AN INVESTIGATION INTO THE CAUSES, EFFECTS AND IMPROVEMENT OF VOLTAGE DROPS ON AN 11 KV FEEDER

This Thesis submitted in partial fulfillment of the requirements for the Award of Degree of Bachelor of Science in Electrical and Electronic Engineering

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January 2019

CERTIFICATION

This is to certify that this thesis entitled "**An Investigation into the Causes, Effects and Improvement of Voltage Drops on an 11 kV Feeder**'' is done by the following students under my direct supervision. This project work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering, Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on………..2019

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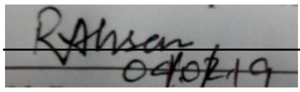

Dr. Md. Rezwanul Ahsan

Dedicated
To
My Parents
And
Teachers

ACKNOWLEDGEMENT

First of all, I give thanks to Allah. Then I would like to take this opportunity to express my appreciation and gratitude to my thesis supervisor Dr. Md. Rezwanul Ahsan, Assistant professor, department of Electrical and Electronics Engineering, Daffodil International University and Engineer Md. Abdus Salim (AE) DESCO kallyanpur sub-station for being dedicated in supporting, motivating and guiding me through this thesis. This thesis can't be done without their useful advice, helps, information and data collection. Also thank you very much for giving me opportunity to choice this thesis topic.

I also want to convey my thankfulness to Dr. Md. Rezwanul Ahsan, Assistant professor, department of Electrical and Electronics Engineering, Daffodil International University for this, support and constant encouragement.

Apart from that, I would like to thank my entire friends for sharing knowledge information and helping me in making this thesis a success.

To my beloved family, I want to give them my deepest love and gratitude for being very supportive and also for their inspiration and encouragement during my studies in this University.

ABSTRACT

As technology is advancing the consumptions of power is steadily rising. There are three steps for proper electrification these are Power Generation, Power Transmission and Power Distribution. This three are equally important for proper electrification, without any one of this three the electricity system will be incomplete.

Energy losses occur in the process of supplying electricity to consumers due to technical losses. The technical losses are due to energy dissipated in the conductors and equipment used for transmission, transformation, sub-transmission and distribution of power. These technical losses are inherent in a system and can be reduced to an optimum level. This paper presents a study on technical losses in distribution system and analysis of the impact of losses in power sector. Moreover, the impact of different types of transformer and other type of equipment's connections to the substation and feeder will also be investigated.

Keyword-- Feeders, sub-transmission network, voltage drops.

The causes and feeder loss of DESCO kallyanpur sub-station of Dhaka has been calculated. This study is done & the calculation shows that the technical loss of total distribution system loss in which 11.28% in 11KV line loss. This loss is reduceable by different kind of method.

So how to improve and reduce the loss of feeder, we describe in this paper.

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LIST OF ABBREVIATION

DESCO	Dhaka Electric Supply Company
REB	Rural Electrification Board
BPDB	Bangladesh Power Development Board
PGCB	Power Grid company of Bangladesh
KW	Kilowatt
KWh	Kilowatt-hour
DF	Diversity Factor
CF	Capacity Factor
LF	Load Factor
KV	Kilo Volt
KVA	Kilo Volt Ampere
MV	Mega Volt
MVA	Mega Volt Ampere
LT	Low Transmission
HT	High Transmission
PMT	Pole Mounted Transformer
ONAF	Oil Natural Air Force
VCB	Vacuum Circuit Breaker
AC	Alternating Current
DC	Direct Current
HVDS	High Voltage Distribution System
SF6	Sulphur Hexafluoride Circuit Breakers
MIS	Management Information System
DMS	Distribution Management System

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CHAPTER 01

INTRODUCTION

1.1 Introduction

Power is generated for the consumer utilization. From when power is generated it is transmitted through transmission lines via grids & then distributed to the consumer. Power distribution is final and most crucial link in the electricity supply and chain and most visible part of the electricity sector.

Initially sub-transmission and distribution system are designed and constructed to run on low system loss. But in practice, after passing of time the average system loss gradually increases as higher than the expectation. In order to arrest the escalation of system loss we have to analyze the reasons behind it.

The reasons of system loss can be classified as “Technical” and “Non-Technical”. Technical losses are unavoidable, but can be kept up to certain reduced level. The technical losses are most visible losses because it is related to material properties and its resistance to the follow of current that is also dissipated as heat. The technical losses can be clearly classified as the losses in power dissipated in distribution lines and transformers due to their internal resistance. Non-Technical losses, which are the major components of the escalated system loss, can be eliminated through good management.

1.2 Objective

The purpose of this thesis was to construct a program that can be An Investigation into the Causes, Effects and Improvement of Voltage Drops on an 11 kV Feeder in sub-station of DESCO. With all the effort of this internal time it was my goal to produce such a beautiful and informative report paper, what will be useful to all. Here I have tried my level best to make my report up to date. Daily office work, talking with the experts and discussions, were excellent just because of their amusing helping nature.

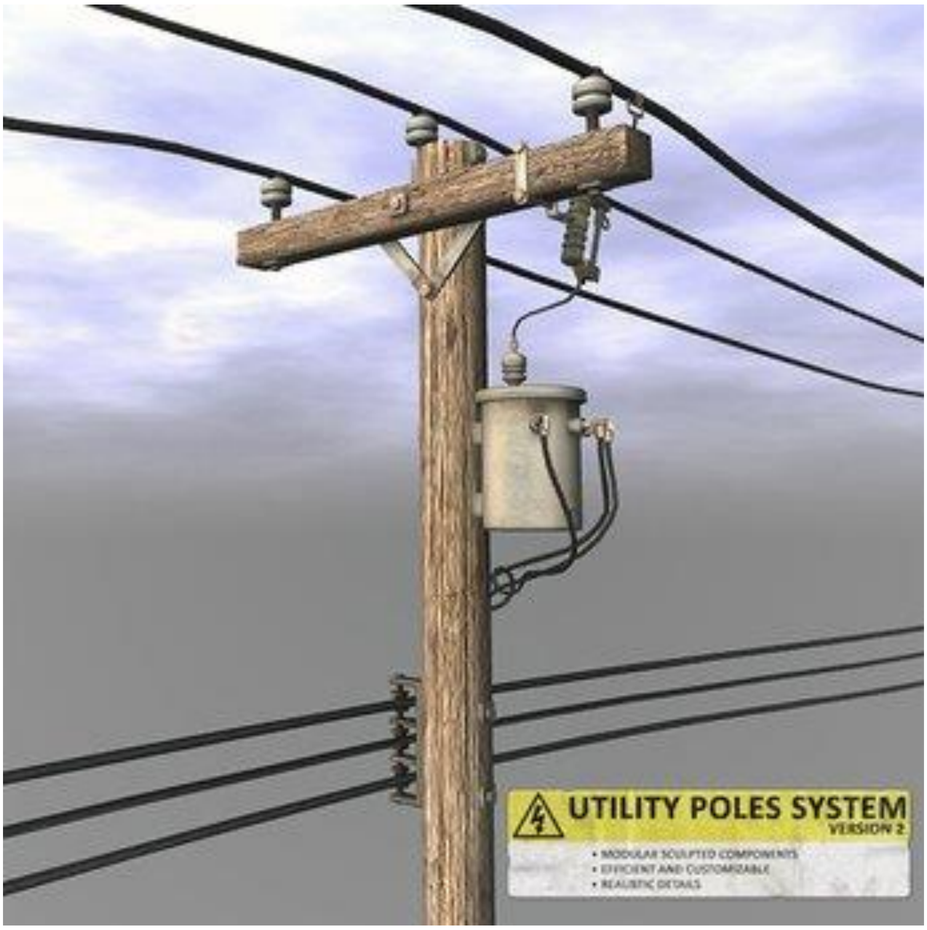


Figure 1.1: 11KV Transmission Line Model

1.3 Loss in electrical power system

In order to study technical, non-technical losses, which constitute a portion of the total losses in electrical power systems. Power system losses can be divided into two categories:

a) Technical losses &
b) Non-technical losses

- Technical losses are naturally occurring losses and consist mainly of power dissipation in electrical system components such as

  - Transmission lines
  - Capacitive loss
  - Power transformers
  - Measurement systems etc.

