International Journal of Engineering and Technical Research (IJETR)
ISSN: 2321-0869, Volume-2, Issue-5, May 2014

Power Devices Implementation & Analysis in ETAP

Vancha Abhilash, , Kamlesh Pandey

***Abstract*— Power system engineers are currently facing challenges to increase the power transfer capabilities of existing transmission system. This is where the Flexible AC Transmission Systems (FACTS) technology comes into effect. With relatively low investment, compared to new transmission or generation facilities, the FACTS technology allows the industries to better utilize the existing transmission and generation reserves, while enhancing the power system performance.**

The FACTS controllers clearly enhance power system performance, improve quality of supply and also provide an optimal utilization of the existing resources. SVC & shunt Reactor are the key FACTs controllers and is widely recognized as an effective and economical means to enhance power system stability. In this paper an overview to the general FACTS controllers is given along with the simulation of above FACTS controllers using ETAP simulation software.

***Index Terms*— FACTS, load flow analysis in ETAP, Transient stability, Voltage stability, Thermal rating, Power system flexibility.**

I. INTRODUCTION

For the last few years electrical engineers have been focusing on the power system studies using software tools. Recent advances in engineering sciences have brought a revolution in the field of electrical engineering after the development of powerful computer based software. This research work highlights the effective use of Electrical Transient Analyzer Program (ETAP) software for analyses and monitoring of large electrical power system which comprises of large power distribution network.

According to its manufacturer, "ETAP offers a suite of fully integrated Electrical Engineering software solutions including arc flash, load flow, short circuit, transient stability, relay coordination, optimal power flow, and more. Its modular functionality can be customized to fit the needs of any company, from small to large power systems." "Operation Technology, Inc. is the designer and developer of ETAP, the most comprehensive analysis software for the design, simulation, operation, monitoring, control, optimization, and automation of power systems. ETAP is the industry leader used worldwide in all types and sizes of power systems, including generation, transmission, distribution, and industrial systems such as oil and gas, manufacturing, steel, cement, mining, data centers, nuclear facilities, transportation, smart grid solutions, renewable energy, and more.

Manuscript received May 20, 2014.
Vancha Abhilash, Department of Electrical & Electronics Engineering, Amity University, Noida, Uttar Pradesh
Kamlesh Pandey, Department of Electrical & Electronics Engineering, Amity University, Noida, Uttar Pradesh

A. Power System Stability:

Power system stability will actuate both generator and transmission network voltage regulators; the generator speed variations will actuate prime mover governors; and the voltage and frequency variations will affect the system loads to varying degrees depending on Power system stability is the ability of the system, for a given initial operating condition, to regain a normal state of equilibrium after being subjected to a disturbance[1]. Stability is a condition of equilibrium between opposing forces; instability results when a disturbance leads to a sustained imbalance between the opposing forces. The response of the power system to a disturbance may involve much of the equipment. For instance, a fault on a critical element followed by its isolation by protective relays will cause variations in power flows, network bus voltages, and machine rotor speeds; the voltage variations their individual characteristics. Further, devices used to protect individual equipment may respond to variations in system variables and thereby affect the power system performance. A typical modern power system is thus a very high-order multivariable process whose dynamic performance is influenced by a wide array of devices with different response rates and characteristics[2]. Hence, instability in a power system may occur in many different ways depending on the system topology, operating mode, and the form of the disturbance.Fig.1 shows a possible classification of power system stability into various categories and subcategories.

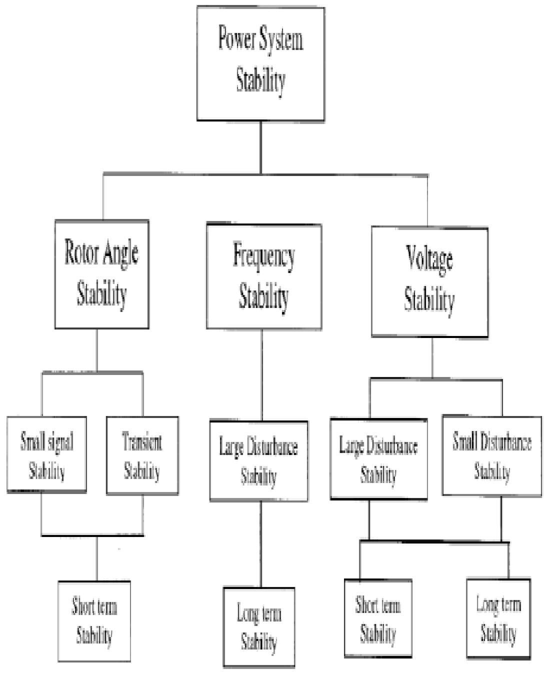


Fig: Classification of power system

a) Large disturbance rotor angle stability or Transient stability:

