# Literature Review on Voltage stability phenomenon and Importance of FACTS Controllers In power system Environment

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## Abstract

Now a days the use of stable, reliable, economical, secure and efficient electrical paper drastically increasing in many sectors but the generated power in not being supported as much as increasing demand. The voltage stability plays major role in power system environment to meet the required demand. In this paper presents the phenomena of voltage stability in power system in which it reviews various reasons for voltage instability, types of voltage stability, characteristic of voltage stability, voltage control methods in power system environment, factors affecting voltage instability and collapse, scenario of voltage collapse and characteristics of reactive compensating devices are primarily discussed. It also reviews overview of major FACTS controllers, types of FACTS controllers, applications of FACTS controllers and their use in power system environment are discussed briefly.

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***Index terms***— Voltage Stability, Voltage Instability, Voltage Collapse, Reactive compensating devices, FACTS Controllers.

# 1 INTRODUCTION

n recent years greater demands have placed on the transmission network, with this increased demands on transmission lines, hence it is the responsibility of the power suppliers to supply safe and economical electric power to customers with the existing transmission line efficiently. "Voltage stability is the ability of a power system to maintain steady acceptable voltages at all buses in the system under normal operating conditions and after being subjected to a disturbance" [1].

In power system environment voltage stability plays major role, it is integral part of the power system stability. In general Voltage stability problems occur more frequently in a heavily loaded system. The change in voltage is directly proportional to change in load and hence voltage stability is sometimes termed as load stability.

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Voltage stability is a part of power system stability and hence is a subset of overall power system stability and is a dynamic problem. Thus voltage instability and collapse cannot be separated from the general problem of system stability. The reactive power compensation close to the load centres as well as at critical buses in the network is essential for overcoming voltage instability. The location, size and speed of control have to be selected properly to have maximum benefits. The SVC and STATCOM provide fast control and help improve system stability [2].

The suitable location of FACTS devices, under contingencies is more important than consideration of normal state of system. Now a day's many literatures are proposed various intelligent techniques to control FACTS devices in optimal manor for enhancing voltage stability which intern enhanced the power system stability.

# 2 II. VOLTAGE STABILITY PHENOMENON IN POWER SYSTEM

In recent years, voltage instability has been responsible for several major network collapses in New York, Florida, French, Northern Belgium, Swedish, Japanese, Mississippi, Srilanka, North America, Pakistan and Tokyo etc. ??1][3].

# 3 a) Major reasons for voltage stability problems in power system

There are some reasons for voltage stability problems in power system as follows It is define as the ability of the power system to maintain stable voltages for large disturbances such as such as system faults, loss of load, or loss of generation.

Large disturbance voltage stability may be further subdivided into two types a) Transient stability b) Long term stability ii. Smalldisturbance (Small signal) voltage stability Small disturbance voltage stability is concerned with a system's ability to control voltages following small perturbations, such as gradual change in load, this types of stability can be studied with steady-state approaches that use linearization of the system dynamic equations at a given operating point.

# 4 c) Factors Affecting voltage instability and collapse

The main factor causing instability is the inability of the power system to meet the demand for reactive power.

# 5 i. Transient voltage instability

Under low voltage condition the electrical torque of an induction motor is not adequate to meet the required mechanical torque due to this effect the induction motor may not regain the original speed and continue to decelerate leading to stalling of motors which intern aggravates the low voltage problem. This phenomenon is called transient voltage instability. Transient voltage instability is also associated with HVDC links, particularly inverter terminals connected to AC systems with low short circuit capacity [2] [5] [6].

# 6 ii. Long term voltage instability

On-load tap-changing transformers and distribution voltage regulations act within a time frame of tens of seconds to tens of minutes to regulate the load a voltage is termed as long term voltage instability. An important factor in long term voltage stability is the current limiting generator [2] [7].

# 7 d) Typical scenario of voltage collapse

When a power system is subjected to a sudden increase of reactive power demand following a system contingency, the additional demand is met by the reactive reserves carried by the generators and compensators.