- Non-technical losses, on the other hand, are caused by actions external to the power system, or are caused by loads and conditions that the technical losses computation failed to take into account. Non-technical losses are more difficult to measure because these 4 losses are often unaccounted for by the system operates and thus have no recorded information. The most probable causes of non-technical losses are:
  - Electricity theft
  - Non-payment by customers
  - Errors in technical losses computation
  - Errors in accounting and record keeping that distort technical information

1.4 Technical losses

In an electric utility system some energy is lost during transfer of energy from source to consumer. In DESCO system lines are designed and construction as if that the system loss remains within the acceptable limit. But in practice the average loss is higher than expected one. In order to reduce the system loss we need to analyze the reasons behind it.

Technical loss occurs in a distribution system at various locations starting from the distribution sub-station down to the consumers.

Technical losses cannot be determined with a high degree of absolute accuracy because of the general non-availability of adequate system data. An electric system is a dynamic one, changing constantly and the equipment are generally no available to make measurements continually on every facility at the same time. Assumptions are therefore made to determine various factors of various sections of the system.

Here we have analyzed system loss of kallyanpur sub-station under DESCO. Capacity of the kallyanpur sub-station is $[(20/28) \times 3]$ MVA and there are total 6 numbers of 11KV outgoing feeder& Total 18,000 consumers. All the losses in this sub-station are within allowable limit. In determination of the primary (HT) line loss we have contend all sections of the primary system for better result.

1.5 Important terms for calculation

Diversity Factor: The ratio of the sum of individual maximum demand to the maximum on power station is known as diversity factor.

Capacity Factor: Means the ratio of (a) the net amount of electricity a plant actually generates in a given time period to (b)the amount that the plant could have produced if it had operate continuously at full power operation during the same period. Capacity factor is dependent on both the mechanical availability of the plant and the economic desirability to run the plant given the particular cost to run it.

Kilowatt (KW): Means a measure of electricity defined as a unit of demand or capacity, measured as 1 kilowatt (1,000watt) of power generated.

Kilowatt-hour (KWh): Means a measure of electricity define as a unit of work or energy, measured as 1 kilowatt (1,000watt) of power expanded for 1 hour.

Load Factor: Load factor means the ratio of average load to peak load served by a plant or power system during a specified time interval. A higher load factor indicates higher use of the generating resources.

Rate: Means the authorized charges, per unit or level of consumption**,** for a specified time period for any of the classes of generation license services provided to a customer.

Regulations: Means any regulations developed and promulgated by the commission according to the Bangladesh Energy Regulatory Commission Act, 2003 (Act No 13 of 2003), including subsequent amendments to the Act.

CHAPTER 02

METHODOLOGY OF THE THESIS

2.1 Introduction

A sub-station is a component of an electricity transmission or distribution system where voltage is transformed from high to low, or the reverse, using transformer. A transmission sub-station transforms the voltage to level suitable for transporting electric power over long distances. This is to minimize capital and operating costs of the system. Once it is transported close to where it is needed, a distribution sub-station transforms the voltage to a level suitable for the distribution system.

Figure 2.1: 11KV Transmission line

2.2 Methodology

This chapter starts with a motivation of the chosen methodology. It continues with an explanation of how the study was performed and how the data was collected. Next follows a discussion of the validity of the study and in the end there is an explanation of how the factors that affect the availability have been measured. Both primary and secondary data are being collected for the purpose of this report. This report is concentrated of 33/11 KV kallyanpur sub-station of Dhaka of DESCO.

Primary Data: Primary data are collected from the books about sub-station, the Engineers through a face-to-face interview with a formal questionnaire.

Secondary Data: secondary data has been collected from the online resources, journals and brochures.

2.3 Methodology for calculation of technical loss

The information's of kallyanpur sub-station under DESCO are listed; the system losses are calculated in the following order:

1. Distribution Substation
   a) No. Load Loss
   b) Load Loss
   c) Loss KW Demand
   d) KWh Loss
2. Distribution Transformer
   a) No. Load Loss
   b) Load Loss
   c) Loss KW Demand
   d) KWh Loss
3. Feeder
   a) Loss KW Demand
   b) KWh Loss
4. Secondary
   a) Loss KW Demand
   b) KWh Loss

2.4 Feeder losses

The loss in the feeder is due only to the load current following through the resistance of the wires in the lines.

The single line diagram of each feeder is prepared that all loads have been determined and entered on the diagram, the accumulated load for each line section have been placed on the map and that the line section have been listed on a from shown page.

The process of calculating the loss through each section of the line is as follows:

1. Assuming all transformer reflect in the system their actual KVA load.
2. Enter on the single line diagram the accumulated load "KVA (Load)" which is carried on each line section.

3. At 11KV, 1KVA, three phase, is 0.05249 amperes in each phase conductors.
4. For each line section.

   The Watt loss ={KVA (Load)$^{X^1}/_{Diversity\ Factor(DF)} \times 0.05249\}^{2X}$} resistance per Km.×Kilometers×3 (for three phase).

   The Watt loss = {KVA (Load)$^{X^1}/_{Diversity\ Factor(DF)} \times 0.157\}^{2X}$} resistance per Km.×Kilometer×2 (for single phase).
5. Summation of the losses for all line section. The result is in watts. The watts divided by 1000is KW loss demand.
6. The KWh loss for the feeder is KWh = KW×Feeder loss×Hours.
7. The percent of KWh loss is, %KWh = (KWh Loss×100) / Sub-Station KWh (Load).

2.5 Low tension system losses

The low tension losses are caused by the load currents flowing through the resistance of the wires and it should be noted that for each KVA of load at low tension the currents are 27.61 times greater than they are at high tension voltage. The result is that for each KVA at low tension the loss is 762 times greater than for KVA at high tension for the same conductor.

The method of calculating the low tension losses are determined in a similar manner to that use in determining the feeder losses, except that the customer loads are used instead of the transformer loads.

1. Prepare a single line diagram for low tension system of some sample transformer.

2. For each line section use the diversified load as given in the engineering and staking manual and calculate the loss for each line section.

3. Per Km loss was determine and the total LT loss was found by multiplying the per Km loss by total length of LT line.

4. For the services take the average length and size of the service conductor and calculate the loss for the undiversified load and them multiply by number of services.

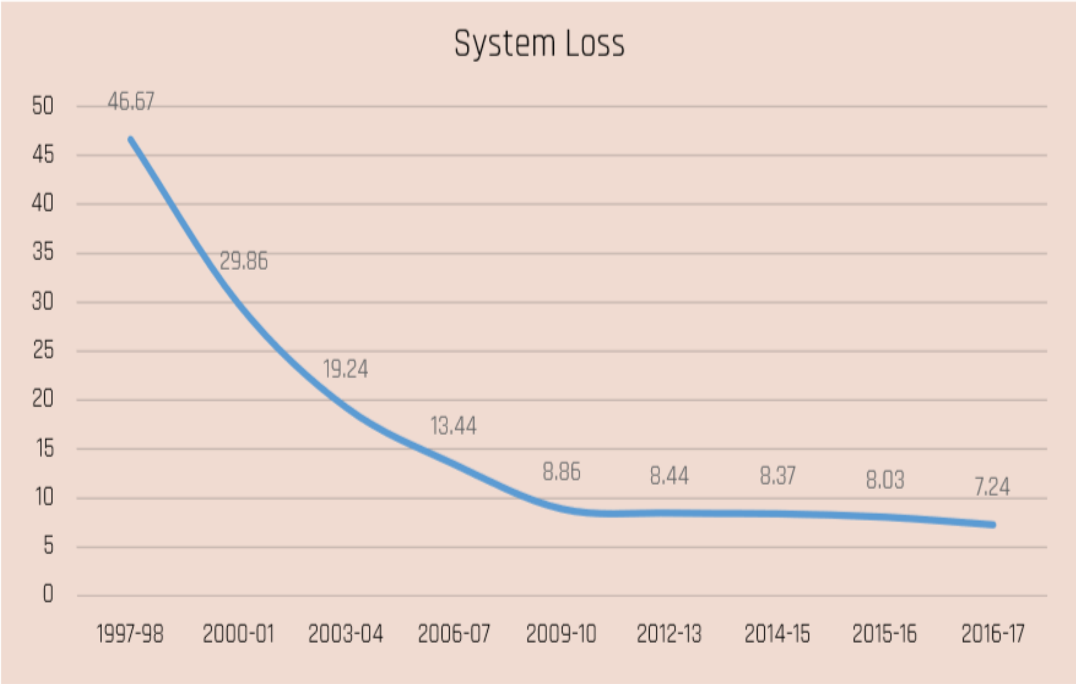


Figure 2.2: Yearly System Loss in DESCO

2.6 Scope

The guidance and data in this report paper are intended to be used by operating, maintenance, and repair personnel. The information applies to gas engine prime movers, power generators, switchgear, and subsidiary electrical components. It also covers fuel, air, lubricating, and starting system. This includes military and commercial technical manuals and engineering data pertaining to their particular plant.

