and results are tabulated as below:

Table - 3: Raigarh – Raipur – Bhilai - Bhatapara Section

S No	Case	Power Flow / ckt (MW)	Voltage (kV)			
			Raigarh	Raipur	Bhilai	Bhatapara
C7	Base Case (C6)	Raigarh-Raipur : 92	425	424	419	420

			Voltage (kV)			
		Bhatapara-Bhilai : 65				
C8	C7 + 125 MVAR B/R at Bhatapara		425	424	417	415
C9	C8 + 125 MVAR B/R at Raigarh		420	420	417	414

- From the above results, it can be observed that installation of 1x125MVAR bus reactor each at Bhatapara & Raigarh shall facilitate in controlling voltages under the acceptable limits.
- Proposed 125 MVAR Bus reactor along with 1x63 MVAR reactor at Raigarh shall facilitate reactive compensation in four steps of 0, 63, 125 & 188 (125+63) MVAR ratings.
- Keeping above in view, following is proposed to limit voltages in Raigarh – Raipur – Bhatapara/Bhilai section:
  - i) Installation of 1x125 MVAR bus reactor at 400kV Bhatapara
  - ii) Installation of 1x125 MVAR bus reactor at 400kV Raigah
  - iii) Adjustment of transformer taps at suitable locations

(D) Wardha – Aurangabad (PG) – Bhusawal Section

- This section observes high voltage condition especially in off-peak hours due to following reasons:
  - Long stretch of Raipur-Wardha (370 km) and Wardha-Aurangabad section (400 km) and light load condition thereon during off peak hours
  - Light load condition on 765kV transmission corridors from Raipur Pool – Wardha-Aurangabad D/c, Aurangabad- Dhule S/c and Seoni-Wardha 2xS/c sections
  - 765kV Wardha shall have 1x240+1x330 MVAR Bus reactors at 765kV level in future. 765kV Aurangabad S/s shall have 1x240 MVAR Bus reactor, however there is no Bus Reactor planned at 400kV level
  - With the installation of above future bus reactors at 765kV Wardha & Aurangabad S/s, voltages in this section shall be reduced, but may still remain outside acceptable limits. Therefore installation of additional reactors at suitable locations like 400kV Aurangabad is also examined.
- Study results with above additional Bus reactor has been examined and results tabulated as below:

Table-4: Wardha – Aurangabad (PG) – Bhusawal Section

S No	Case	Power Flow/ ckt (MW)	Voltage(kV)		
			Wardha	Aurangabad (PG)	Bhusawal
C10	Base Case (C9)	Raipur –Wardha: 455 Wardha- Aurangabad (PG) :486 Aurangabad-Bhusawal:234	418	421	421
C11	C10+125 MVAR		418	417	420

			Voltage(kV)		
	B/R at Aurangabad (PG)				

- From the above results, it can be observed that installation of additional 1x125MVAR bus reactor at Aurangabad is adequate to control the voltages under the acceptable limits.
- Keeping above in view, following is proposed to limit voltages in Wardha – Aurangabad (PG) - Bhusawal section:
  i) Installation of 1x125 MVAR bus reactor at 400kV Aurangabad (PG)
  ii) Adjustment of transformer taps at suitable locations

(E) Parli (PG) – Solapur(PG) – Kolhapur Section

- This section observes high voltage condition in off-peak hours due to lightly loaded lines in the area, even though 80 MVAR bus reactor at Kolhapur & 63 MVAR Bus reactor at Solapur & Parli is existing in this pocket.
- In present situation, to contain bus voltages within stipulated limits, opening of 400kV Kolhapur – Mapusa one ckt is carried out as an operational measure, still voltage remains outside acceptable limits. Keeping in view the importance of the Parli(PG) S/s as a gateway to transfer power from eastern part to western part, installation of 1x150MVAR variable reactor at Parli (PG) is examined
- The results with above compensation at Parli is given as under:

Table-5: Parli – Solapur – Kolhapur Section

S No	Case	Power Flow/ ckt (MW)	Voltage(kV)		
			Parli	Solapur	Kolhapur
C12	Base Case (C11)	Parli – Solapur :234 Solapur – Kolhapur :170	424	422	420
C13	C12+150MVAR variable reactor at Parli(PG)		418	419	417

