AUGMENTATION OF POWER DISTRIBUTION PLANT

Major Project Report

(Part-II)

Submitted in Partial Fulfillment of the Requirements for Semester-IV of

MASTER OF TECHNOLOGY

IN

ELECTRICAL ENGINEERING
(Electrical Power Systems)

By

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Certificate

This is to certify that the Major Project Report (Part-II) entitled “”AUGMENTATION OF POWER DISTRIBUTION PLANT” submitted by **Mr. Dhruv K Kapadia (Roll No:15MEEE10)** towards the partial fulfillment of the requirements for Semester-IV of Master of Technology (Electrical Engineering) in the field of Electrical Power Systems of Nirma University is the record of work carried out by him under our supervision and guidance. The work submitted has in our opinion reached a level required for being accepted for examination. The results embodied in this major project work to the best of our knowledge have not been submitted to any other University or Institution for award of any degree or diploma.

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I, Dhruv K. Kapadia (Roll No. 15MEEE10), give undertaking that the Major Project entitled "Augmentation of Power Distribution Plant" submitted by me, towards the partial fulfillment of the requirements for the degree of Master of Technology in Electrical Engineering (Electrical Power Systems) of Nirma University, Ahmedabad, is the original work carried out by me and I give assurance that no attempt of plagiarism has been made. I understand that in the event of any similarity found subsequently with any published work or any dissertation work elsewhere; it will result in severe disciplinary action.

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Abstract

Power-flow or load-flow studies are very helpful for the designing and the future expansion of power systems.Also it is very helpful for getting the best output for the operation of existing systems. It is also having to find out the set of voltages: magnitude and angle, network impedances,that creates the load flows thay are known as the exact at the system terminals. So, this theory is useful to augmentation of power distribution network of Petronet LNG plant. It is planned to expand terminal capacity from existing 10 MMTPA to 15 MMTPA (Phase-3A) and further up to 17.5 MMTPA (Phase-3B). There are two option for augmentation of power distribution system. Addition of two nos. of transformers are needed to supply further power requirement. Study for augmentation of two no. of grid transformers of 40 MVA 220/11kV or 220/33kV of suitable rating as pr load details provided by PLL. Selection and percentage impedance and calculation to be selected so that fault level of the existing system does not increase. Rating to be selected for transformer is 40 MVA, 220kV. The secondary voltage selection will be the recommendation based on study.

Abbreviation

GERC .... Gujarat Electricity Regulatory Commission
MMTPA .... Million metric tons per annum
GETCO .... Gujarat Energy Transmission Corporation Ltd.
LFA .... Load flow analysis
DG .... Distributed Generation
NR .... Newton Raphson
FDLF .... Fast De-Coupled Load Flow
GTG .... Gas Turbine Generator
GS .... Gauss Seidal

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Chapter 1

Introduction

1.1 Background

Petronet Terminals Petronet LNG Limited, one of the quickest developing world-class organizations in the Indian vitality division, has set up the nation's 1st LNG regasication terminal at Dahej, Gujarat, and second terminal at Kochi, Kerala. Petronet LNG is at the bleeding edge of India's hard and fast national drive to guarantee the nation's vitality security in the years to come.

Petronet LNG has established its first LNG plant in Dahej, Gujarat, which having capacity around 10 million metric tones per annum and its capacity will be expand around 15 miilions metric tons per annum and the total operating capacity wiil be expanded upto 25 millions metric tons per annum soon.

Petronet LNG has decided to expand the terminal capacity from 10MMPTA to 15MMPTA and later upto 17 MMPTA.Exitsing system power requirement is about 24 MW but after the expansion of the existing system the power requirement will reach upto 50 MW.The system is having 3 phases such as Phase-1,Phase-2 and Phase 3A and their ratings are respectively 10MW,12MW and 14MW and this combines system is calles as the Existing phase.

220 KV supply which is coming from the GETCO Substation for the power requirement and additionally 5 GTGs are also available for the other power prerequisites.

Typical method is to run the power grid in parallel with the gas turbine generator as per the power requirement scenario.21 MVA grid supply is sufficient enough for power prerequisite of the system.There are 2 grid transformers which having rating of 21 MVA on load tap changer transformer also available for the power requirement of other purposes.

The progression down the voltage from 220 kv to 11 kv for the system purpose.There are 5 GTGs having rating of 11kv and all the GTGs are connected with the 11kv grid.Now we need a sufficient power for another development of the plant about 10 MMPTA to 15MMPTA which is called as the Phase-3B.

Adding two new transformers for the expansion of the power distribution system.We have 2 options for the arrangement of the transformers. To begin with choice is proposed to enlarge two no. of network transformer of 40 MVA, 220/11kV with on rated tap changer in the current switchyard. In second choice to exapnd 2 no. of grid transformer rated of 40 MVA , 220/33kV voltage level with on load tap changer is also provided in the system.

Voltage stability is the one of the most important part for the expansion of the any distribution system.There are some issues occurred in the power system due to the voltage instability so it is very important to calculate the voltage stability of the system with good efficiency and precision so the main purpose of the project is to analyse the voltage stability so we can find out the weakest bus of the system which may increase the instability of the system ,which may going to the total voltage collapse and damage the system so we have to use the necessary compensatory action at the proper time to utilize the system

1.2 Objectives

- The principle purpose of this theory is to outline the extra power distribution arrangement of petronet LNG, so sufficient power wiil be available for the proposed 3B existing system.
- It is very important to study the existing system,so design of the new power distribution system can be easy.
- In the following part is to configuration phase 3B and develope the new dispersion system,which is based on two different stategies such as including two transformers parallel with the existing transformers.
- The entire electrical analysis are donr in the ETAP software.Some other methods are also available such as NR method, GS method etc. On the basis of literature survey it is easy to figure out which method is better.
- At the final, it is very important to learn the switchyard design,GETCO specification,GERC regulation etc. for designing 220/11 kv switchyard.
- And at the final,to examine the newly designed distribution system in both choices.After that on the basis of the comparision of the both options it is very easy to figure out more ideal and profitable options.

1.3 Project Planning

Fig. 1.1 delineates whole stream of project design.At the beginning the whole arrangement is review on the bases of load flow analysis,voltage stability analysis and learning of ETAP software. Number of research papers are accessible in the litareture,on the basis of that some of the essential research papers are examined.

On the basis of the literature survey and after surveying some good papers,it is easy to figure out the problems in the reseach proposition.Then,title of the project has been decided.The project work is devide into 3 phase.

After study of theoretical concept, in phase-1, to design of phase-1 of existing and it is simulated in Etap software. In phase-2, phase-2 & phase-3A is simulated in Etap software. Than total existing system is simulated in Etap. Load flow analysis and fault analysis is analyzed in Etap software. Voltage levels are taken as load flow result for further study.

In phase-3, to design phase-3B and simulate phase-3B in Etap software. Than designing of new power distribution system in two option by addition of two new transformer in parallel with existing transformers. Load flow & fault analysis is taken for both option in Etap software.

In last phase, To study of switchyard design, GETCO specification, GERC regulations etc. And design the 220/11 kV switchyard in Auto-CAD software. comparison of analysis result for both options is giving the justification that which is the best option for new power distribution system.