CHAPTER 03

CAUSES OF VOLTAGE DROPS ON AN 11 KV FEEDER

3.1 Introduction

Electric power providers have a duty to ensure that consumers are always supplied with the required voltage level. However, consumers of DESCOs in this Feeder, located in kallyanpur, Dhaka, have been experiencing low voltage levels for some time now. In most cases, voltage drops is a major concern in low voltage distribution.

However, under normal circuit conditions, the receiving-end voltage is not the same as the sending-end voltage. This is due to voltage drops along the line which is caused by the combined effects of resistance and impedance of the conducting media. There has been a lot of effort to dig into its causes and effect on appliances, circuit components and other electrical machines.

1. Relate line resistance with the direction of real power flow along a transmission line under specific conditions. Also finds the effects a transmission line encounter if the power factor of a load is poorer than the power factor of the transmission line impedance. Furthermore, a new condition has been derived for price inversion at sending-end even under lagging power factor condition.
2. Voltage drop is the main indicator of power quality and it has a significant influence at normal working regime of electrical appliances, especially motors. His work was mainly focused on low voltage distribution system. This paper focuses on the causes and effect of voltage drop on an 11 kV feeder, which is a sub transmission line in kallyanpur.

3.2 Transmission and Distribution Network of Dhaka

Dhaka is the capital of the Bangladesh. There is therefore the need for a constant and reliable electric energy supply for the industrial and commercial consumers in the municipality. In view of this, a supply point substation was built at kallyanpur, in 1960 to cater for the power demand. Dhaka Electric Supply Company Ltd is the authorized company for the Electric Power Distribution sector in Bangladesh by BPDB (Bangladesh Power Development Board) company, was founded as a public limited company on November 03, 1996 under the Companies Act 1994. It was a demand of time to establish the company as part of an ongoing Power Sector Reforms to increase efficiency in the area of power generation, transmission and distribution. It started with the Authorized Capital of Tk 5.00 billion. At the side of the PGCB substation are takes 132 kv from the national grid and the step down it then through two 25 MVA transformers for 33 kv and supply it to DESCO. At the side of DESCO, this 33 kv is received from PGCB side then through appropriate control and protective system to supply the main bus bars of the substation. It is through these bus bars that all the outgoing 33 kv feeders are taped to their respective switchgears to feed the various industries and mining companies which require 33 kV supply. The sixth 11 kV feeder line achieved through a 28 MVA power transformer at the substation. These 33 kv feeders are controlled and monitored by an Oil Natural Air Force (ONAF) circuit breaker.

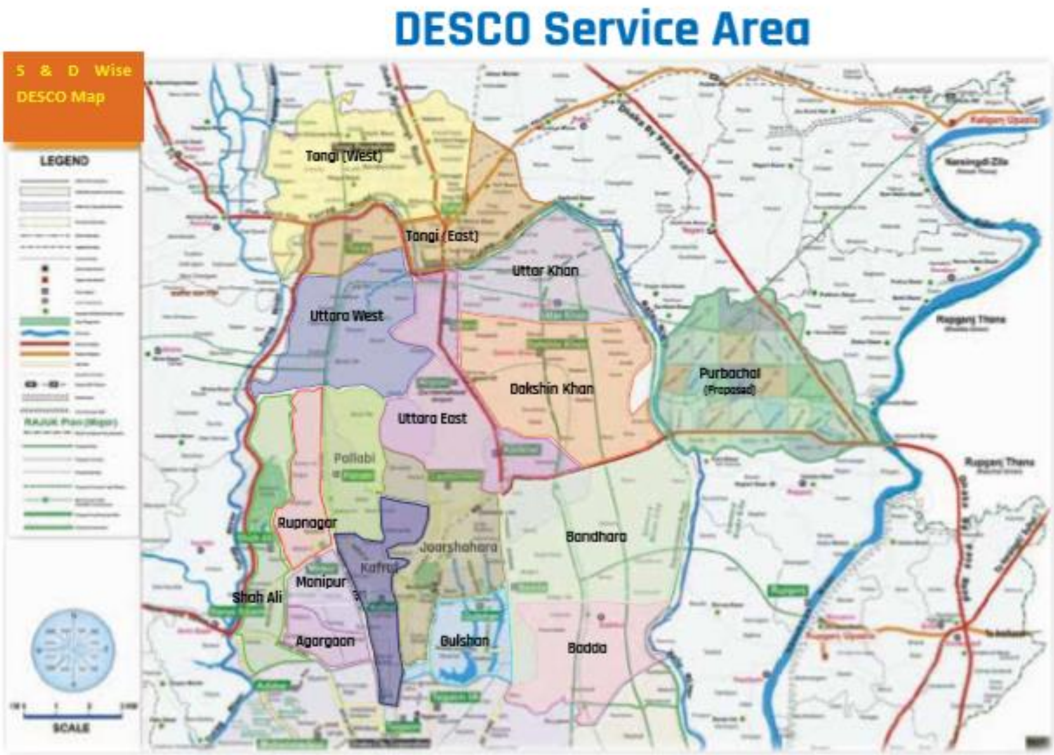


Figure 3.1: DESCO Area Map

3.2.1 The 28MVA Transformer

The 3×20/28 MVA transformer at the main substation is a 33 to 11 kV transformer. This transformer is protected by an VCB and an SF6 circuit breaker. The incomer of the transformer carries an average current of 300A and 360A at peak load time, West Dhaka City. These feeders are protected by an VCB and an SF6 circuit breaker.

Figure 3.2: Power Transformer

3.2.2 Feeder Ⅲ

The Feeder Ⅲ was constructed purposely to supply 11 kV to DESCO. It is the most loaded 11 kV feeder line in Kallyanpur of DESCO; it serves about highest load on this substation. The total length of the 11kvfeeder is about 3 km. It currently feeds most of the secondary Distribution in Dhaka.

Figure 3.3: The 11KV Feeder Ⅲ

3.2.3 Loading of the Feeder

Strategically, the route of the Ⅲ Feeder makes it possible to serve many residential, commercial and most of the light industries in Dhaka. The feeder takes an average load of 60% and 65% at peak load time of the total power delivery from the 20/28 MVA power transformer at main substation.