- From the above results, it is observed that installation of additional 1x150MVAR variable reactor at Parli(PG) is adequate to control the voltages under the acceptable limits.
- Keeping above in view, following is proposed to limit voltages in Parli – Solapur – Kolhapur section:
  i) Installation of 1 x 150MVAR variable reactor at 400kV Parli(PG)
  ii) Adjustment of transformer taps at suitable locations

(F) Kutch / Saurashtra region

It has been observed that due to addition of many renewable generation projects i.e. wind power projects, solar projects in Kutch/Saurashtra area and intermittency of generation from

these renewable sources, wide variation in power flow on EHV lines as well as light load condition on long lines during low demand/off peak hours, various pockets in Kutch and Saurashtra region experiences high voltage situations. Studies has been carried out for above two different complexes and results are as under:

(F1)Ranchodpura (Vadavi)–Dehgam-Pirana Section (Kutch)

- This section observes high voltage condition in off-peak hours due to lightly loaded lines in the areas viz. 400kV Mundra – Bhachau-Ranchodpura – Dehgam D/c line, even though bus reactor (125+63 MVAR) at Dehgam and 50 MVAR Bus reactor at Ranchodpura (Vadavi) S/s are existing.
- In present situation, to contain bus voltages within stipulated limits, opening of 400kV Nagda- Dehgam one ckt is carried out as an operational measure
- Studies have been carried out for future time frame with additional reactive power compensation at EHV substations. Keeping in view of the importance of the Pirana substation to transfer the power in Gujarat area and to address the space constraints at 400kV Dehgam S/s, installation of 150MVAR variable reactor at 400kV Pirana(PG) has been examined. Further, with the growing short circuit strength of 400kV Ranchodpur(Vadavi) S/s, it is proposed that additional 125 MVAR Bus reactor at Ranchodpura may be considered. Results with above proposed reactive compensation is as given below:

Table-6: Ranchodpura –Dehgam –Pirana Section

S No	Case	Power Flow/ ckt (MW)	Voltage(kV)		
			Ranchodpura	Dehgam	Pirana
C14	Base Case (C13)	Limdi-R'pura : 50 Mundra - Bachau:223 Pirana-Dehgam:76	425	421	422
C15	C14+125 MVAR B/R at Ranchodpura		421	420	421
C16	C15 +150 MVAR variable reactor at Pirana		419	418	417

- From the above results, it can be observed that installation of additional 1x125MVAR bus reactor at Ranchodpura and 1x150MVAR variable reactor at Pirana shall facilitate in controlling the voltages within the acceptable limits.
- Proposed 125 MVAR Bus reactor along with 1x50 MVAR reactor at Ranchodpura shall facilitate reactive compensation in four steps of 0, 50, 125 & 175 (125+50) MVAR ratings.
- Keeping above in view, following is proposed to limit voltages in Ranchodpura(Vadavi) – Dehgam - Pirana section:
  i) Installation of 125 MVAR bus reactor at 400kV Rachodpura (Vadavi) S/s

ii) Installation of 150 MVAR Variable reactor at 400kV Pirana S/s

iii) Adjustment of transformer taps at suitable locations

(F2) Versana – Rajkot (Hadala) – Limbdi/Jetpur – Amreli Section (Saurashtra region)

- Presently, 50 MVAR bus reactors are available each at 400kV Versana, Rajkot, Jetpur as well as Amreli S/s of GETCO in this region.
- In present situation, to contain bus voltages within stipulated limits, opening of 400kV Amreli- Jetpur & Jetpur-Limdi (Choarnia) line is being carried out as an operational measure.
- Studies have been carried out for future time frame with additional reactive power compensation at 400kV Versana, Rajkot and Amreli substations. The results are given as under:

Table-7: Versana – Rajkot (Hadala) – Jetpur – Amreli Section

S No	Case	Power Flow/ ckt (MW)	Voltage(kV)			
			Versana	Rajkot	Jetpur	Amreli
C17	Base Case (C16)	Versana -Rajkot : 177 Jetpur-Amreli:94	423	428	432	430
C18	C17+125 Mvar B/R at Versana		419	426	430	429
C19	C18+125 Mvar B/R at Rajkot		418	422	427	426
C20	C19+125 Mvar B/R at Amreli		416	419	421	418