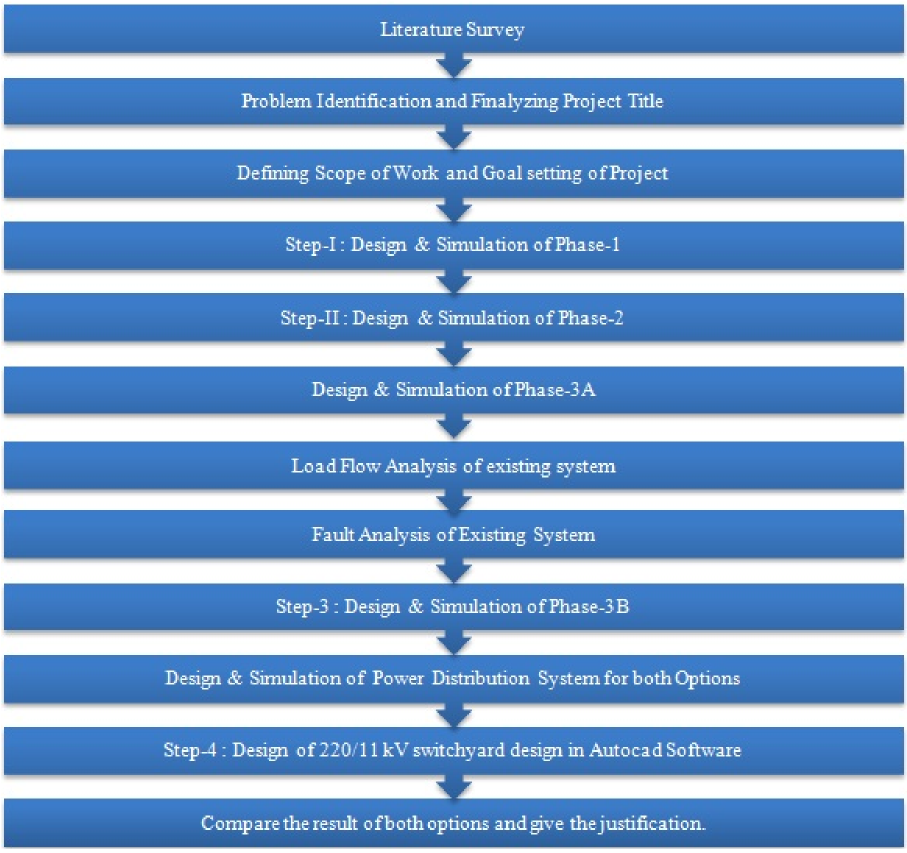

Figure 1.1: Project Planning

1.4 Literature Survey

1.**Arockiya Xavier Prabhu, Sudhanshu Sharma, M.Nataraj, DivyaPrakash Tripathi** in Design of Electrical System Based On Load Flow Analysis Using ETAP For IEC Projects, J.4-6 March 2016 IEEE 6th International Conference on Power Systems (ICPS)",

- This paper gives the information about the load flow analysis using ETAP for IEC projects and helpful to determine the parameters of electrical equipment on the basis ETAP result. It is the essentia examination for the elctrical power system designing. It talks about the input value for the designin of the electrical system, qualities to be expected if information doesnt accessible,satisfactory value of the load flow and stategies to be taken for accomplish result.

2.**C.J.Soni, P.R.Gandhi, S.M.Takalkar** in DESIGN AND ANALYSIS OF 11 KV DISTRIBUTION SYSTEM USING ETAP SOFTWARE, 22-23 April,2015 International conference on computation of power, Energy Information and communication(ICCPEIC)",

- This paper presents the design and loss optimization of distribution system. Here Urban power network is considered and 11kV feeder is designed and losses are calculated. Feeder bifurcation and re-conductoring techniques are adopted for loss optimization of distribution network. ETAP software is used for analysis of the distribution system. The cost benefit analysis of the feeder bifurcation and re-conductoring of the 11kV distribution network is also carried out.

3.**Brian stott** in Review of Load-Flow Calculation Methods, 28 June,2005 Proceedings of the IEEE (Volume: 62, Issue:7, July 1974)",

- This paper gives a survey. A survey is presented on currently available numerical techniques of power system load flow calculation using digital computer. The review deals with methods that have received widespread practical application, recent attractive developments and other methods that have interesting or useful characteristics.The analytical bases, computational requirements and comparative numerical performances of the methods are discussed. Attention is given to the problems and techniques of adjustments in load flow solutions and the suitability of various methods for modern applications such as security monitoring and optimal load flow are examined.

4. **Colin Bayliss and Brian Hardy** in " SUBSTATION LAYOUTS, , Ch-3 in Transmission and Distribution Electrical Engineering",

paper gives a survey. A survey is presented on currently available numerical techniques of power system load flow calculation using digital computer. The review deals with methods that have received widespread practical application, recent attractive developments and other methods that have interesting or useful characteristics.The analytical bases, computational requirements and comparative numerical performances of the methods are discussed. Attention is given to the problems and techniques of adjustments in load flow solutions and the suitability of various methods for modern applications such as security monitoring and optimal load flow are examined.

5.**S. Chakrabarti** in Notes on power system voltage stability,

- The objectives of this literature are to give basic introduction of voltage stability andclassification of voltage stability. Different method exits for carrying out steady statevoltage stability analysis. Different techniques for analysis of voltage stability are alsoexplained. It nicely explains voltage stability analysis of ten bus test system withdifferent loading conditions. It also gives explanation of continuation power flow (CPF) method by which the power flow solution can be obtained near or at the voltage collapse.

6. **P. Kundur, John Paserba, VenkatAjjarapu** in " Definition and Classification of power system stability, IEEE Transaction on power system, Vol. 19, No.2 May 2004",

- This paper aims to define power system stability more precisely establish a systematicbasis for its classification, and discuss linkage to associated issues such as power systemreliability and security. The index terms of frequency stability, oscillatory stability, powersystem stability, and voltage stability are explained.

Chapter 2

Basics of Load Flow Study and Fault Analysis

2.1 Power flow study

In power engineering, the power-flow study is a numerical analysis of the flow of electric power in an interconnected system. A power-stream think about for the most part uses streamlined documentation, for example, a one-line diagram and p.u. system, and concentrates on different parts of AC power parameters, for example, voltages, voltage angle, active power and reactive power,that study power systems in normal steady-state operation.

Power flow or load-flow studies are imperative for arranging future development of force frameworks and also in deciding the best operation of existing frameworks. The vital data got from the power-stream study is the magnitude and phase angle of the voltage at each bus, and the active and reactive power streaming in each line.

Notwithstanding a power-stream think about, PC programs perform related computations, for example, Short circuit fault, unit commitment and economic dispatch. Specifically, a few projects utilize direct programming to locate the ideal power stream, the conditions, which give the most minimal cost per kilowatt-hour conveyed.

A load flow study is particularly important for a framework with numerous load focuses, for example, a refinery complex.It is an investigation of the framework's ability to sufficiently supply the connected loss.

Transformer tap positions are chosen to guarantee the right voltage at basic areas. Playing out a load flow contemplate on a current system gives understanding and suggestions with regards to the framework operation and improvement of control settings to get greatest limit while limiting the working expenses.

The output of such an examination are as far as real power, reactive power, magnitude and phase angle. Moreover, power flow calculations are vital for ideal operations of gatherings of producing units.

2.2 Model

An AC power-flow model is a model utilized as a part of electrical building to break down power networks. It gives a nonlinear system, which depicts the energy move through every transmission line. The issue is non-linear in light of the fact that the power stream into load impedances is an element of the square of the connected voltages. Because of nonlinearity, as a rule the examination of extensive system by means of AC power-stream model is not possible, and a direct (but rather less precise) DC power-flow model is utilized.

Normally investigation of a three-phase system is rearranged by accepting balanced loading of every one of the three phases. steady state operation is accepted, with no transient changes in power flow or voltage because of load or era changes. The framework recurrence is additionally thought to be steady. A further rearrangements is to utilize the p.u. systemt speak to all voltages and impedances, scaling the genuine target framework qualities to some advantageous base. A framework one-line chart is the premise to fabricate a numerical model of the generators, burdens, transports, and transmission lines of the system, and their electrical impedances and ratings.

