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Voltage instability and its prevention using facts controller

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Abstract*—Voltage collapse, grid failure problem occurring frequently because of increasing demand in power sector. It is very important to analyse the power system with respect to voltage stability. In this paper an attempt has been made to investigate the voltage stability analysis of IEEE 9 bus system using SVC. The objective of this paper is to stabilize the voltage of the system when it experiences load change. Continuation power analysis is done with PSAT software.

***Keyword*—SVC, voltage instability, SVC, PSAT, Continuation power flow, FACTS**

I. INTRODUCTION

Few days back 21 Indian states plunged into darkness as the northern, north-eastern and eastern grids collapsed .Overstressed system compels the transmission lines to work close to the limit n eventually a grid failure. Transmission lines operate at voltage levels from 69kV to 765 kV and are tightly connected for reliable operation. Factors like de regulated market environment, economics, right of way clearance and environmental requirements have pushed to operate transmission lines close to their operating limits any fault if not detected and isolated quickly will cascade into a system wide disturbance causing widespread outages for a tightly interconnected system operating close to its limits. Transmission protection systems are designed to identify the location of faults comprising the security of the system, the large interconnected transmission networks are prone to faults due to lightning discharges and reduced insulation strength. changing loads and atmospheric conditions are unpredictable factors, this may cause overloading of line due to which voltage collapse takes place. The reason to it is massive demand, creaky infra-structure, and insufficient supply. This creates an overstretched, unstable system, prone to failures and disruption.

- Recently several blackouts have been related to voltage collapses some of them are
- Sri lanka power system disturbance, may 2, 1995
- Northern grid disturbance in Indian power system, December 1996
- North American power system disturbance , Aug 14,2003
- National grid system of Pakistan disturbances of September 24,2006
- Stability defined by American institution of electrical engineers are as follows

Stability when used with reference to the power system is that attribute of the system or part of the system which enables it to develop restoring forces between the elements there of ,equal to or greater than the disturbing forces so as to restore a state of equilibrium between the element.[5]

PRINCIPAL CAUSES OF VOLTAGE STABILITY PROBLEMS

- High reactive power consumption at heavy loads
- Generating stations are too far from load centers
- Difference in transmission of reactive power under heavy loads
- Due to improper locations of FACTS controllers
- Poor coordination between multiple FACTS controller

OUTCOMES OF VOLTAGE INSTABILITY

- Loss of load in area
- Tripping of transmission lines
- Voltage collapse in the system

MEASURES FOR PREVENTION OF VOLTAGE INSTABILITY

- Placement of FACTS controllers
- Co-ordination of multiple FACTS controllers
- Installation of synchronous condensers
- Placement of series and shunt .

Obvious question to be asked then is: **Can FACTS help to prevent similar things to happen in the future?** The answer is that it will definitely play a role, and an important one, at that. And for sure, since blackouts in the majority of cases are caused by a deficit of reactive power, FACTS comes into the picture as a remedy in a natural way.

What is facts

FACTS controller is defined as power electronic based system and other static equipment that provide control of one or more AC transmission system parameters. The problem of maintaining voltages within the requires limits is complicated by the fact that the power system supplies power to a vast number of loads and is fed from many generating units. As the load vary the reactive power requirements of the transmission system vary.

Since reactive power cannot be transmitted over long distances, voltage control has to be effected by using special devices dispersed throughout the system. the proper selection and coordination of equipment for controlling reactive power and voltage are among the major challenges of power system engineering.[2]

STATIC VAR COMPENSATOR.

It is a thyrisor based controller that provides rapid voltage control to support electric power transmission voltages during immediately after voltage disturbances. the svc provides an excellent source of rapidly controllable reactive power compensation for dynamic voltage control through its utilization of high speed thyristor switching/controlled reactive devices.

Table 1: **Voltage magnitudes and angles of IEEE9BUS**

Bus No.	Voltage Magnitude (pu) without facts	Angle in radians without facts	Voltage magnitude (pu) with SVC at Bus 5	Angle radians with SVC at Bus 5	Voltage magnitude (pu) with SVC at Bus 8	Angle radians with SVC at Bus 8
1	1.04	0	1.04	0	1.04	0
2	1.025	0.16197	1.025	0.16113	1.025	0.16049
3	1.025	0.08142	1.025	0.0820	1.025	0.08063
4	1.0258	-0.03869	1.0349	-0.03828	1.027	-0.03861
5	0.99563	-0.06962	1.02	-0.6968	0.99797	-0.6955
6	1.0127	-0.06436	1.0199	-0.06331	1.0147	-0.643
7	1.0258	0.06492	1.0318	0.06466	1.0297	0.06382
8	1.0159	0.0127	1.0207	0.01325	1.025	0.1166
9	1.0324	0.03433	1.0351	0.3512	1.0355	0.3368

The data obtained in the above table is obtained by carrying out power flow using PSAT. The application of SVC at different buses and the voltage magnitude obtained after application of SVC is shown.