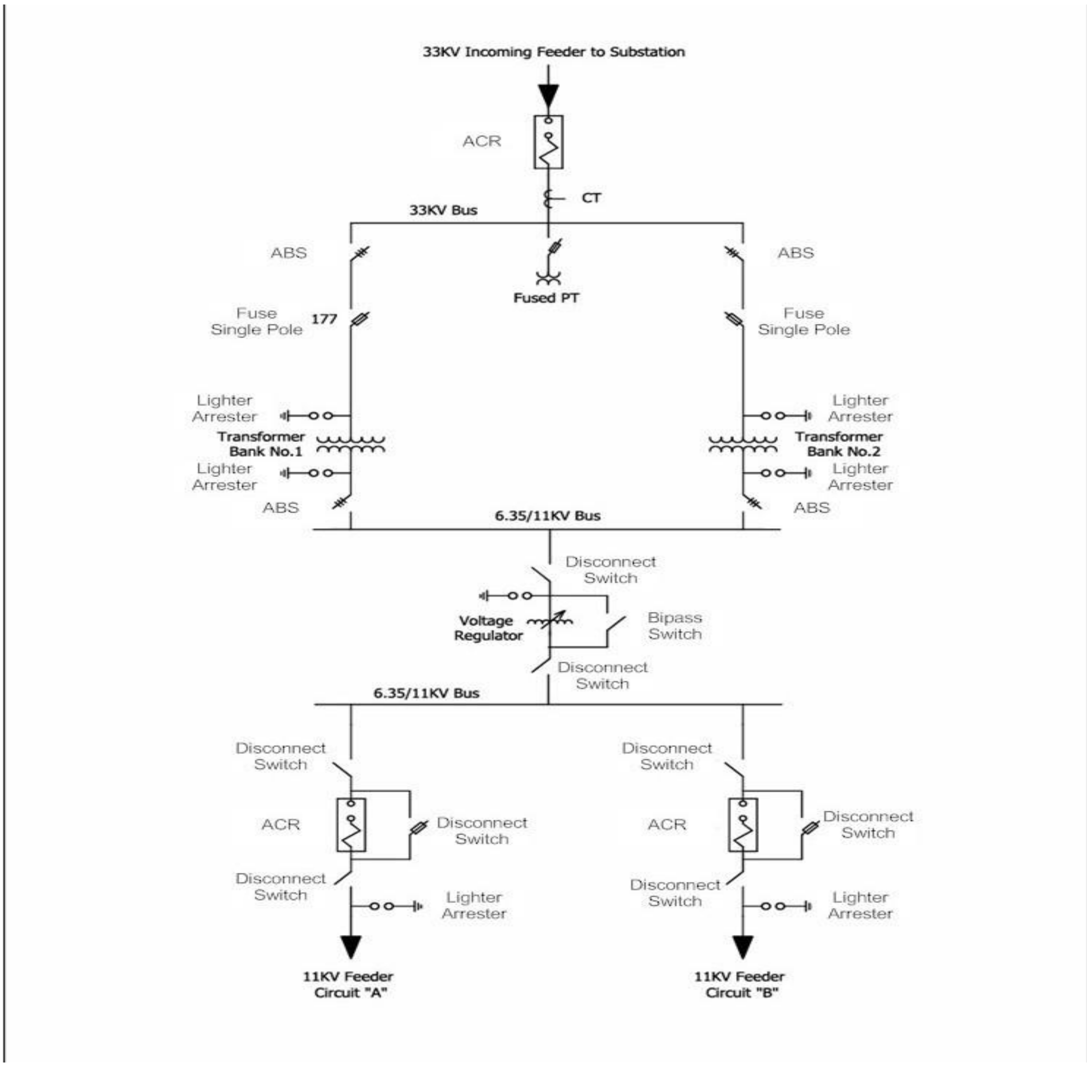


Figure 3.4: Sketch of the Transmission Network System in Bangladesh.

3.2.4 Transformers

A transformer is a device that changes ac electric power at one voltage level to ac electric power at another voltage level through the action of a magnetic field. Twenty-Eight distribution transformers are installed on this feeder, which is about 61 % of total distribution transformers on of 11/0.4 KV Three phase 200 KVA and Single phase 15 KVA transformers 11 kV feeders in Dhaka. They are made of 18 ground mounted (GMT) and 10 pole mounted (PMT), of which 12 are 500 kVA rated, 10 are 315 kVA rated, 3 are 100 kVA rated and 3 are rated 50 kVA.

Figure 3.5: Distribution Transformer

3.2.5 Constructional Features

The Ⅲ Feeder was constructed with concrete poles having an average span of 90 m between poles and a maximum span of 94 m. The headgears are made of wishbone bracket and pin insulators for intermediate poles and angle iron cross arm and strain insulator for terminal and sectional poles. The main feeder is constructed with 70 mm2 ACSR Dog conductors. Which is shown in Figure 3.3.

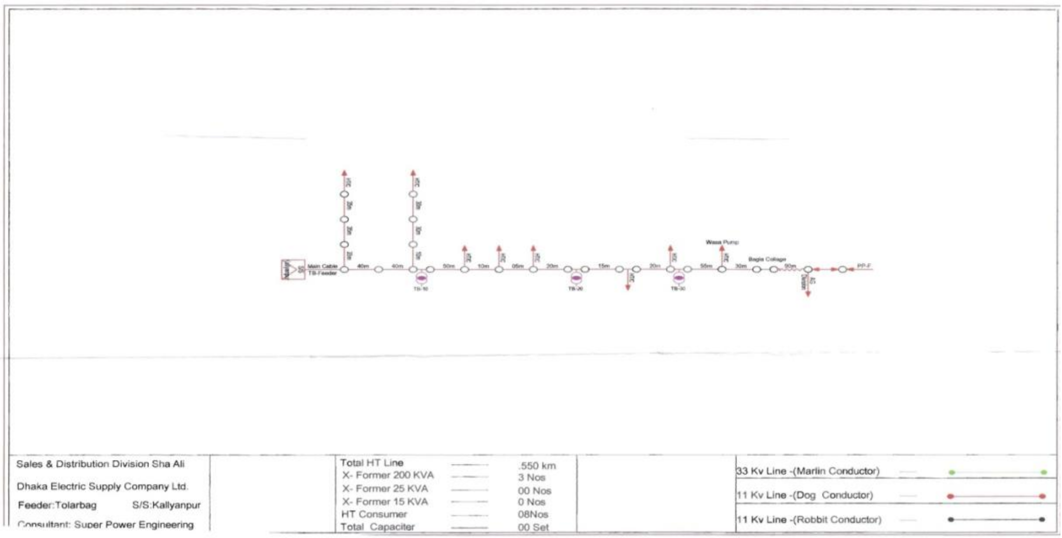


Figure 3.6: Single line Diagram of 11kv Distribution feeder

3.2.6 Current State of the Feeder

The Ⅲ Feeder was constructed about 24 years ago. Consequently, there have been a lot of changes to its original state due to maintenance. Most of the existing poles on the feeder have been replaced by wooden poles due to the SPC pole in which they were. The 70 mm2 ACSR Dog conductors used originally to construct the line, has been replaced by 120 mm2 aluminum at most portions on the line.

3.3 Analysis of the Ⅲ Feeder

A power system must be efficient from a technological point of view, that is to say it must be able to carry the loads imposed upon it without causing excessive heating in the conductors and consequent damage to the insulation. Furthermore, the voltage drops throughout the network must be kept to a minimum.

3.3.1 Load Characteristics on the Ⅲ Feeder

Analysis of the types of consumers on the Ⅲ feeder indicates that about 80% are residential consumers, 5% are industrial consumers and 15 % are for commercial activities as can be seen in Fig. 3.4. The consumer status can help determine the consumption pattern on the feeder.

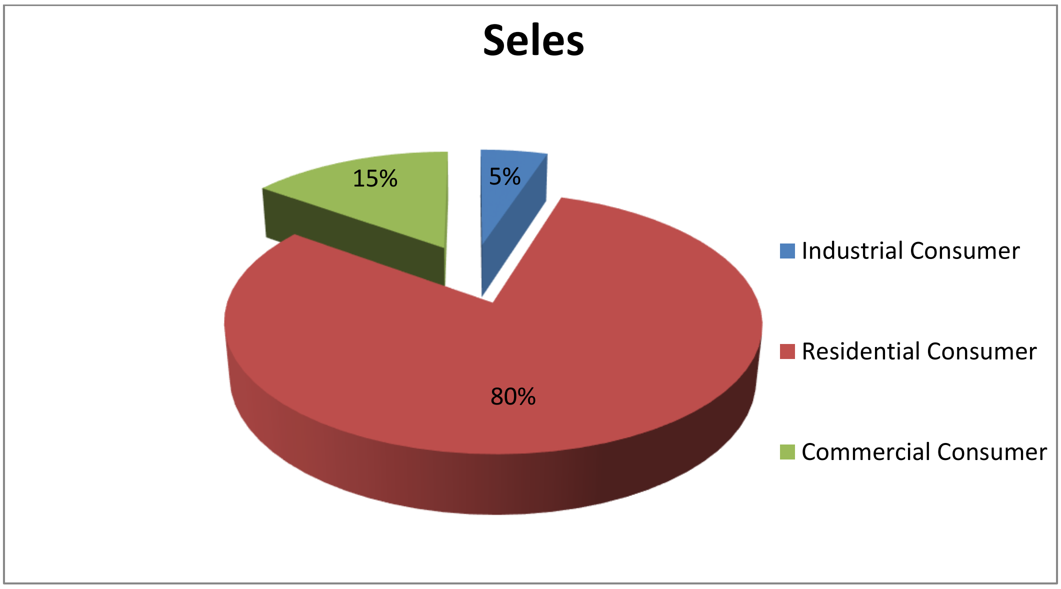


Figure 3.7: Types of Consumers on Ⅲ Feeder

The average load on the feeder has increased considerably from 140A in 2005 to 300A in 2019 as shown in Figure 3.5. Analytical projections

Indicates that load on the feeder will increase to about 80% of the present level by 2020. Therefore, proper mechanism must be enforced to cater for the high increase in load as well as meeting the standards of the protection policies of REB in terms of voltage drop.