2.3 Power-flow problem Formulation

The objective of a power-flow study is to get finish voltages angle and magnitude data for every bus in a power system for indicated load and generator genuine power and voltage conditions. After we get this data, active and reactive power stream on each branch and in addition generator reactive power yield can be scientifically decided. Because of the nonlinear nature , numerical strategies are utilized to acquire an answer that is inside a worthy resilience.

The answer for the issue starts with recognizing the known and unknown factors in the system. These factors are subject to the sort of bus. A bus doesnot have any generator which is known as a Load Bus. In special case, a transport which has generator more than one associated is called as a Generator Bus. The special case is one subjectively chose transport that has a generator. It is called as the slack bus.

In the power-flow problem, it is assumed that the real power PD and reactive power QD at each Load Bus are known.Therefore, Load Busses are likewise called as PQ Busses. For Generator Buses, its expected that the real power generated PG and the voltage magnitude $| V |$ is known. For the Slack Bus, it is assumed that the voltage magnitude $| V |$ and voltage phase are known. Therefore, for each Load Bus, both the voltage magnitude and angle are unknown and must be solved for; for each Generator Bus, the voltage angle must be solved for; there are no variables that must be solved for the Slack Bus. In a system with N buses and R generators, there are then 2(N-1)-(R-1) unknowns.

In order to solve for the 2(N-1)-(R-1) unknowns, there must be 2(N-1)-(R-1)equations that do not introduce any new unknown variables. The possible equations to use are power balance equations, which can be written for real and reactive power for each bus. The real power balance equation is:

$$0 = -P_i + \sum_{k=1}^{n} | V_i| \, | V_i| \, (G_{ik} \cos\theta_{ik} + B_{ik} \sin\theta_{ik})$$

$$0 = -Q_i + \sum_{k=1}^{n} | V_i| \, | V_i| \, (G_{ik} \sin\theta_{ik} - B_{ik} \cos\theta_{ik})$$

where, P_i is net active power and Q_i is the net reactive power injected at bus i.

Equations contained real and reactive power adjust conditions for each Load Bus and the genuine power adjust condition for every Generator Bus. The fact that the net responsive power infused is thought to be obscure and thusly including the reactive power adjust condition would bring about an extra obscure variable so Just the genuine power adjust condition is composed for a Generator Bus.For the same,equations are not written for the slack bus.

Mainly the voltage angles ik are typically moderately little for the numerous transmission system.so there is powerful conecton between the real power and voltage angle, and reactive power and voltage magnitude and its feeble.

Accordingly,real power transport from higher voltage bus to lower voltage angle, and reactiv epower transport from high voltage to low voltage transport.In some case,this estimation is not working when voltage angle is vast.

There are several methods to solve load flow problems i.e., NR method, GS method, etc.

2.3.1 Newton-Raphson (NR) Method

Newton-Raphson is one of the most prominent method.This strategy starts with introductory conjectures of every single obscure variable .

2.3.2 Gauss-Siedal (GS) Method:

It is the soonest conceived strategy.That indicates slowe speed of merging contrasted with other iterative strategies, yet that utilizes almost no memory.

2.4 Fault:

In an electric power system, a fault current is any abnormal electric current. For e.g,in short circuit usually current pass through a normal load.If failure occurs in the circuit than open circuit fault may happen. In three-phase systems, a fault may include at least one stages and ground, or may happen just between phases.

In a "ground fault" or "earth fault", current streams into the earth. The forthcoming s.c. current of an anticipated fault can be figured for generally circumstances. In power systems, protective devices can identify faulty conditions and open C.B. and different protective devices to reduce the loss of system . In a polyphase system, if a fault effect different phases in a same way which is called as a "symmetrical fault".

The output assymmetrical fault is becoming very complexed to study if some of the phases effects.With the help of the symmetrical components these types of the fault can be analyzed. The design of systems to detect and interrupt power system faults is the main objective of power-system protection.

2.5 Fault Analysis:

Symmetric faults can be studied by strategies which are used in power systems, and in actuality numerous product instruments exist to finish this sort of examination consequently. Be that as it may, there is another strategy which is as exact and is normally more informative.

To begin with, some assumptions are made. It is accepted that every single electrical generator in the systems are in phase, and operates at the normal voltage. Electric motors can likewise be thought to be generators, since when a fault happens, they more often than not supply as opposed to draw power. After that ,voltages and currents calculated for the case.

Next, the location of the fault is thought to be provided with a negative voltage source, equivalent to the voltage at that area in the base case, while every other source are set to zero. This strategy makes utilization of the guideline of superposition.Study of the imminent S.C. current is required for determination of protective devices, for example, fuse and circuit breakers.

If a circuit is to be appropriately ensured, the fault current must be sufficiently high to work the protective device inside as short a period as could be expected under the circumstances; likewise it must have the capacity to withstand the fault current and stifle any subsequent curves without itself being annihilated or managing the arc for any huge time allotment.

Chapter 3

Voltage Stability:

3.1 Introduction:

Anytime of time, a power system working condition has to be steady, meeting different operational criteria. Voltage instability is given much consideration by power system analysts and organizers as of late, and it is viewed as one of the significant part.

Voltage instability is the phenomena in which the receiving end voltage goes down from its original value value and doesnt come to its original value even after restoring mechanisms such as VAR compensators, or keeps on swaying for absence of damping against the unsettling influences.

In the Voltage collapse the voltage value goes down, unsatisfactory incentive therefore of a torrential slide of occasions going with voltage insecurity.Once connected with weak system and long lines, voltage issues are currently additionally a wellspring of worry in very created organizes subsequently of heavier stacking.

3.2 Factors Affecting Voltage Stability:

The factors which affect the voltage stability are given as follows:

3.2.1 Synchronous generators :

They are the essential devices for voltage and reactive power control in power systems. As per power system security the most vital reactive power stores are situated there. In voltage stability concentrates real and reactive power ability of generators is expected to consider precisely accomplishing the best outcomes.

The active power points of confinement are because of the outline of the turbine and the boiler.Its limits are consistent. Responsive power cutoff points are more confounded, which have a round shape and are voltage subordinate. Typically reactive power cutoff points are portrayed as consistent breaking points in the load flow programs. The voltage reliance of generator reactive power points of confinement is, be that as it may, an imperative perspective in voltage dependability examines..

3.2.2 Automatic Voltage Control of Synchronous Generator:

It is critical for voltage stability to have enough nodes where voltage might be kept consistent. The automatic voltage controllers of synchronous generators are the most vital for it. The activity of voltage controllers is sufficiently quick to keep voltage steady when generators are worked. It incorporates additionally the excitation current limiters and now and again likewise the stator current limiter.

3.2.3 On-Load Tap Changer:

The automatic voltage control of power transformers is arranged with on-load tap changers. At the point when voltage reduceses in the distribution system, the load additionally reduces. The tap changer works after time delay if voltage blunder is sufficiently expansive reestablishing the load. The activity of an on-load tap changer may be hazardous for a power system under unsettling influence. The stepping down of the tap changer builds the voltage in a circulation organize; along these lines reactive power exchange increments from the transmission system to the distribution nwtwork.

The customized voltage control of constrain transformers is engineered with on-load tap changers. Exactly when voltage reduces in the transport system, the load also decreases. The tap changer works after time delay if voltage botch is adequately broad restoring the pile. The action of an on-load tap changer might be dangerous for a power system under unsettling impact. The wandering down of the tap changer manufactures the voltage in a course sort out; thusly responsive power trade increases from the transmission framework to the transport mastermind.