As it is commonly referred to, is concerned with the ability of the power system to maintain synchronism when subjected to a severe transient disturbance. The resulting system response involves large excursions of generator rotor angles and is influenced by the nonlinear power-angle relationship.[3] Transient stability depends on both the initial operating state of the system and the severity of the disturbance. Usually, the disturbance alters the system such that the post-disturbance steady state operation will be different from that prior to the disturbance. Instability is in the form of a periodic drift due to insufficient synchronizing torque, and is referred to as first swing stability. In large power systems, transient instability may not always occur as first swing instability associated with a single mode; it could be as a result of increased peak deviation caused by superposition of several modes of oscillation causing large excursions of rotor angle beyond the first swing. The time frame of interest in transient stability studies is usually limited to 3 to 5 sec following the disturbance. It may extend to 10 sec for very large systems with dominant inter-area swings. Power systems experience a wide variety of disturbances. It is impractical and uneconomical to design the systems to be stable for every possible contingency. The design contingencies are selected on the basis that they have a reasonably high probability of occurrence.

b) Types of Power System Stability Controls and Possibilities for Advanced Control:

[3]Stability controls are of many types, including:
• Generator excitation controls
• Prime mover controls, including fast valuing
• Generator tripping

- Fast fault clearing
- Dynamic braking
- Load tripping and modulation
- Reactive power compensation switching or modulation (series and shunt)
- Current injection by voltage source inverter devices (STATCOM, UPFC, SMES, battery storage)
- Fast phase angle control
- HVDC link supplementary controls
- Adjustable speed (doubly fed) synchronous machines
- To discriminate both conventional and load shedding Fast Fault Clearing& High Speed Reclosing, Load shedding approaches are preferred over the rest.

II. SYSTEM MODEL

The system under study is one of the 400kv substations under NTPC. It consists of seven generators, Circuit breakers, transformers, Lightning arresters, Isolators, Many feeders etc. There are fourteen feeders, shunt reactor and SVC and these are used to improve the power factor. All circuit breakers are SF6 and motor operated.

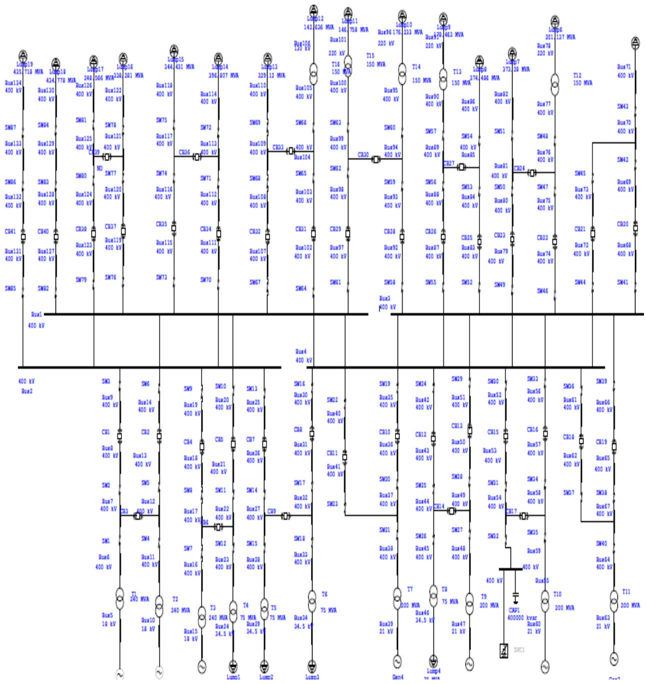


Fig: Single line diagram of 400 kV substations

III. SIMULATION IN ETAP

A. Load flow analysis

Load Flow Analysis of the 400Kv substations carried out using ETAP in which Newton- Raphson method is used and it is observed that at the some Buses are under and over voltage which can be clearly seen from showing the sectional view of the feeders.