3.3.2 Voltage Analysis of the Ⅲ Feeder

Voltage measurements, three-times daily (6 am, 12 noon and 7 pm), were taken over a period of one-half month commencing from 10th October 2019 to 25th November 2019. The voltage readings obtained indicates that: The average sending-end voltage, Vs = 11000 V The average receiving-end voltage, Vr = 10150 V

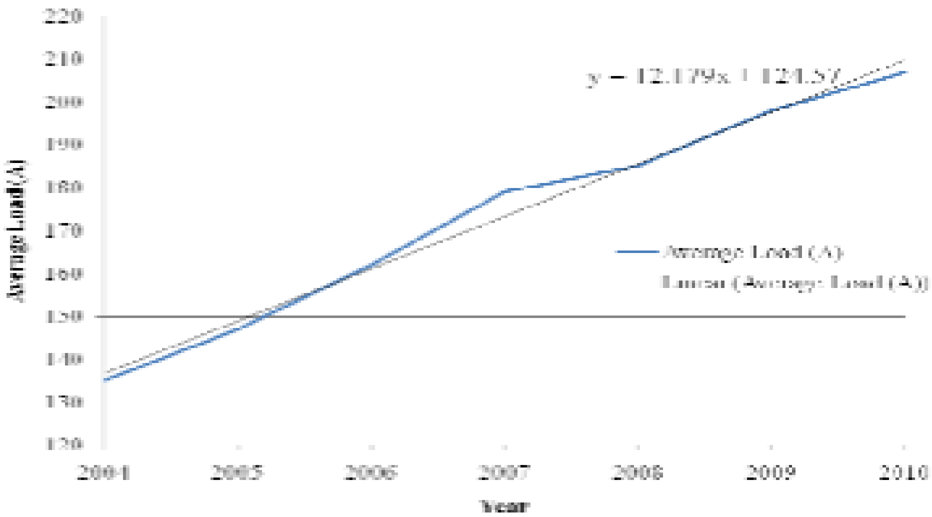


Figure 3.8: Average Load Characteristics of Ⅲ Feeder

Thus, the voltage drop, IZ, on the feeder is:

$$IZ = Vs - Vr$$

$= 11000 – 10150$

$= 850$ V

Since the average current on the feeder as at the time of taking the data is 207 A, then the total impedance, Z, of the feeder is deduced as:

$$Z = \frac{850}{300} = 2.66\ \Omega$$

3.3.3 Performance of the Feeder

The performance of a line can be defined by determining the efficiency and regulation of the line. The efficiency of a line is defined as:

Percentage Efficiency $= \frac{Pr}{Ps} \times 100$ (1)

Therefore, power sent, *Ps*, from the sending-end,

$Ps = Vs\ I$

= 11000 × 300

= 3300000 VA

= 3.3 MVA

and the power delivered, *Pr*, at the receiving-end,

$Pr = Vr\ I$

= 10150 × 300

= 3045000 VA

= 3.045 MVA

Hence, from Eq. 1, the efficiency of the line is

Percentage Efficiency= $\frac{3045000}{3300000} \times 100$

= 92.27 %

3.3.4 Voltage Regulation

The regulation of a line is defined as the change in the receiving-end voltage, expressed in per cent of full load voltage, from no load to full load, keeping the sending-end voltage and frequency constant.

Thus,

Voltage Regulation $= \frac{Vs - Vr}{Vr} \times 100$

$= \frac{11000-10150}{10150} \times 100$

= 8.374 %

3.3.5 Permissible Voltage Regulation

The transmission capacity of radial lines, especially medium and long lines up to 150 kV often limited to by voltage drop or voltage regulation. The highest limit practically depending on the line voltage and on the reactive power compensation available.

Per the protection policy of REB, the permissible voltage regulation, line impedance, and efficiency of an 11 kV transmission line are as shown in Table 1. Comparing these values with the calculated values, we can conclude that the operational performance of Ⅲ Feeder is below the permissible limits and therefore need to be corrected.

TABLE 3.1

COMPARISON BETWEEN CALCULATED VALUES OF TRANSMISSION LINE PARAMETERS AND REB STANDARDS

Parameters	Permissible Values	Calculated Values
Voltage Regulation (%)	< 6	8.374
Line Impedance (Ω)	< 2.5	2.66
Efficiency (%)	>96	92.27

3.4 Causes of Voltage Drop on the Ⅲ Feeder

The voltage drop of a line depends basically on two parameters; these being the impedance of the line and the current flowing through the conductor. Therefore an increase in either impedance or current will cause a corresponding increase in voltage drop.

3.4.1 Causes of Voltage Drop Due to Resistance Increase

The Ⅲ feeder has a higher impedance level as compared to the permissible value. A thorough inspection of the line reveals that the high impedance is caused by:

- Conductor poor joints and terminations,
- Joint hot spots,
- Using under-sized conductors, and
- Using non-uniform conductor material.

3.4.1.1 Conductor Joints and Terminations Poor

Poor joints and terminations is one of the contributing factors of high voltage drops on the Ⅲ feeder. Poor joints and terminations are resulted from loose contact between the two conductors which are joined together. When current flows through a loose contact, there will be high opposition to current flow which generates heat at that points.

3.4.1.2 Joint Hot Spots

Whenever a mechanically weak joint or termination is made, high resistance point is created. High resistance creates localized heating and since heating increases oxidation and creep, the connection becomes less tight, and further heating occurs, until the contacts tends glow. As resistance of aluminum and copper increases with respect to temperature, a higher voltage drop is realized at that point.

3.4.1.3Using Under-Sized Conductors

Voltage can be thought of as the pressure pushing charges along a conductor, while the electrical resistance of a conductor is a measure of how difficult it is to push the charges along. Using the flow analogy, electrical resistance is similar to friction for flowing currents: long thin wires provide more resistance than do short thick wires.

3.4.1.4Using Non-Uniform Conductor Material

Corrosion is an important factor to be considered in the selection of conductor materials. The two types of corrosion which exhibit greatest influence on the electrical properties of a metal are oxidation and galvanic corrosion. Galvanic corrosion, which is caused by the difference in electrical potential between two or more metals, has to be given careful consideration when selecting conductor metals.

3.4.2 Causes of Voltage Drop Due to Current Increase

The main cause of voltage drops on the Ⅲ feeder which is due to current increase is overloading of the feeder. It is worth noting that voltage drop on a line varies proportionally Current also has similar effects as it varies directly proportional to the voltage drop. In situations where major faults occur on II feeder, some of its load is diverted to the Ⅲ feeder which raises its load values to as high as 450 A. This results in consumers at the end on the feeder experiencing very low voltages.

3.5 Observations and Conclusions

3.5.1 Observations

It was observed that the outage level of Ⅲ Feeder is currently high, of which stands at an average of three times daily with a least duration of 15 minutes. These outages are mostly caused by:

- Over-grown of vegetation very close to the line, which comes in contact to the feeder in the events of strong winds,
- Over-sagged conductors as a result of long spans between poles, and
- Obsolete headgear accessories, equipment and bent conductors.

3.5.2 Conclusions

Thorough assessment shows that, linking Ⅲ Feeder is the most economical and reliable method to adopt. Although the proposed method comes with extra cost, it can be concluded that its implementation will bring a great relief to the consumers on the feeder, reduce the voltage drop, minimize the load current and improve the reliability of the feeder.

CHAPTER 04

THE EFFECTS OF VOLTAGE DROPS ON AN 11 KV FEEDER

4.1 Introduction

The present level of Transmission and Distribution (T & D) losses in Bangladesh power system is estimated to be 13.55%. The T& D losses in Bangladesh is very high compared to the losses in the power systems of the developed countries like USA, Canada, USSR, Korea and Japan. The T & D losses in developed countries are as shown in the table 8.1.