In spite of the fact that heating loads are resistive, the thermostats increment the measure of load if the decrement of load voltage is sufficiently long. The time constants of thermostatic burdens are high, which makes it moderate.

3.3 Compensation devices:

3.3.1 Shunt reactors:

Shunt reactors are utilized to adjust for the impacts of line capacitance, especially to cutoff points voltage ascend on open circuit or light load. A shorter overhead line may likewise require reactor if it is provided from a week system. A shunt reactor of adequate size must be associated with the line to farthest point fundamental frequency temporary overvoltage to around 1.5 pu for a span of under 1 second.

Such lineconnected reactor likewise serves to breaking point stimulation overvoltage. At heavy loading conditions a portion of the reactor may must be disengaged. This is accomplished by exchanging reactor utilizing C.B. Shunt reactor are comparative in development to transformer, however have a single winding on an iron center with air-gaps and submerged in oil. They might be of either single phase or three phase development.

3.3.2 Shunt capacitor:

Shunt capacitor supply reactive power and lift local voltage. They are utilized all through the system and are connected in an extensive variety of sizes. The most imperative favorable position of shunt capacitor is that their responsive power yield is corresponding to the square of the voltage. Thus, the reactive power output is lessened at low voltage when it is probably going to be required most.

3.3.3 Series capacitors:

Series capacitors are associated in arrangement with the line conductor to adjust for the inductive reactance of the line. This diminishes the exchange reactance between the buses to which the line is associated, builds most extreme power that can be transmitted, and lessens the compelling reactive power loss. Despite the fact that they are not more often than not for voltage control in that capacity, they do add to enhanced voltage control and reactive power adjust. The reactive power delivered by an series capacitor increment with expanding power exchange: it is automatic in such manner.

3.3.4 Synchronous condensers:

A synchronous condenser is a synchronous machine running without a prime mover or a mechanical load. By controlling the field excitation, it can be made to either create or assimilate responsive power. With a voltage controller, it can naturally alter the reactive power output to keep up consistent terminal voltage. It draws a little measure of dynamic power from the power system to supply loss.

They are regularly associated with the tertiary winding of transformer. Synchronous condensers have various type of compensation over static compensator. They add to system short circuit capacity. Their reactive power generation is not influenced by the system voltage. Some ignition turbine topping units can be worked as synchronous condenser if needed.

Chapter 4

Application of load Flow Study

4.1 Step for simulation of Existing system in ETAP software:

- Take data of Petronet LNG plant, Dahej i.e., soft copy of single line diagram of existing system, bus data, transmission line data, motor data, generator, transformer, cable data etc. for input. First is to design of phase-1 of existing system in ETAP software from single line diagram.
- Simulate phase-1 & remove all error.
- Second is to design of phase-2 of existing system in ETAP software from single line diagram.
- Simulate phase-2 & remove all error.
- Third is to design of phase-3A of existing system in ETAP software from single line diagram.
- Simulate phase-3A & remove all error.
- Than create Existing phase by connecting three phases, generators, transformer, grid etc. as per data given by PLL to built power distribution system of existing system.
- Simulate phase-3B & remove all error.
- Than create a new system by connecting phase-3B with Existing phase.
- Simulate load flow analysis of new system.

4.2 Simulation of New Phase:

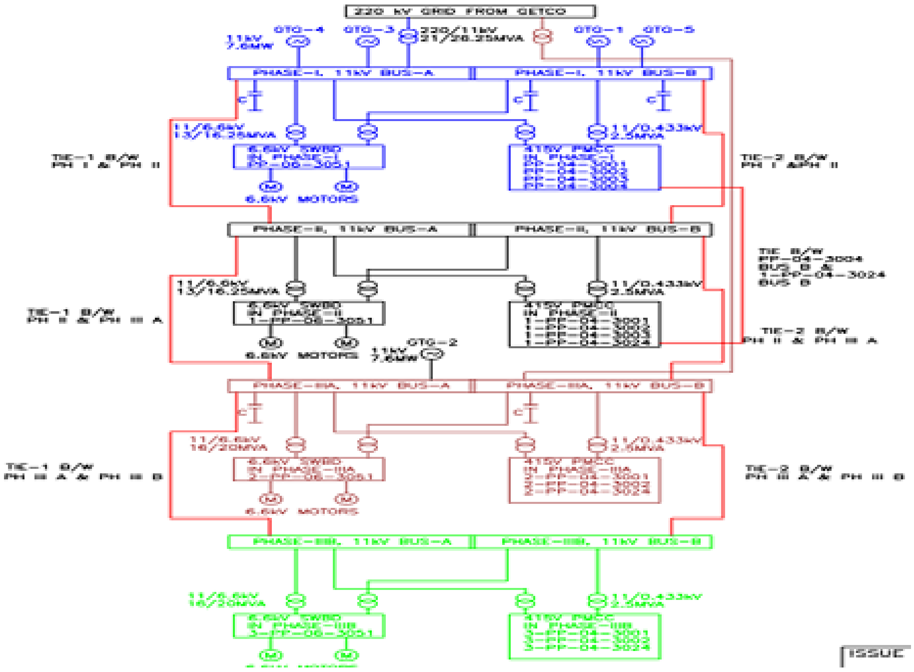

Figure 4.1: Schematic diagram of existing system

4.3 Analysis of New phase of Petronet LNG plant in ETAP software:

Load flow analysis of existing system is carried out using ETAP software. First we put all bus data, line data, generator data, and transformer data in simulated figure. Initially we take base value of system parameter in normal condition then observe the all simulated results. After simulation, we can find out the voltage loading, MW loading, MVAR loading, transformer loading etc. in running condition. All the simulation results of power flow and line flow results are tabulated below.

4.3.1 General Information of new system (Option 1):

Table I: General Information of system:

General Information	
Buses	345
Branches	353
Generator	2
Power Grids	2
Loads	680

4.3.2 Total Loading of system(option 1):

Table II: Total Loading of system

Total Loading	
Load- MW	69.543
Load-Mvar	-39.599
Generation-MW	69.543
Generation-Mvar	-39.599
Loss-MW	0.639
Loss-Mvar	-49.246

4.3.3 Sources of the system(opton 1):

Table III: Sources of new system

ID	Rating	Rated kV	MW	Mvar	Amp
GI-102	7.6 MW	11	7	4.338	419.8
GI-103	7.6 MW	11	7	4.338	419.8
Line-1 ONGC	15241 MW	220	27.778	-24.152	96.6
Line-2 DAHEJ	15241 MW	220	27.765	-24.124	96.52

4.3.4 Bus Loading of Phase-1 in New system:

Table IV: Bus Loading of Phase-1 in the system

Bus ID	Nominal kv	MW Loading	Mvar Loading	Amp Loading
BS-04-1A	0.433	0.967	0.462	1440
BS-04-1B	0.433	0.685	0.335	1019
BS-04-2A	0.433	0.933	0.456	1400
BS-04-2B	0.433	0.764	0.38	1142
BS-04-3A	0.433	0.595	0.303	893.3
BS-04-3B	0.433	0.595	0.303	893.3
BS-03-4A	0.433	0.01	0.007	15.99
BS-04-4B	0.433	0.826	0.408	1234
BS-04-5A	0.433	0.197	0.1	298.5
BS-04-5B	0.433	0.197	0.1	297.1
BS-04-6A	0.433	0.134	0.075	206.9
BS-04-6B	0.433	0.148	0.081	225.9
BS-04-7A	0.433	0.197	0.1	299.7
BS-04-7B	0.433	0.197	0.1	297.6
BS-04-8A	0.433	0.197	0.1	299.7
BS-04-8B	0.433	0.197	0.1	297.6
BS-04-9A	0.433	0.197	0.1	299.9
BS-04-9B	0.433	0.197	0.1	297.8
BS-04-10A	0.433	0.197	0.1	297.8
BS-04-10B	0.433	0.197	0.1	297.8
BS-04-11A	0.433	0.197	0.1	297.5
BS-04-11B	0.433	0.197	0.1	297.5
BS-04-12A	0.433	0.197	0.1	298
BS-04-12B	0.433	0.197	0.1	298
BS-04-13	0.433	0.826	0.408	1234
BS-04-14	0.433	0	0	0
BS-06-1A	6.9	7.776	3.2	699.3
BS-06-1B	6.9	8.021	3.297	721.8
BS-11-1A	11.5	19.238	14.641	1232
BS-11-1B	11.5	13.07	12.33	915.9
BS-11-2A	11.5	8.92	6.722	569.3
BS-11-2B	11.5	14.473	7.075	821.2
BS-22-01	220	27.778	24.152	96.6
BS-22-02	220	27.765	241.24	56.45
BS-22-3A	220	10.321	11.675	40.93
BS-22-3B	220	10.513	14.78	47.64