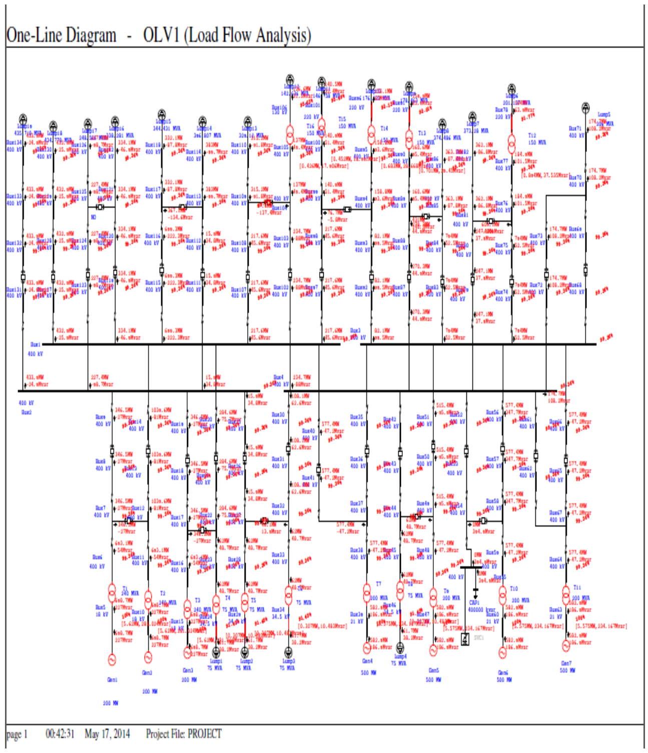


Fig: 400KV Substation load flow analysis

B. RESULTS:

Buses	134
Branches	133
Generators	7
Power Grids	0
Loads	19
Load-MW	4336.521
Load-Mvar	2036.856
Loss-MW	49.276
Loss-Mvar	2173.898

Table 1: Load flow results of entire system without FACT devices

Buses	134
Branches	133
Generators	7
Power Grids	0
Loads	19
Load-MW	4371.009
Load-Mvar	1786.764
Loss-MW	47.218
Loss-Mvar	2084.977

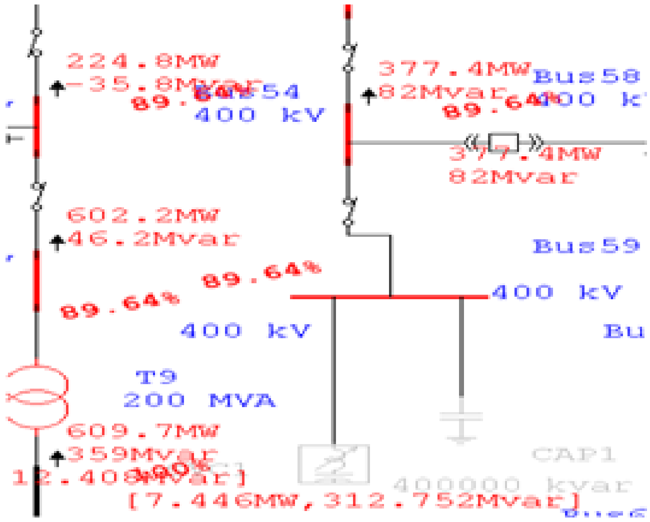
Table 2: Load flow results of entire system with SHUNT REACTOR

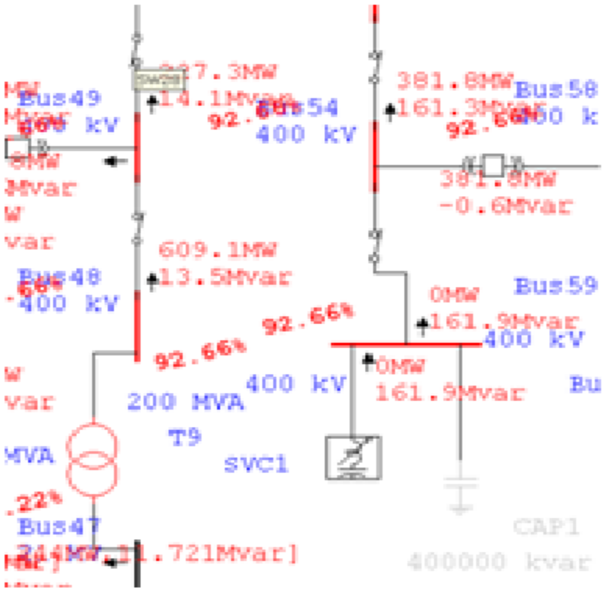
Buses	134
Branches	133
Generators	7
Power Grids	0
Loads	19
Load-MW	4412.854
Load-Mvar	1499.465
Loss-MW	45.36
Loss-Mvar	2004.771