Voltage instability may occur in several different ways. In its simple form it can be illustrated by considering the two terminal network of fig. 1 it consists of a constant voltage source (Es) supplying a load (ZLD) through a series impedance (ZLN). This is representative of a simple radial feed to load or a load area served by a large system through a transmission line. The control of voltage levels is accomplished by controlling the production, absorption, and flow of reactive power at all levels in the system. The devices used for this purpose may be classified as follows ii. Series capacitors

? Series capacitors are self-regulating.

? The reactive power supplied by series capacitors is proportional to square of the line current and is independent of the bus voltages. ? This has favourable effect on voltage stability.

The present trend is to operate the existing transmission system more close to their stability and thermal limits with reliable and optimal. Power electronics based Flexible AC transmission system (FACTS) gives efficient solution for optimal utilization of transmission systems with minimal installation and operational cost ??1][4].

# 8 III.

# 9 OVERVIEW OF MAJOR FACTS CONTROLLERS

The development of FACTS-devices has started with the growing capability of power electronics components. Devices for high power levels have been made available in converters for higher and even highest voltage levels. Several FACTS have been introduced for various applications worldwide. a) Basic Types of FACTS controllers? Shunt controllers ? Series controllers ? Combined shunt-series controllers ? Combined series-series controllers

The shunt controllers are applied to control voltage at and around the operating point by injecting reactive current.

Series controllers are applied to improving voltage profile in a cost effective way ware voltage fluctuations are large. However the series controllers are several times more powerful than the shunt controllers.

The combined controllers provide the best of both i.e. an effective power/current flow and line voltage control.

FACTS-devices provide a better adaption to varying operational conditions and improve the usage of The ability of FACTS controllers to control the interrelated parameters that govern the operation of transmission systems including series impedance, shunt impedance, current, voltage, phase angle and the damping of oscillations at various frequencies below the rated frequency. These constraints cannot be overcome, while maintaining the required system reliability, by mechanical means without lowering the useable transmission capacity.

There are a number of stability issues that limit the transmission capacity these include transient, dynamic, steady state stabilities, frequency collapse , sub synchronous resonance and voltage collapse. The FACTS technology can certainly be used to overcome any of the stability limits. An over-view of problems occurring in the grid and which FACTS to be used to solve these problems are given in the table blow. The application of these devices depends on the problem which has to be solved, below table shows various problems in the grid and which FACTS device to be used to solve these problems [12][16].

# 10 CONCLUSION

This paper gives a summary of voltage stability analysis, importance of voltage stability & voltage instability in power system, and various reasons for voltage instability, methods of preventing voltage instability, characteristics of reactive power compensating devices (shunt & Series) and also explains the importance of FACTS controllers in power system environment enhancing voltage stability which intern enhance the power system stability.

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Figure 1:

[1]