4.3.5 Bus Loading of Phase-2 in New system:

Table V: Bus Loading of Phase-2 in the system

Bus ID	Nominal kV	MW loading	Mvar loading	Amp loading
1-BS-04-1A	0.433	0.275	0.154	418
1-BS-04-1B	0.433	0.519	0.561	1005
1-BS-04-2A	0.433	1.028	0.467	1485
1-BS-04-2B	0.433	0.998	0.454	1442
1-BS-04-3A	0.433	0.808	0.413	1190
1-BS-04-3B	0.433	0.801	0.41	1181
1-BS-04-4A	0.433	0.197	0.178	352.2
1-BS-04-4B	0.433	0.258	0.278	502.5
1-BS-04-5A	0.433	0.197	0.178	352.2
1-BS-04-5B	0.433	0.258	0.278	502.5
1-BS-04-6A	0.433	0.204	0.103	301.7
1-BS-04-6B	0.433	0.204	0.103	301.1
1-BS-04-7A	0.433	0.203	0.103	301.5
1-BS-04-7B	0.433	0.197	0.1	292.9
1-BS-04-8A	0.433	0.197	0.1	293.4
1-BS-04-8B	0.433	0.197	0.1	293.4
1-BS-04-9A	0.433	0.197	0.1	293.7
1-BS-04-9B	0.433	0.197	0.1	293.6
1-BS-04-10A	0.433	0.236	0.12	349.9
1-BS-04-10B	0.433	0.216	0.11	320.5
1-BS-06-1A	6.9	4.49	1.896	401.3
1-BS-06-1B	6.9	6.06	2.472	541.2
1-BS-11-1A	11.5	6.618	2.969	369.7
1-BS-11-1B	11.5	8.403	4.218	479.3

4.3.6 Bus Loading of Phase-3A in New system:

Table VI: Bus Loading of Phase-3A in the system

Bus ID	Nominal kV	MW Loading	Mvar Loading	Amp. Loading
2-BS-04-1A	0.433	0.815	0.41	1197
2-BS-04-1B	0.433	0.801	0.401	1176
2-BS-04-2A	0.433	0.374	0.189	554.3
2-BS-04-2B	0.433	0.36	0.182	533.3
2-BS-04-3A	0.433	0.784	0.394	1150
2-BS-04-3B	0.433	0.781	0.392	1146
2-BS-04-4A	0.433	0.356	0.178	526.4
2-BS-04-4B	0.433	0.355	0.178	524.9
2-BS-04-5A	0.433	0.355	0.178	526
2-BS-04-5B	0.433	0.355	0.178	526
2-BS-04-6A	0.433	0.422	0.208	623.8
2-BS-04-6B	0.433	0.421	0.207	620.6
2-BS-04-7A	0.433	0.407	0.204	608.2
2-BS-04-7B	0.433	0.407	0.204	596.8
2-BS-06-1A	6.9	8.09	3.323	724.9
2-BS-06-1B	6.9	7.649	3.149	684.3
2-BS-11-1A	11.5	10.129	11.007	762.5
2-BS-11-1B	11.5	26.438	19.402	1672

4.3.7 Bus Loading of Phase-3B in New system:

Table VII: Bus Loading of Phase-3B in the system

Bus ID	Nominal kV	MW Loading	Mvar Loading	Amp. Loading
3-BS-04-1A	0.433	1.121	0.645	1197
3-BS-04-1B	0.433	0.79	0.402	1176
3-BS-04-2A	0.433	0.197	0.1	554.3
3-BS-04-2B	0.433	0.197	0.1	533.3
3-BS-04-3A	0.433	0.197	0.1	1150
3-BS-04-3B	0.433	0.197	0.1	1146
3-BS-04-4A	0.433	0.197	0.1	526.4
3-BS-04-4B	0.433	0.197	0.1	524.9
3-BS-04-5A	0.433	0.197	0.1	526
3-BS-04-5B	0.433	0.197	0.1	526
3-BS-04-6A	0.433	0.197	0.1	623.8
Bus1	0.433	0.873	0.452	620.6
Bus2-1	0.433	0.083	0.05	608.2
Bus7-1	0.433	0.239	0.126	596.8
Bus8-1	0.433	0.436	0.226	724.9
Bus9	0.433	0.436	0.226	684.3
Bus37-2	0.433	0.239	0.126	762.5