TABLE 4.1

T & D LOSSES IN DEVELOPED COUNTRIES

Sl.No	Name of Country	T & D Losses in %
1	USA	8.8%
2	Canada	8.5%
3	USSR	8.2%
4	Korea	11.0%
5	Japan	6.0%

It has been reported that the losses in power system in Japan and Korea were also of the order of 20%. Adopting modern techniques of Distribution system planning and design, they have brought down the losses to the international level of 6 to 8%. There is a need to take up similar excises in respect of Bangladeshi power systems to reduce T & D losses, then our total transmission & distribution loss dropped to 6-7.5% & our efficiency must be increased as like developed country, and our country will be ahead to one step. When the country is facing severe power shortages need to emphasis. The typical existing T & D losses is shown in the Table 8.2.

TABLE 4.2

T & D LOSS FOR BANGLADESHI POWER SYSTEM

Sl. No	System	% of Contribution of each voltage level to total losses
1	EHV System	2.86%
2	33 KV System	1.25%
3	11 KV System	11.28%
4	LV System	58%

The 11KV HT Distribution System contributes about 2.86% of total T & D losses of Bangladeshi Power System. The main contributing factor for the losses in the area is the wrong HT Distribution system practice chosen by Bangladesh coupled with non-adherence to prescribed norms of voltage drops. The 11KV HT Distribution system losses include the losses in 11KV/400 Volts Transformers and 11KV feeders line losses. Transformer is the most energy efficient equipment used in industry. The nominal efficiency of the power Transformer is in the order of 99 to 99.5% and for Distribution Transformer is in the order of 98 to 99% though the efficiency of Transformer is very high, it offers a good potential to save energy. An attempt was made to increase the operating efficiency of the Transformer by maintain the voltage profile, proper loading and power factor correction.

The voltage variation is due to Demand variation and reactive power variation. To establish the voltage variations, an 11KV HT Distribution feeder named loaded feeder is taken as sample feeder for analysis purpose and feeder voltage are measured in four locations. The loaded feeder receives power from a 33KV/11KV 28MVA Sub-station located at a place kallyanpur. The approximate length of the Feeder is 0.55 Km. the loaded feeder is a radial feeder and meets a demand of approximately 10MVA during peak hours and 5MVA demand during off-peak hours. The feeder consists of various types of loads like domestic, Institution, industrial and commercial loads. The 11KV HT Distribution feeder Voltage was recorded for 24Hours in three different locations of equal distance at 11KV/400 Volts Distribution Transformer end and the effect of voltage variation on the Distribution Transformer losses and efficiency was studied and concluded.

4.2 Effects of Voltage Drops on the Feeder

As the transformer at the end of the feeder is receiving low voltage levels at the high voltage side, a corresponding voltage level will be stepped down by the transformer. Therefore, any increase in the load on the feeder will result in low voltages of which further regulation cannot be made on the transformer. This will result in poor performance of domestic appliances like lighting systems, television sets, air conditioners, refrigerators, etc.

At peak load time most of these appliances will be unable to function properly. The industrial consumers on the feeder which is at the end of the feeder and uses high-rating motors to drive, will not be able to operate at full capacity at low voltage levels and sometimes results in total shut down. DESCO, as service provider, will therefore lose a lot of revenue since most of the consumers will not be operating at their full capacity. Also high power losses will be recorded on the feeder, which will increase the total technical losses of the company.

4.3 Voltage Variation in 11KV HT Distribution Feeder

The 11KV HT distribution feeder voltage of DESCO's varies from peak-hours to off-peak hours in a day. Before implementation of ABT, the peak hours HT distribution voltage goes below 11KV and typical value is 10.1 to 10.7KV at feeder ends. After implementation of ABT, the peak hour's voltage is close to 11KV. But during off-peak hours, the voltage rise to the level of 11.3 to 11.5 KV even at feeder end. The Voltage profile of 11KV HT distribution system was recorded with the help of Hioki Make Power Quality Analyzer in four different locations of 11KV/400 Volts Distribution Transformers and recorded voltage profile data are used to analyses the energy saving purpose.

The HT Distribution feeder voltage was first sampled (Sample 1) at an 11KV/400 Volts Distribution Transformer located close to the main 33KV / 11KV 15MVA substation (Technical) feeding point. The HT Distribution Voltage was second sampled at 1.2Kilometers away (Darussalam) from the feeding point. The HT Distribution feeder voltage was third sampled at 2Kilometers away (Kallyanpur Girl's School & College) from feeding point. The HT Distribution feeder voltage was all the three HT Distribution feeder voltage samples recorded for 24 Hours in a day at three different locations of Distribution Transformer end.

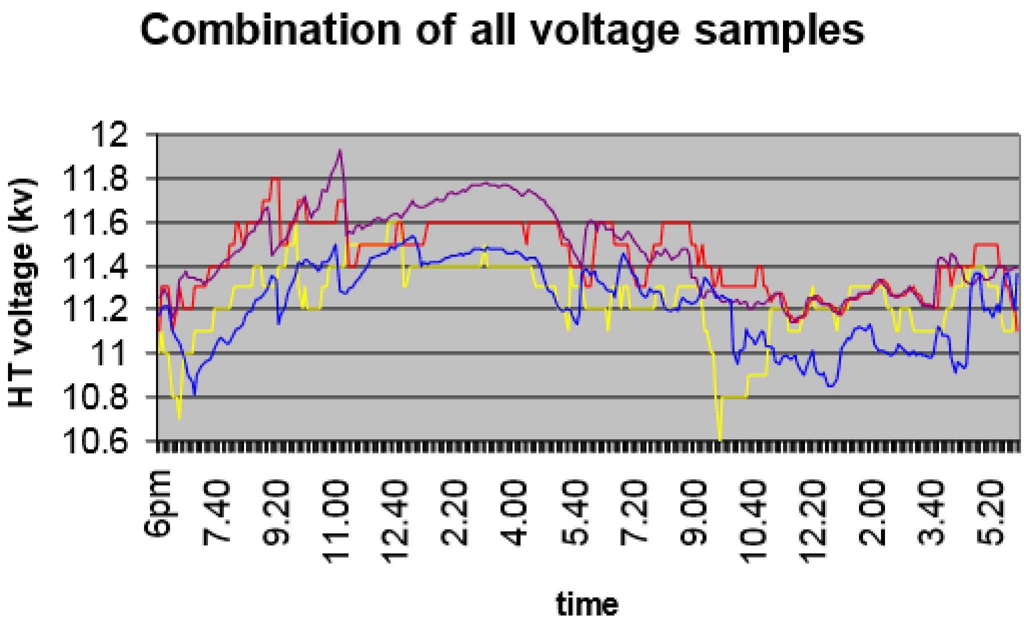


Figure 4.1: 11KV HT Distribution Feeder Voltage Samples Profiles

Figure 4.1: Shows that majority of the time the 11KV distribution feeder voltage is above 11.3KV. The feeder voltage varies from 10.7 KV to 11.7 KV. In all samples it's observed that the voltage varies in the band between 11.5 KV and 11.3 KV occurs 70% of time in a day (During Off-peak Hours and Normal Hours). During peak hours and part of normal hours the voltage varies between 10.7 and 11.3 KV and occurs for 40% of time in a day. After the implementation of available based tariff (ABT) in Bangladeshi power system, the 11KV HT Distribution voltage varies from 11.3 to 11.7 KV even during peak hours (5.00pm to 9.00pm). Before ABT implementation, the 33KV/11KV 28MVA Sub-station tries to maintain 11.3KV at transformer on 11KV side in order to maintain the feeder end voltage at 11KV. After the implementation due to reactive VAR compensation, the feeder drop has come down. There is a need to revise the sending end voltage of 11KV feeder to 11.3 KV to minimize over voltage during off-peak hours.

4.4 Reasons for Voltage Variation in 11KV HT Distribution System

The major reasons for the voltage variation in 11KV HT Distribution System were investigated with the help of DESCO officials and observed the following reasons for the variations.

- Absence of OLTC Facility in 33KV / 11KV Power Transformers / Sub-stations.
- Non- Familiar about the reliability of On-load Tap Changing Gear.
- Effect of Installation of Reactive VAR Compensator.
- Effect of Power Factor Incentives to HT and LT Industries.