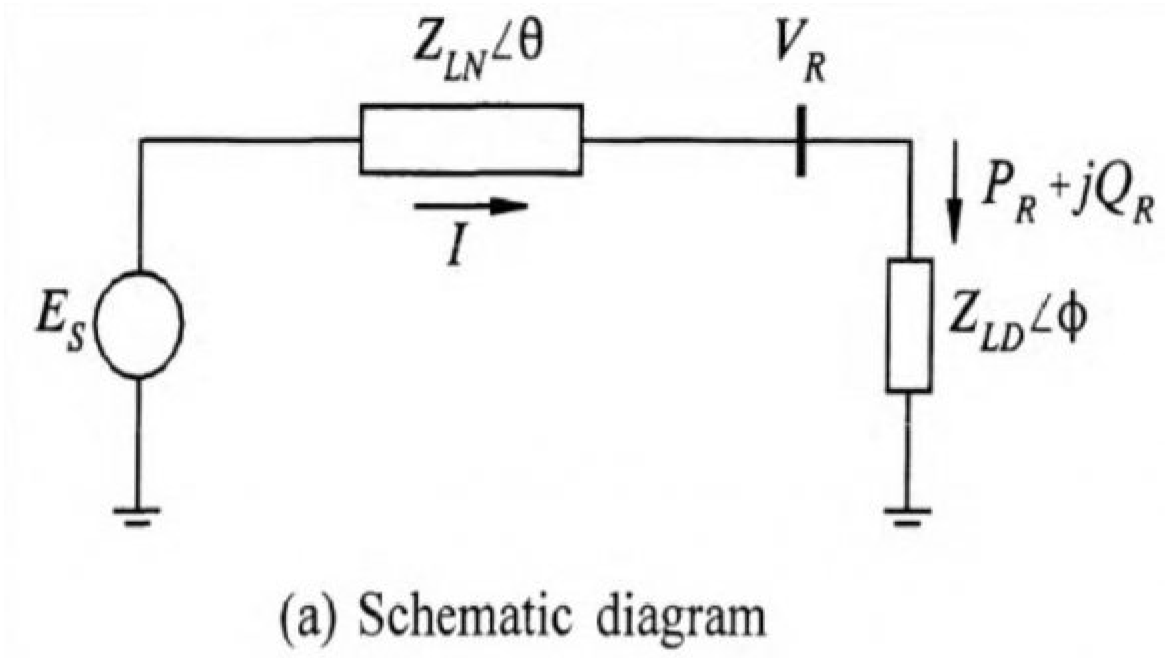
1 


Figure 2: Fig. 1 :

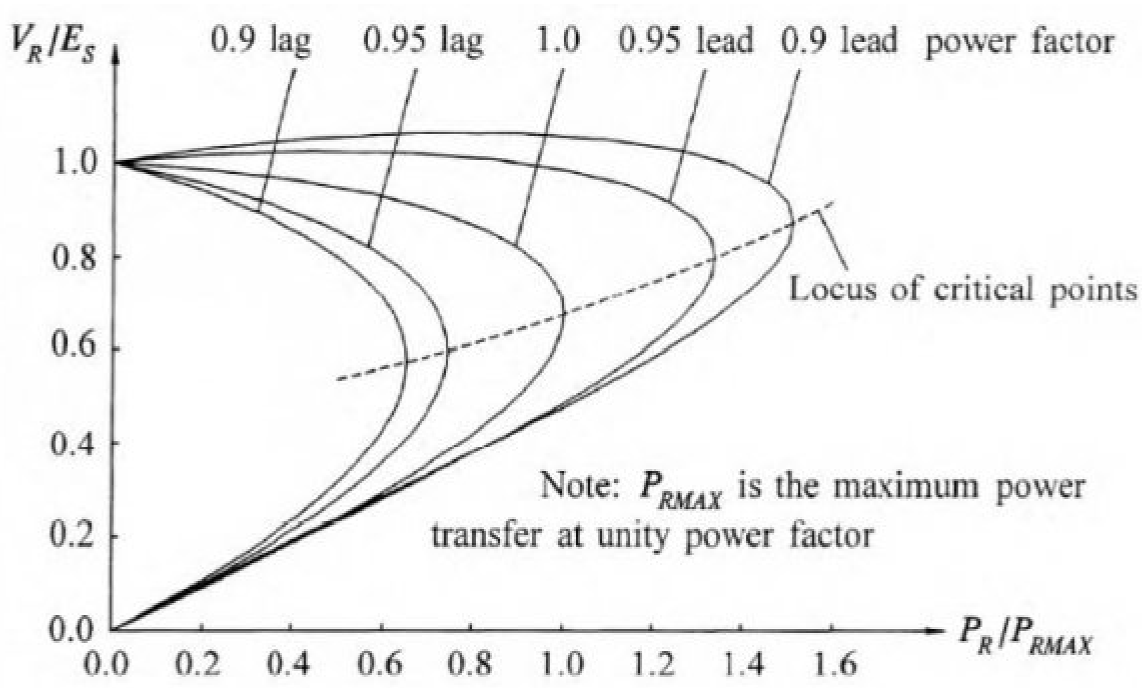
2 


Figure 3: Fig. 2 :