4.3.8 Voltage Profile at every bus in New system (option 1):

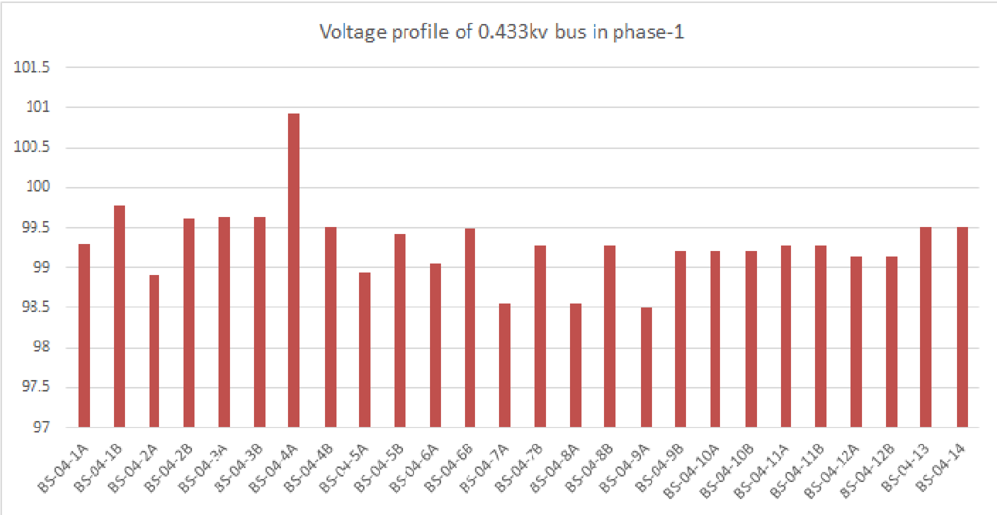

Figure 4.2: Voltage Profile of 433 rated voltage in phase-1 of the system

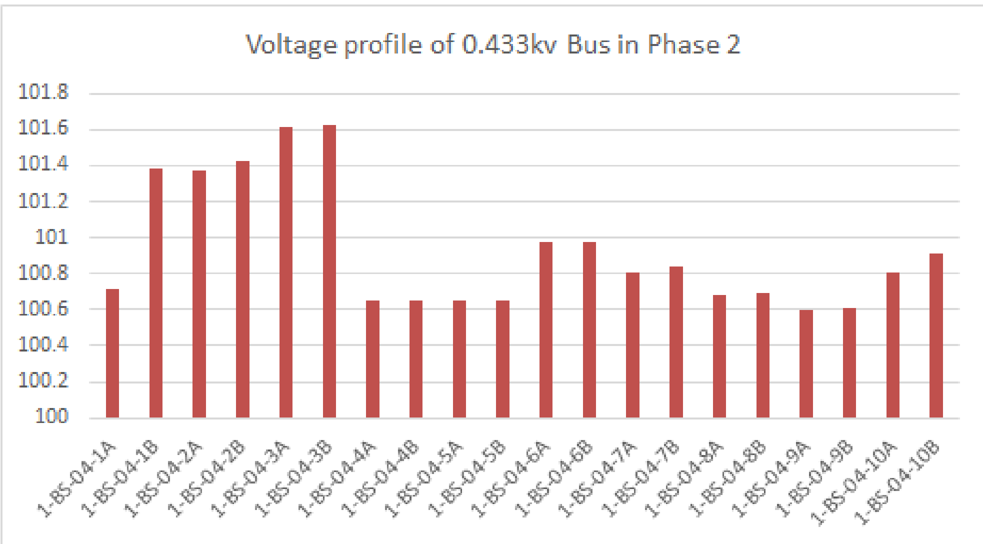

Figure 4.3: Voltage Profile of 433 rated voltage in phase-2 of the system

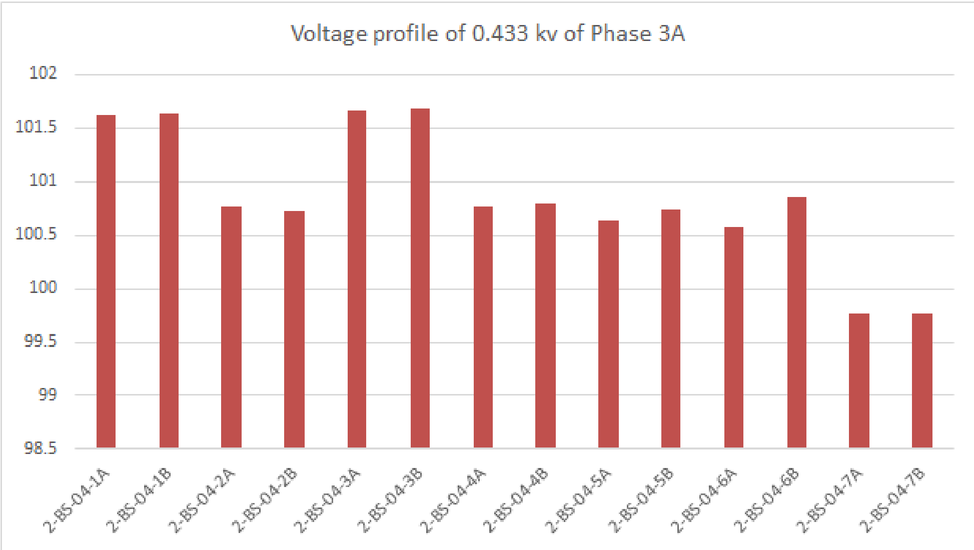

Figure 4.4: Voltage Profile of 433 rated voltage in phase-3A of the system

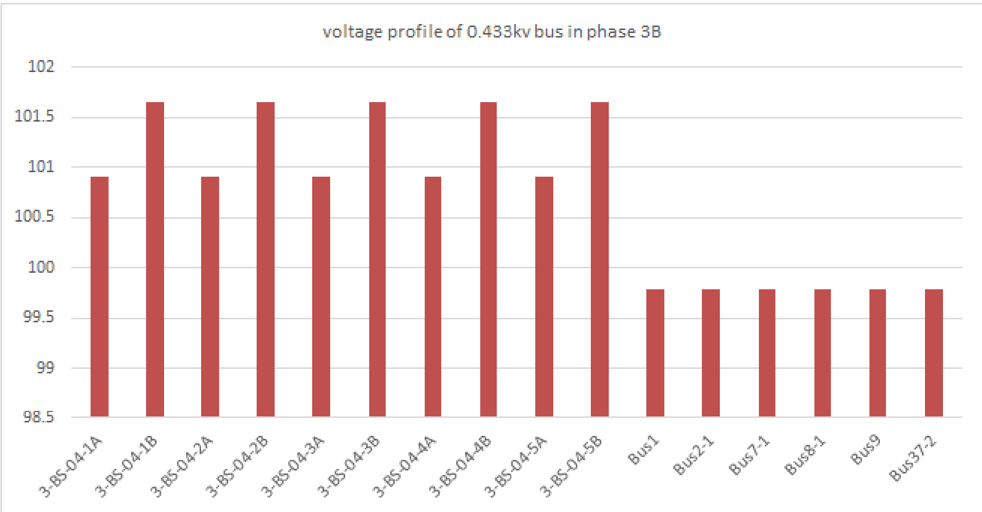

Figure 4.5: Voltage Profile of 433 rated voltage in phase-3B of the system

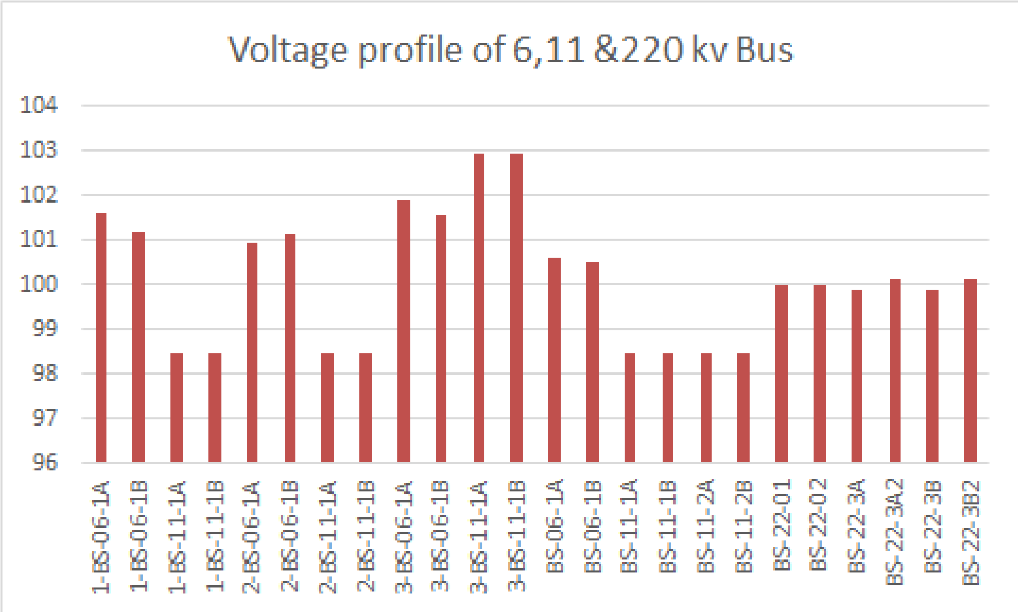

Figure 4.6: Voltage Profile of 6,11 220kv rated voltage in system

4.3.9 General Information of new system (Option 2):

Table VIII: General Information of the system:

General Information	
Buses	343
Branches	350
Generator	2
Power Grids	2
Loads	680

4.3.10 Total Loading of system(option 2):

Table IX: Total Loading of the system

Total Loading	
Load- MW	69.672
Load-Mvar	-7.704
Generation-MW	69.672
Generation-Mvar	-7.704
Loss-MW	0.776
Loss-Mvar	-17.448