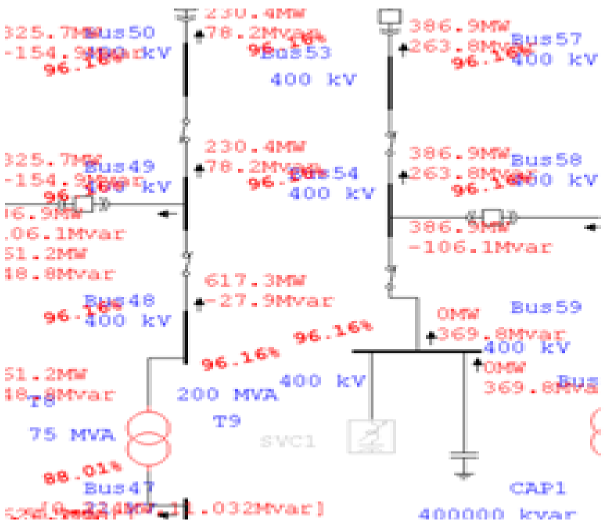
Table 3: Load flow results of entire system with SVC

C. Effect of SHUNT REACTOR & SVC on the network:

Voltage level in busses has been increased by adding compensating devices which are show in below figures







Voltage profile of busses as been increased when compared with the network without FACT/Compensating devices, initially bus voltage was 89.64% but on adding the devices it has been increased to 90 and above by injecting Mvar into the system. As result, overall performance has increased

.

D. HARMONIC ANALYSIS:

Harmonics of 5th order have been reduced by using filter and which can be showed in below charts and graphs