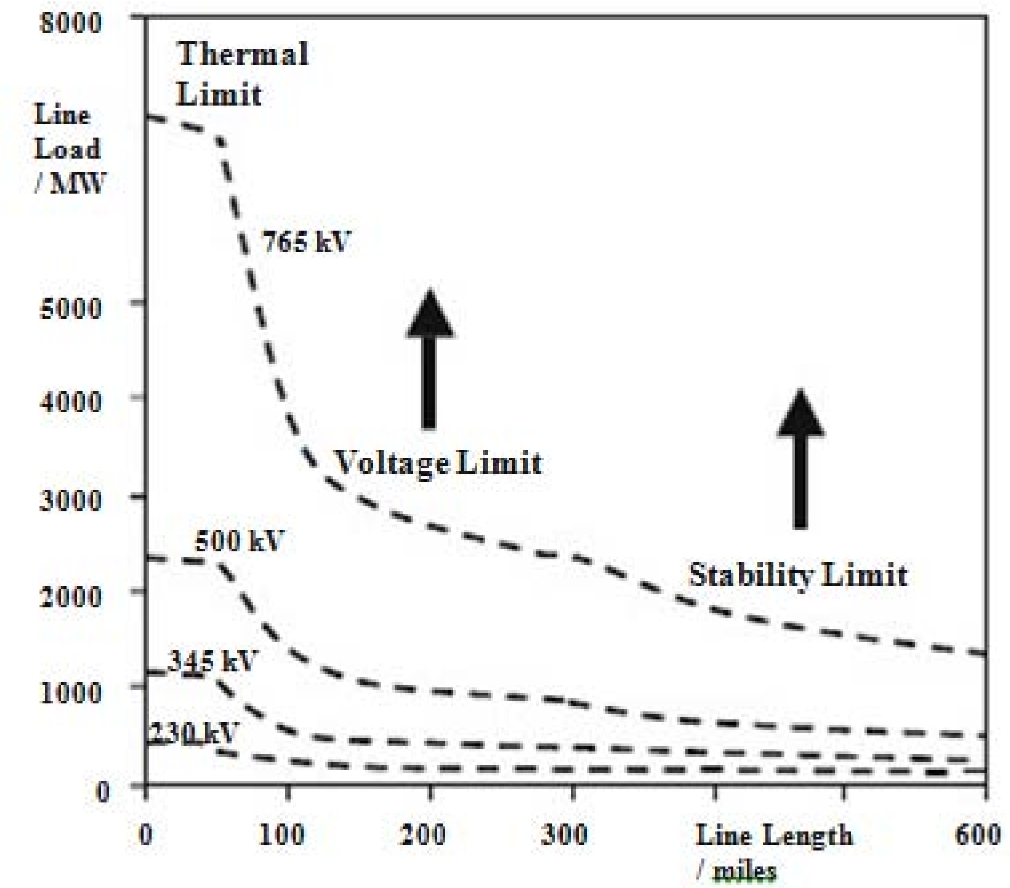



Figure 4:

| Subject | Problem | Corrective action | FACTS |
|---|---|---|---|
| Voltage limits | Low voltage at heavy load | Supply reactive power | SVC, STAT-COM |
| | | Reduce line reactance | TCSC |
| | High voltage at low load | Absorb reactive power | SVC, STAT-COM |
| | High voltage following an outage | Absorb reactive power, prevent overload | SVC, STAT-COM |
| | Low voltage following an outage | Supply reactive power, prevent overload | SVC, STAT-COM |
| Thermal limits | Transmission circuit overload | Increase transmission capacity | TCSC,SSSC, UPFC |
| Load flow | Power distribution on parallel lines | Adjust line reactance | TCSC,SSSC, UPFC |
| | | Adjust phase angle | TCSC,SSSC, PAR |
| | Load flow reversal | Adjust phase angle | TCSC,SSSC, PAR |
| Short circuit power | High short circuit current | Limitation of short circuit current | TCSC, UPFC |
| Stability | Limited transmission power | Decrease line reactance | TCSC,SSSC |

**3**

Figure 5: Fig. 3 :

**1**

Figure 6: Table 1 :

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