4.3.11 Sources of the system(opton 2):

Table X: Sources of new system

ID	Rating	Rated kV	MW	Mvar	Amp
GI-102	7.6 MW	11	7	4.338	420.8
GI-103	7.6 MW	11	7	4.338	420.8
Line-1 ONGC	15241 MW	220	27.833	-8.227	76.17
Line-2 DAHEJ	15241 MW	220	27.839	-8.152	76.13

4.3.12 Bus Loading of Phase-1 in New system:

Table XI: Bus Loading of Phase-1 in the system

Bus ID	Nominal kv	MW Loading	Mvar Loading	Amp Loading
BS-04-1A	0.433	0.968	0.462	1440
BS-04-1B	0.433	0.685	0.335	1022
BS-04-2A	0.433	0.933	0.456	1404
BS-04-2B	0.433	0.764	0.38	1145
BS-04-3A	0.433	0.595	0.303	895.5
BS-04-3B	0.433	0.595	0.303	895.5
BS-03-4A	0.433	0.01	0.007	16.03
BS-04-4B	0.433	0.826	0.408	1237
BS-04-5A	0.433	0.197	0.1	299.3
BS-04-5B	0.433	0.197	0.1	297.9
BS-04-6A	0.433	0.134	0.075	207.4
BS-04-6B	0.433	0.148	0.081	226.5
BS-04-7A	0.433	0.197	0.1	300.5
BS-04-7B	0.433	0.197	0.1	298.3
BS-04-8A	0.433	0.197	0.1	300.5
BS-04-8B	0.433	0.197	0.1	298.3
BS-04-9A	0.433	0.197	0.1	300.7
BS-04-9B	0.433	0.197	0.1	298.5
BS-04-10A	0.433	0.197	0.1	298.5
BS-04-10B	0.433	0.197	0.1	298.5
BS-04-11A	0.433	0.197	0.1	298.3
BS-04-11B	0.433	0.197	0.1	298.3
BS-04-12A	0.433	0.197	0.1	298.7
BS-04-12B	0.433	0.197	0.1	298.7
BS-04-13	0.433	0.826	0.408	1232
BS-04-14	0.433	0	0	0
BS-06-1A	6.9	7.776	3.2	701.1
BS-06-1B	6.9	8.021	3.297	723.6
BS-11-1A	11.5	24.141	20.164	1607
BS-11-1B	11.5	10.929	19.572	1145
BS-11-2A	11.5	10.313	4.976	585.1
BS-11-2B	11.5	8.222	14.314	859.2
BS-22-01	220	27.833	8.277	76.17
BS-22-02	220	27.839	8.152	75.13
BS-22-3A	220	27.814	15.661	83.81
BS-22-3B	220	38.441	14.774	108.1

4.3.13 Bus Loading of Phase-2 in New system:

Table XII: Bus Loading of Phase-2 in the system

Bus ID	Nominal kV	MW loading	Mvar loading	Amp loading
1-BS-04-1A	0.433	0.276	0.153	418.6
1-BS-04-1B	0.433	0.518	0.559	1005
1-BS-04-2A	0.433	1.028	0.467	1489
1-BS-04-2B	0.433	0.998	0.454	1445
1-BS-04-3A	0.433	0.808	0.413	1193
1-BS-04-3B	0.433	0.801	0.41	1184
1-BS-04-4A	0.433	0.197	0.177	352.3
1-BS-04-4B	0.433	0.257	0.278	502.6
1-BS-04-5A	0.433	0.197	0.177	352.3
1-BS-04-5B	0.433	0.257	0.278	502.6
1-BS-04-6A	0.433	0.204	0.103	302.5
1-BS-04-6B	0.433	0.204	0.103	301.9
1-BS-04-7A	0.433	0.203	0.103	302.3
1-BS-04-7B	0.433	0.197	0.1	293.7
1-BS-04-8A	0.433	0.197	0.1	294.2
1-BS-04-8B	0.433	0.197	0.1	294.1
1-BS-04-9A	0.433	0.197	0.1	294.4
1-BS-04-9B	0.433	0.197	0.1	294.4
1-BS-04-10A	0.433	0.236	0.12	350.8
1-BS-04-10B	0.433	0.216	0.11	321.3
1-BS-06-1A	6.9	4.49	1.896	402.3
1-BS-06-1B	6.9	6.06	2.472	542.6
1-BS-11-1A	11.5	6.619	2.97	370.7
1-BS-11-1B	11.5	8.403	4.218	480.4

4.3.14 Bus Loading of Phase-3A in New system:

Table XIII: Bus Loading of Phase-3A in system

Bus ID	Nominal kV	MW Loading	Mvar Loading	Amp. Loading
2-BS-04-1A	0.433	0.815	0.41	1200
2-BS-04-1B	0.433	0.802	0.401	1179
2-BS-04-2A	0.433	0.374	0.189	555.8
2-BS-04-2B	0.433	0.36	0.182	534.8
2-BS-04-3A	0.433	0.786	0.394	1186
2-BS-04-3B	0.433	0.783	0.392	1180
2-BS-04-4A	0.433	0.356	0.179	542.8
2-BS-04-4B	0.433	0.355	0.178	540.8
2-BS-04-5A	0.433	0.355	0.178	527.4
2-BS-04-5B	0.433	0.355	0.178	527.4
2-BS-04-6A	0.433	0.423	0.208	643.2
2-BS-04-6B	0.433	0.422	0.208	639.7
2-BS-04-7A	0.433	0.407	0.208	609.7
2-BS-04-7B	0.433	0.407	0.204	609.7
2-BS-06-1A	6.9	8.09	3.323	726.7
2-BS-06-1B	6.9	7.649	3.149	686
2-BS-11-1A	11.5	10.132	7.495	644
2-BS-11-1B	11.5	22.182	15.797	1392

4.3.15 Bus Loading of Phase-3B in New system:

Table XIV: Bus Loading of Phase-3B in the system

Bus ID	Nominal kV	MW Loading	Mvar Loading	Amp. Loading
3-BS-04-1A	0.433	1.121	0.645	1713
3-BS-04-1B	0.433	0.79	0.402	1165
3-BS-04-2A	0.433	0.197	0.1	293.5
3-BS-04-2B	0.433	0.197	0.1	291.3
3-BS-04-3A	0.433	0.197	0.1	293.5
3-BS-04-3B	0.433	0.197	0.1	291.3
3-BS-04-4A	0.433	0.197	0.1	293.5
3-BS-04-4B	0.433	0.197	0.1	291.3
3-BS-04-5A	0.433	0.197	0.1	293.5
3-BS-04-5B	0.433	0.197	0.1	291.3
3-BS-06-1A	6.9	4.484	1.912	411.6
3-BS-06-1B	6.9	6.052	2.482	540.3
3-BS-11-1A	11	11.106	8.642	719.1
3-BS-11-1B	11	13.85	12.28	945.8
Bus1	99.54	0.452	1308	0
Bus2-1	99.54	0.05	121.6	0
Bus7-1	99.54	0.125	357.2	0
Bus8-1	99.54	0.226	654	0
Bus9	99.54	0.226	654	0
Bus37-2	99.54	0.125	357.2	0