CHAPTER 05

IMPROVEMENT OF VOLTAGE DROPS ON AN 11 KV FEEDER

5.1 Introduction

Electric power is the basic infrastructure for economic development of any developing country like Bangladesh. In Bangladeshi power system generation level more than 10,000 MW. We know that now transmission network is 132kV as the highest transmission voltage, besides HVDC lines, regional grids under operation and information of a National Grid interconnecting all the regional grids is under a network. In the sub-transmission and distribution sector also, substantial expansion has taken place and follow the rule of REB, more or less, have been able to fulfill the objectives of Government in terms of expanding the electricity network to rural areas. Out of total more than 80% villages have been electrified in last five years. The Government declared 100% villages are electrified in year of 2021. In fact, distribution is the weakest network in Bangladesh.

The distribution reforms are identified as one of the main area to improve gap between supply and demand. The distribution system plays an important role in any electric power system and requires a detail analysis of various types of losses occurring in a distribution system and methods are required to be developed for reducing the same.

5.2 Suggestions for Improving Efficiency

Line losses in LT distribution lines may be considerably reduced by installing shunt capacitors of optimum rating at vantage points as decided during load stations. The optimum rating of capacitor banks for a distribution system is 3/4th of the average KVAR requirement of that distribution system. The advantage point is at 3/4th the length of the main distributor from the transformer. The loss reduction by connecting capacitor during peak loads, found to be 7-8% from simulation studies carried out.

By connecting the capacitors across all individual inductive loads it is observed from simulation studies that 9% voltage improvement 18% reduction in current and reduction of losses up to 8% can be achieved depending upon the extent of PF improvement.

Simulation studies have shown that by having Express feeders, the voltage profile can improve and losses can be reduced by around 25% and by implementing HVDS, it can further reduce by approximately 25-30%. There can be a total benefit of nearly 50% loss reduction.

5.3 Efficiency Improvement

To improve the distribution system efficiency, technical, commercial and administrative interventions would be required.

Figure 5.1: Capacitor-bank

5.3.1 Technical Investigation

The very purpose of technical investigation is to reduce the technical loss up to the manageable level. The target and maximum technical loss levels for each distribution voltage levels are given.

Various measures for technical loss reduction are:

- Augmentation/strengthening of overloaded 33/11kV substation.
- Creation of new 33/11kV substations to reduce the length of 11kV feeder as well as overload of 33kV lines and 33/11kV transformers.
- Re-configuration of feeder lines and distribution transformers in such a way as to reduce the length of LT lines.
- Re-conductoring of overloaded and old feeders.

5.3.2 Commercial Investigation

It was found that out of all sub stations total losses of 30-40% in sub transmission and Distribution system (ST&D), major portion (about 10-20%) constitutes commercial losses. In fact, due to absence of meters, in most of the cases, there is no clue on the areas that are incurring maximum losses. This information is very vital to devise special corrective measures to alleviate the problem of high losses.

Therefore, to contain this loss, following measures are considered:

- Provision of100% tempers proof and high precision metering of all category of consumers.
- Consumer mapping and indexing to bring all consumers on record maintaining status profile of indexed consumers by periodic survey.
- Creation of data base of consumers with past consumption pattern.

5.3.3 Administrative Investigation

Administrative investigations are required for improvement of billing, revenue collection efficiency, customer satisfactions etc. for which following actions are considered:

- Verification of consumer energy meters and replacement wherever defective.
- Adoption of at least hand held logging units for meter reading
- Strengthening of customer complaint redressal system through computerization.
- Taking prompt action for disconnection and reconnection.
- Reduction of outage rate and improvement of supply reliability with quality.
- Adoption of DMS/SCADA system for collection of various information and generation of reports automatically.
- Initiation of punitive actions to stop theft of energy.

5.4 Proposed Solution to Mitigate Future Occurrence of Voltage Drops

This section discusses some possible solutions to mitigate future occurrence of voltage drops in both the short and long term.

5.4.1 Proposed Method to Reduce Voltage Drop in the Short Term

To achieve a higher line performance of the feeder in its current state, a pressure test should be conducted on the feeder to shutter all weak insulators and a thorough inspection to identify all poor joints and terminations which will enable proper fault maintenance to be carried out.

5.4.2 Proposed Method to Reduce Voltage Drop in the Long Term

In the case of a transmission system, voltage drop may not be of great significance since it is possible to provide means of adjusting the voltage at various points but this has proved ineffective on the Ⅲ Feeder. Therefore, there is the need to find a lasting solution to the high voltage drop on the feeder.

5.5 Increasing the Operating Voltage

Transmitting electricity at high voltage reduces the fraction of energy lost to resistance. For example, raising the voltage by a factor of 10 reduces the current by a corresponding factor of 10 and accordingly the IZ by a factor of 10, provided that the same sized but different type resistance conductors are used in both cases. Even if the conductors are upgraded into high to low resistance. If the maximum voltage drop of the feeder at connecting point is decreased, the current flowing through the line will decrease given that power remains constant. With this method, all conductors and defused insulator have to be upgraded insulators and the distribution transformer should be replaced to suit the voltage level. If the resistance of the conductor is reduced then the I^2R loss be reduced and improve the voltage drop. A considerable reduction in voltage drop could be attained. If 50 % length of the main feeder is changed to 70 mm2 ACSR Merlin conductor, the portions of the Feeder that has to be upgraded are tolarbag to Low Cost (70 mm2 ACSR Merlin). Linking Ⅲ Feeder and I Feeder: Construction of a 1.5 km 70 mm2 ACSR Merlin cable from tolarbag substation to kollyanpur. This method will include the mounting of extensible switch gears at both substations to enable Ⅲ Feeder to be carrying very small load (50 A), and the load on Ⅲ feeder will reduce to about 150A. In achieving this, voltage drop on the feeder will decrease.

5.6 Loss Calculation on Feeder Ⅲ

5.6.1 Loss for Rabbit Conductor

Max. Voltage drop at Connecting point = [Max. Current (A) × Impedance (Z) × Length (Km)] Volt

$$= [90 \times \{\sqrt{(1.015^2 + 0.347^2)}\} \times 0.55] \text{ Volt}$$

= 53.097466 Volt

= 0.05309746 KV

Loss on feeder Ⅲ

Sending End Power = 483720 KWh

Receiving End Power = 430720 KWh

Power loss in Hour = (483720-430720) KWh

= 53000 KWh

System loss = $\frac{483720-430720}{430720}\times 100$

= 12.30 %

TABLE 5.1: COST ESTIMATE OF THE FEEDER Ⅲ IN FIRST TIME INSTOLLATION

Cost of Material						
A. Cost of Materials including overhead cost(according to the price list on dated 01/01/2014 from account department)						
Sl. No.	**Code No**	**Description of Materials**	**Qty.**	**Unit**	**Unit Price in TK**	**Total Amount in Tk.**
1	200'105	SPC Pole 15 Meter	24	Nos	32,489.71	779752.99
2	201'101	Top Mount Bracket	40	Nos	1,622.24	64889.44
3	201'102	Side Mount Bracket	14	Nos	990.90	13872.57
4	201.161	Three Phase Terminal Cross Arm	24	Nos	526.65	12639.70
5	201'163	HT Cross Arm	6	Nos	1,771.00	10626.00
6	201.164	Braching for 11 Kv Terminations	2	Nos	386.27	772.55
7	600'101	11KV Pin Insulator	80	Nos	370.27	29621.24
8	601.103	11 KV Tension Clamp/Suspension	32	Nos	1,037.63	33204.27
9	201'126	Extension Link For Line	45	Nos	92.18	4148.28
10	201'124	5 spool wire rack(Angel)	8	Nos	2,027.80	16222.36
11	600'103	LV Spool Insulator	8	Nos	22.51	180.04
12	201'131	Guy set	14	Nos	3,629.57	50814.02
13	201'158	Two way Clamp	32	Nos	457.56	14641.98