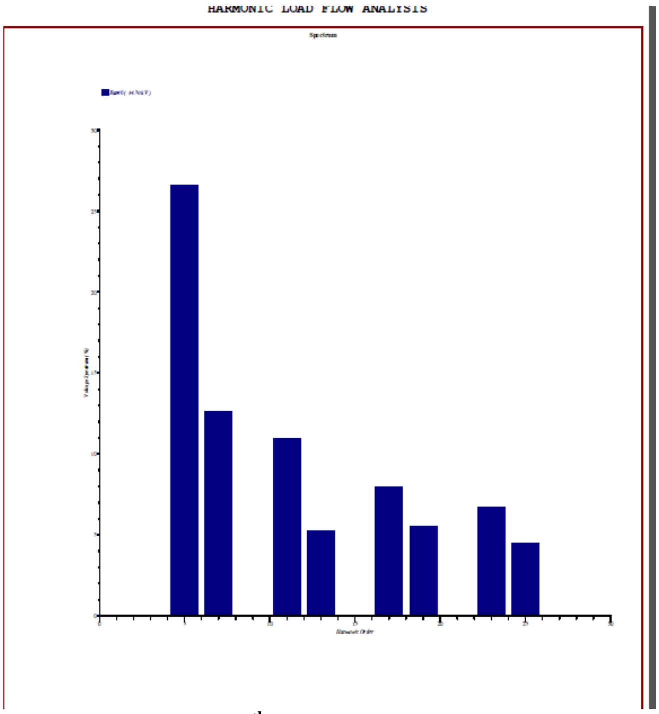


Fig: 5th order harmonics

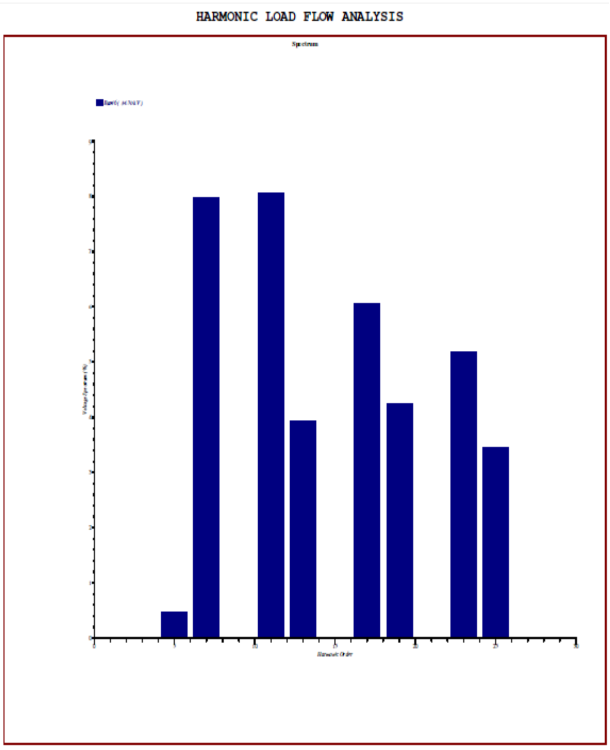
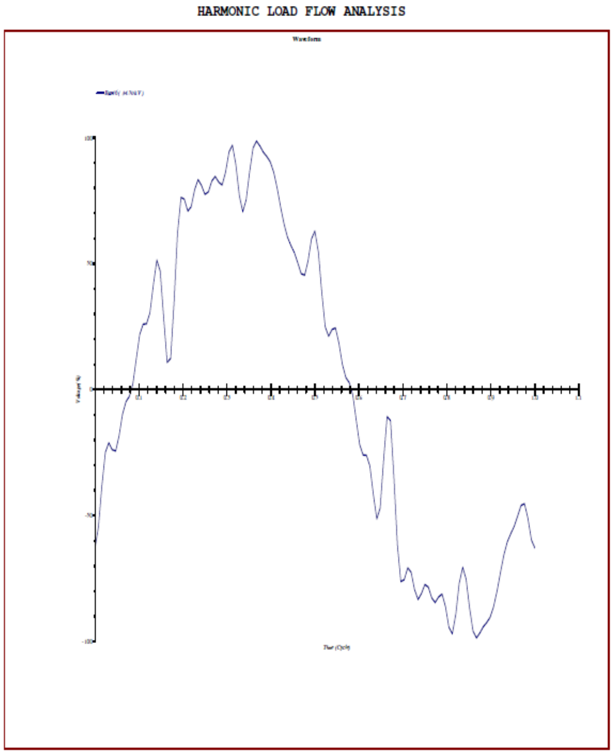
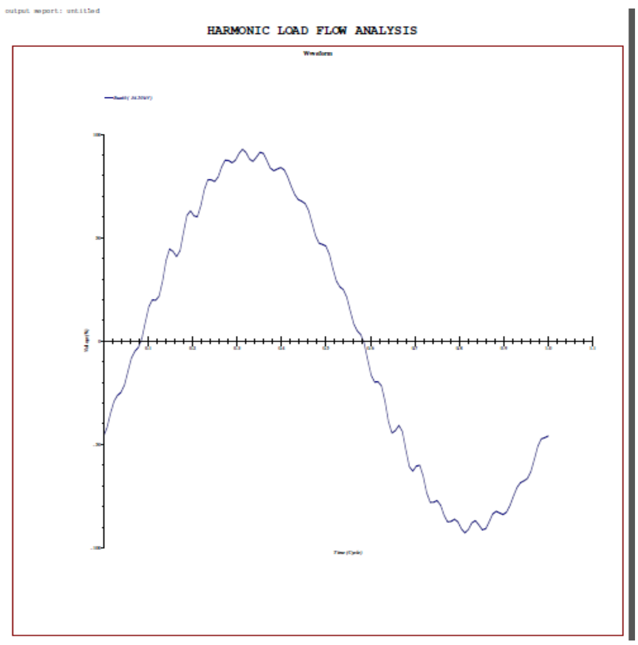


Fig: Reduced 5th order harmonics



Graphical Representation



IV. CONCULSION

In this paper Load Flow study using ETAP software is carried out with an approach to overcome the problem of harmonics and to increase the flexibility of the system. Load Flow Studies using ETAP software is an excellent tool for system planning. A number of operating procedures can be analyzed such as the loss of generator, a transmission line, a transformer or a load. Load flow studies can be used to determine the optimum size and location of capacitors to surmount the problem of an under voltage. Also, they are useful in determining the system voltages under conditions of suddenly applied or disconnected loads. Load flow studies determine if system voltages remain within specified limits under various contingency conditions, and whether equipment such as transformers and conductors are overloaded. Load-flow studies are often used to identify the need for additional generation, capacitive, or inductive VAR support, or the placement of capacitors and/or reactors to maintain system voltages within specified limits.

REFERENCES:

[1]Rohit Kapahi, Load Flow Analysis of 132 Kv substation using ETAP Software, International Journal of Scientific & Engineering Research Volume 4, Issue 2, February-2013 , ISSN 2229-5518

[2]Aswani R, Sakthivel R, Power Flow Analysis of 110/11KV Substation Using ETAP, International Journal of Applied Research and Studies (iJARS) ISSN: 2278-9480 Volume 3, Issue 1 (Jan - 2014)

[3] Swaroop kumar. Nallagalva, Mukesh Kumar Kirar, Dr.Ganga Agnihotri Department of Electrical Engineering, MANIT Bhopal, Transient Stability Analysis of the IEEE 9-Bus Electric Power
System, International Journal of Scientific Engineering and Technology (ISSN : 2277-1581)

Authors:

Vancha Abhilash, M.Tech (power system) Amity University, Noida

Kamlesh pandey M.Tech (power system) Asst. Prof Amity University, Noida.