4.3.16 Voltage Profile at every bus in New system(Option 2):

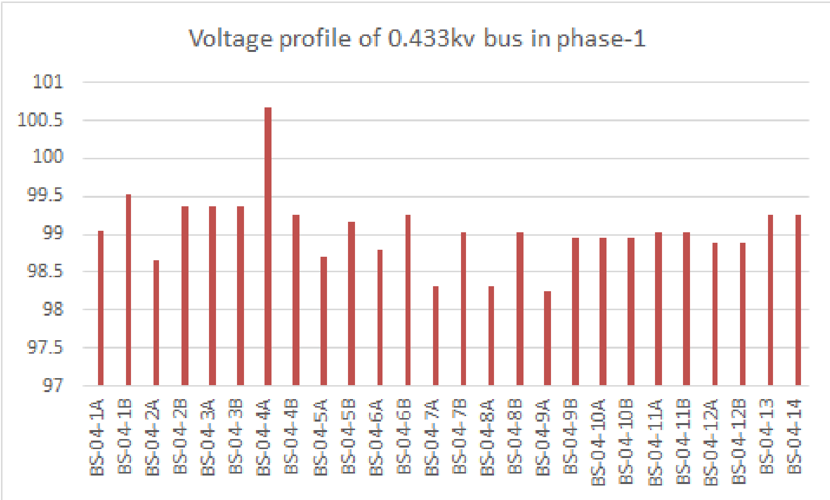

Figure 4.7: Voltage Profile of 433 rated voltage in phase-1 of the system

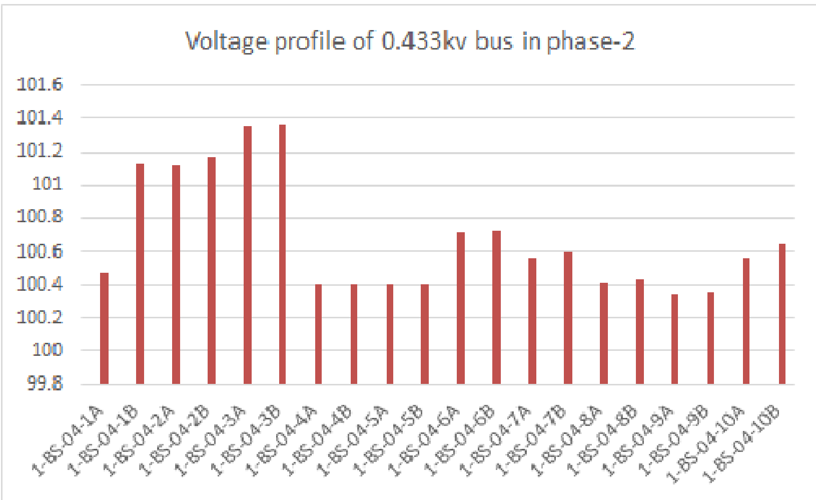

Figure 4.8: Voltage Profile of 433 rated voltage in phase-2 of the system

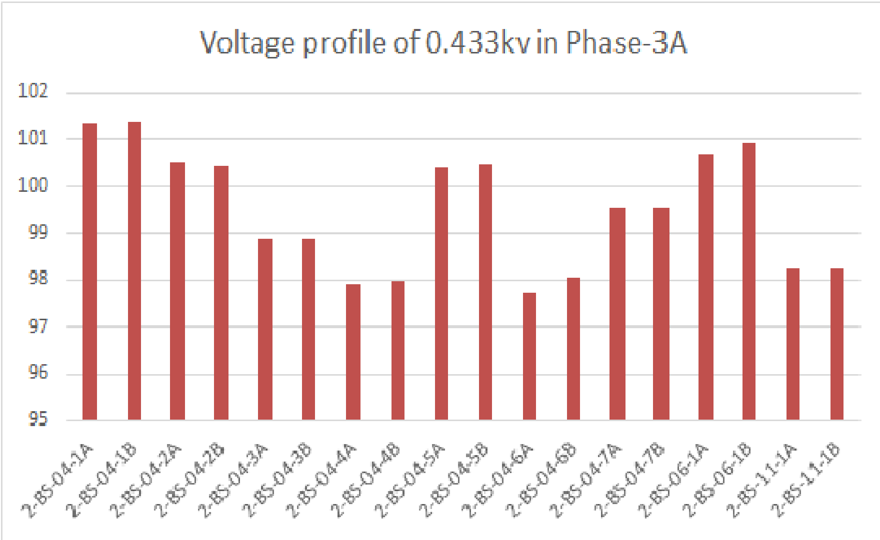

Figure 4.9: Voltage Profile of 433 rated voltage in phase-3A of the system

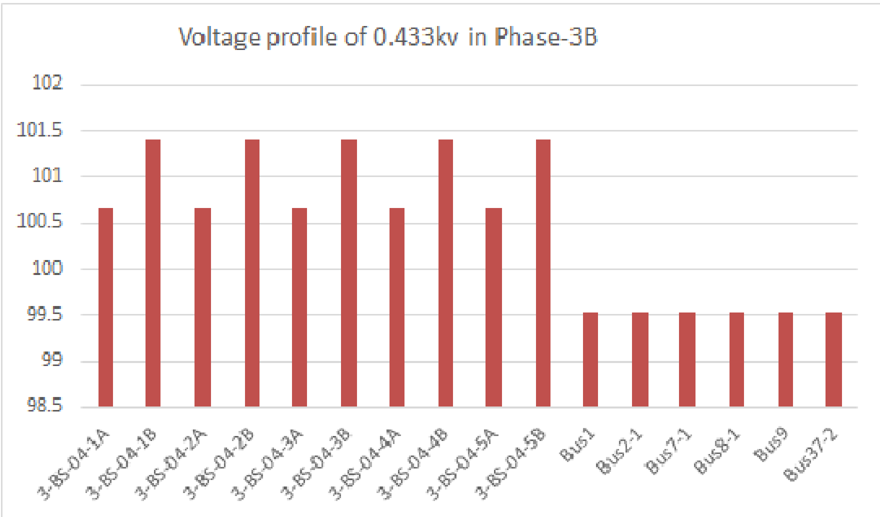

Figure 4.10: Voltage Profile of 433 rated voltage in phase-3B of the system

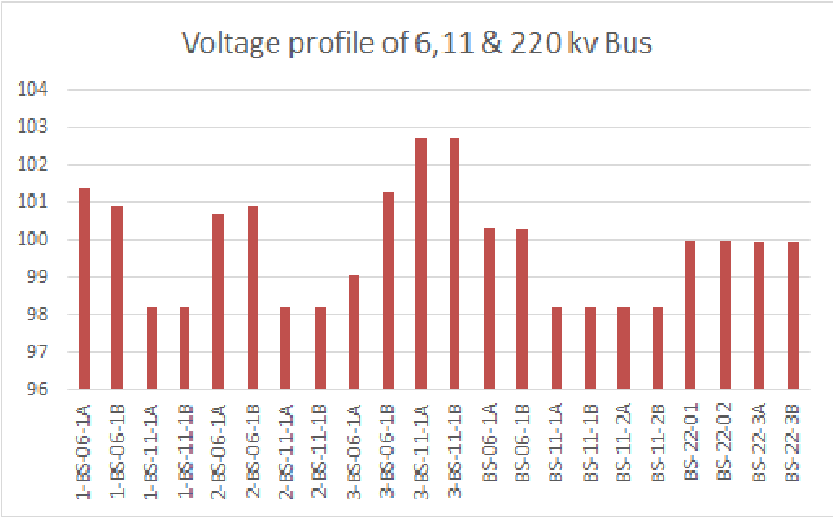

Figure 4.11: Voltage Profile of 6,11 220kv rated voltage in system

Chapter 5

Conclusion :

5.1 Conclusion

After this analysis we can easily find out weak buses. we are defining 98% to 102% voltage range as marginary limit and 95% to 105% voltage range as critical limit or point. By these range we can find out weak buses for improving the voltage profile at that bus by compensation i.e., change in tap in tap changer transformer, by capacitor bank etc. So we can improve the stability of system.On the basis of analysis of the Option-1 and option-2,it is concluded that in the option-2 it is possible for the future expansion of the system.

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