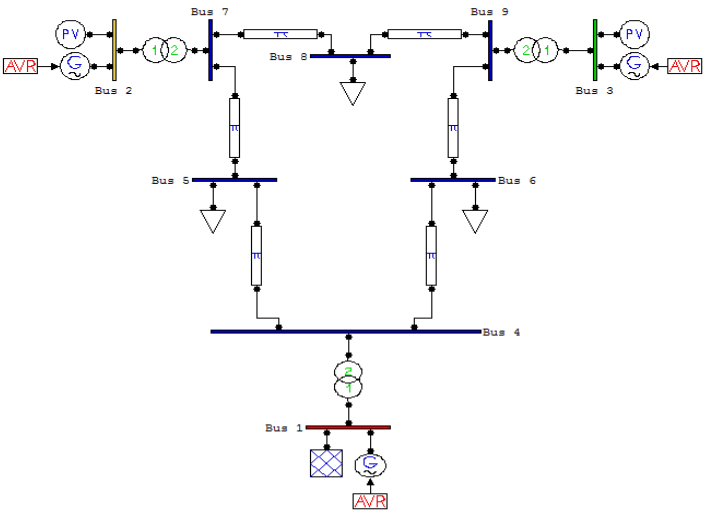
Three lowest voltages obtained after continuation power flow method are:

- Bus I
- Bus IV
- Bus V

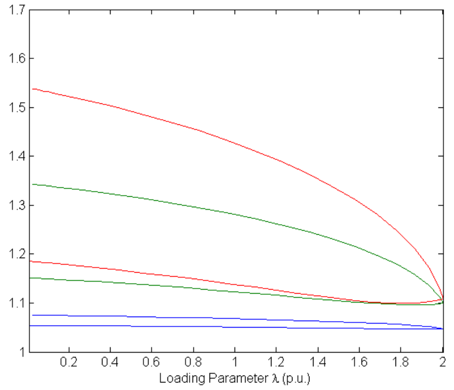
Table 2: **Power generation and power loss of IEEE9BUS**

Voltage is increased at bus 5 using svc as can be seen in the table. Voltage is increased at bus 8 with application of svc

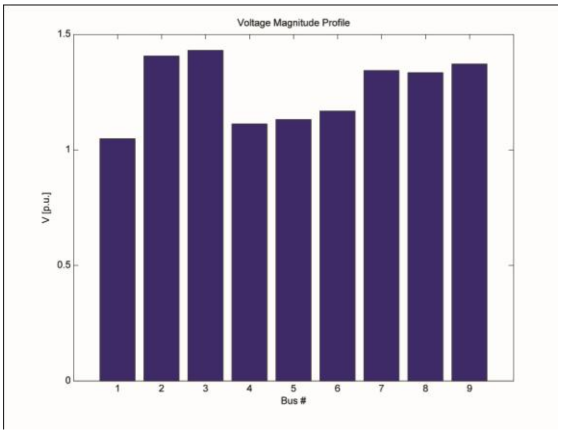
Total generation	**Without facts**	**With SVC at Bus 5**	**With SVC at Bus 8**
REAL POWER [p.u.]	3.1964	3.1951	3.1959
REACTIVE POWER [p.u.]	0.2284	0.19049	0.21492
TOTAL LOSSES			
REAL POWER [p.u.]	0.04641	0.4506	0.4587
REACTIVE POWER [p.u.]	0.9216	-0.95951	-0.93508



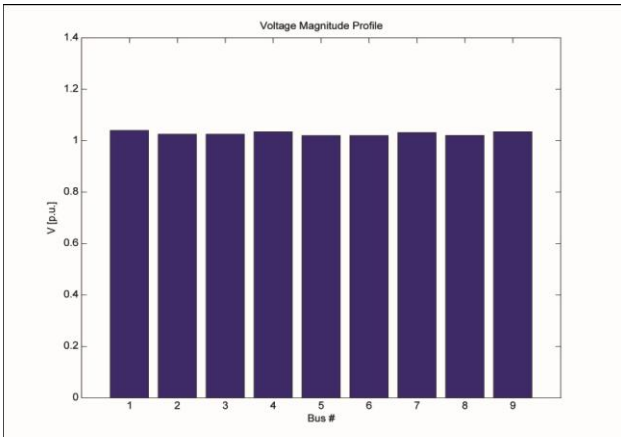
FIGURES: **IEEE 9BUS**



3 lowest voltages obtained after CPF



Voltages profile of 9BUS



Voltages profile of 9BUS after application of SVC

II. CONCLUSION

Static voltage stability analysis of IEEE 9 Bus system is done. Continuation power flow techniques is used to identify weakest bus in the system. SVC facts devices is employed & voltage profile of the system is enhanced. Further reason will be focussed on dynamic voltage stability & optimal location of FACTS using artificial intelligence like PSO.

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