- In view of the space constraints at any of the above three 400kV substations, replacement of 50 MVAR Bus reactors with above proposed 125 MVAR bus reactors can be explored. Proposed 125 MVAR Bus reactor along with 1x50 MVAR reactor each at Versana, Rajkot & Amreli shall facilitate reactive compensation in four steps of 0, 50, 125 & 175 (125+50) MVAR ratings.
- Keeping above in view, following is proposed to limit voltages in Versana – Rajkot (Hadala) – Jetpur – Amreli Section :
  - i) Installation of 1x125 MVAR bus reactor each at 400kV Versana, Rajkot(Hadala) and Amreli Substations
  - ii) Adjustment of transformer taps at suitable location

Further considering the growing complexities of the Power system in WR grid, dynamic reactive support requirement under different operating conditions have also been analyzed. It has been observed that at 400kV Indore S/s, due to proximity of agricultural loads, especially in Rabi Season, the voltage profile tends to be on the lower side, which sometimes experiences below

380 kV also. On the other hand during off peak condition it also experiences of the order of 425-430 kV. In addition Indore being a major anchoring point integrating it North Eastern part of the WR grid with Western part of WR grid, it is prudent to provide dynamic reactive support near this point to facilitate safe, reliable and secured operation of the grid. From the analysis, it is observed that to provide the dynamic voltage support at 400kV Indore Bus especially during low voltage condition followed by 3-ph fault about 200 MVAR capacitive supports is required near Indore to maintain system integrity. Further to contain the high voltages, it is proposed to provide 150 MVAR Inductive support (Reactor) at 400kV Indore(PG) substation.

In view of the above, it is proposed to install +200/-150 MVAR SVC at 400kV Indore(PG) substation.

Conclusion

- In order to contain the high voltages in specific pockets in Western region, 10 nos. 125 MVAR Bus reactors & 2 nos. 150MVAR Variable Reactor along with other operational measures have been suggested. The details are as under:

(A) Jabalpur –Itarsi – Khandwa – Rajgarh Section

i) Installation of 1x125 MVAR bus reactor at 400kV Jabalpur S/s

ii) Installation of 1x125 MVAR bus reactor at 400kV Khandwa S/s

(B) Bina –Shujalpur – Nagda Section

i) Installation of 1x125 MVAR bus reactor at 400kV Shujalpur S/s

(C) Raigarh – Raipur – Bhatapara/Bhilai Section

i) Installation of 1x125MVAR Bus reactor at 400kV Bhatapara S/s

ii) Installation of 1x125MVAR Bus reactor at 400kV Raigarh S/s

(D) Wardha – Aurangabad (PG) – Bhusawal Section

i) Installation of 1x125 MVAR bus reactor at 400kV Aurangabad(PG) S/s

(E) Parli – Solapur – Kolhapur Section

i) Installation of 1x150 MVAR variable reactor at 400kV Parli (PG) S/s

(F) Kutch / Saurashtra Region

(F1) Ranchodpura – Dehgam – Pirana Section

i) Replacement of existing B/R/Installation of 1x125 MVAR bus reactor at 400kV Ranchodpura(GETCO) S/s*

ii) Installation of 1x150 MVAR Variable Reactor at 400kV Pirana (PG) S/s

(F2) Versana – Rajkot (Hadala) – Jetpur – Amreli Section

i) Replacement of existing B/R / Installation of 1x125 MVAR bus reactor each at 400kV Versana, Rajkot & Amreli S/s*

** Depending of the availability of space provisions for placement of Bus reactors*

- In addition to provide dynamic voltage support, it is proposed to install +200/-150 MVAR SVC at 400kV Indore(PG) substation.

Broad estimated cost of the 6 nos of.125 MVAR reactor & 2 nos .Variable reactor and one no.SVC is about: Rs 170Cr (under the scope of POWERGRID) and Broad estimated Cost of the 4 nos .125MVAR reactor: Rs 40 Crs(under the scope of respective STUs).

It is proposed that above bus reactors & SVC proposed at existing POWERGRID substations, being part of the system strengthening of existing transmission system, could be implemented by POWERGRID as strengthening scheme. However bus reactors at STU substations shall be implemented by respective STUs.

It is also recommended that as a practice STU should plan Bus reactors while planning a new 400kV substation into the intra-state transmission system so as to mitigate high voltage phenomenon during off peak periods.

Further, STU should also emphasis on placement of adequate reactive compensation at RES farms as well as interconnecting substations especially in Gujarat.

With implementation of these measures, it is expected that the high voltage profile of WR grid would be within permissible limits to a large extent.

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