14	201'154	Full Band for X-former platform Angle	6	Nos	324.52	1947.11
15	100'107	Al Binding Wire (Insulated)	0.25	Km	16,788.10	4197.03
16	100.108	Al Binding Wire (Bare)	0.25	Km	19,257.08	4814.27
17	100'102	AAC Wasp conductor		Km	104,589.61	0.00
18	100'101	AAC Ant Conductor	0.55	Km	66,817.70	36749.74
19	100'103	ACSR Rabbit Conductor	2.2	Km	84,771.96	186498.31
20	102'101	Preformed Termination	120	Nos	127.41	15289.02
21	102'107	Preformed armour rod for Rabbit	60	Nos	199.69	11981.40
22	101.105	PG Clamp	40	Nos	322.00	12880.00
23	101.128	Crimpits	40	Nos	257.34	10293.42
24	201;129	X-former Platform Angel	3	Nos	8,111.18	24333.54
25	201'165	X-former Platform Support Angel	3	Nos	1,216.68	3650.03
26	201'130	Brace Angle	10	Nos	818.36	8183.63
27	301'102	DOFC	9	Nos	1,796.30	16166.70
28	201'135	Earthing Rod	14	Nos	1,042.28	14591.91
29	100'110	Earthing wire (Insulated)	0.175	Km	228,518.34	39990.71
30	800'104	MCCB with box, 200A	3	Nos	13,989.75	41969.25
31	800.105	MCCB with box, 100A	3	Nos	13,989.75	41969.25
32	300'101	X-former 200 KVA (3-ph)	3	Nos	446,061.83	1338185.48
33	101'136	Lugs (Different size)	9	Nos	415.15	3736.35
34	105'101	Suspension Assembly(HT)	6	Set	27,898.49	167390.96
35	105'102	Deadend Assembly(HT)	6	Set	31,681.42	190088.51
36	105.103	Double Tension Assembly (HT)	3	Set	52,163.34	156490.03
37	105.104	Ins.OH Line Jointing Assembly (HT)	3	Set	86,778.62	260335.86
38	105.105	Ins.Tee-Off Assembly (HT)	3	Set	149,944.25	449832.74
39	105.110	OH to Pole Mounted Transformer Assembly	3	Set	94,008.60	282025.80
40	106.107	Ins. Tension Connector 70 / 70 mm for phase	3	Nos	472.65	1417.95
41	106.110	End Cap for 3*70 mm +1*54.5 mm	4	Nos	530.15	2120.60

42	101'130	Service Bail	7	Nos	81.10	567.69
43	101'132	Service Bail crimpit 50/25	3	Nos	60.20	180.61
44	101'131	Service Bail Crimpit 100/25	4	Nos	85.33	341.32
45	101'115	Mid Span Joints For Rabbit	12	Nos	224.08	2688.96
46	101'117	Mid Span Joints For Ant	3	Nos	202.73	608.20
47	201'117	Nutbolts 5/8X2.5"	24	Nos	279.65	6711.49
48	201.118	16" Nut Bolt with Washer	24	Nos	43.31	1039.42
49	201.189	12" Nut Bolt with Washer	48	Nos	286.59	13756.39
50	201.177	8" Nut Bolt with Washer	24	Nos	286.60	6878.47
51	201'171	Throw bolt with washer	120	Nos	78.20	9384.00
		Total				**4400671.60**

B. Cost of Installation (according to Uniform Rate Schedule-2014)

Sl. No.		**Description of Materials**	**Qty.**	**Unit**	**Unit Price in TK as 2014**	**Total Amount in Tk.**
1		SPC Pole 15 Meter	24	Nos	5,316.00	127584.00
2		Top & Side Mount Bracket	54	Set	333.00	17982.00
3		11KV Pin Insulator with pin	80	Set	163.00	13040.00
4		5 spool wire rack	8	Nos	403.00	3224.00
5		LV Spool Insulator	8	Set	147.00	1176.00
6		Down Guy set	14	Nos	479.00	6706.00
7		X-former Platform Angel	3	Nos	520.00	1560.00
8		DOFC	9	Nos	223.00	2007.00
9		X-former (3-ph) upto 250 KVA	3	Nos	10656.00	31968.00
10		MCCB with box, 200A	3	Nos	1404.00	4212.00
11		AAC Ant/Gnet Conductor	0.55	Km	7262.00	3994.10
12		ACSR Rabbit Conductor	2.2	Km	6052.00	13314.40
13		Muffling	6	Cu.M	9498.00	56988.00
14		Crimpit	40	Nos	79.00	3160.00
15		PG Clamp	40	Nos	79.00	3160.00
16		Mid Span Joints	12	Nos	399.00	4788.00

		Total				294863.50

C. Cost of Recovery (according to Uniform Rate Schedule-2014)

Sl. No.		Description of Materials	Qty.	Unit	Unit Price in TK as 2014	Total Amount in Tk.
1		Steel Pole 15 Meter		Nos	1,975.00	0.00
2		SPC Pole 15 Meter		Nos	2,597.00	0.00
3		SPC/RCC Pole 12 Meter		Nos	2,307.00	0.00
4		SPC /RCC Pole 9/10 Meter		Nos	1,578.00	0.00
5		12M Pole 350/600 dan/Htsteel		Nos	1,689.00	0.00
6		LT Steel / 330dan Steel Pole		Nos	1,246.00	0.00
7		Lay pole (HT/LT)		Nos	1689.00	0.00
8		33 KV tower		nos	6789.00	0.00
9		33 kv Pin insulator 1 set=3 pcs)		set	145.00	0.00
10		33 KV disc Insulator, 1 set=9 pcs		set	207.00	0.00
11		33 KV HT Cross arm		Each Pole	805.00	0.00
12		11KV Pin Insulator with pin, 1 set = 3 pcs		Set	204.00	0.00
13		Top & Side Mount Bracket		Set	351.00	0.00
14		11 KV Cross arm		Nos	443.00	0.00
15		11KV Disk insulator		Set	405.00	0.00
16		Down Guy set		Nos	412.00	0.00
17		Over Head Guy Set		Nos	375.00	0.00
18		X-former Platform Angel		Nos	473.00	0.00
19		L.A		Nos	130.00	0.00
20		DOFC		Nos	130.00	0.00
21		Fuse Mount Channel		Nos	421.00	0.00
22		X-former (3-ph) upto 250 KVA		Nos	9687.00	0.00
23		X-former (1-ph) upto 75 KVA		Nos	1384.00	0.00
24		LV Spool Insulator(400 V		Set	184.00	0.00

		shackle)				
25		MCCB with box, 200A		Nos	533.00	0.00
26		HT/LT Out Rigger		Set	351.00	0.00
27		5 spool wire rack		Nos	301.00	0.00
28		ACSR Wolf/Merlin		Km	3513.00	0.00
29		HT ABC *		Km	2418.00	0.00
30		LT ABC *		Km	2164.00	0.00
31		Wasp/Dog Conductor		Km	2893.00	0.00
32		Ant/Rabbit conductor		Km	2418.00	0.00
33		Gnet conductor		Km	2164.00	0.00
		Total				**0.00**

D.	**DESCO's service charge 20% of (B+C)=**	58972.7
	Grand Total = (A+B+C+D)=	**4754508**

In words: Forty Seven Lakh Fifty Four Thousand Five Hundred Eight TK Only.

5.6.2 Loss for Merlin Conductor

Transformer has made it possible to transmit AC power at high voltage and utilize it at a safe potential. High transmission and distribution voltages have greatly reduce the current in the conductors and the resulting line loss. Only change the conductor rabbit to merlin and defused insulator of 0.55 km feeder line and have installation of the capacitor bank for improving the power factor. Then we can improve the feeder loss.

Max. Voltage drop at Connecting point = [Max. Current (A) × Impedance (Z) × Length (Km)] Volt

$= [90 \times \{\sqrt{(0.1900^2 + 0.3389^2)}\} \times 0.55]$ Volt

= 19.232085 Volt

= 0.019232 KV

Loss by suggest cable on feeder Ⅲ

Sending End Power = 483720 KWh

Receiving End Power = 460720 KWh

Power loss in Hour = (483720-460720) KWh

= 23000 KWh

System loss = $\frac{483720-460720}{460720}\times 100$

= 4.99 %

≈5 %

So we can reduce the system loss = (12.30-5) %

≈7.30 %

By the up grating the conductor from rabbit to merlin conductor.

Total cost in implementing this method is 580387 TK (7739US$) as shown in Table 5.2

TABLE 5.2 COST ANALYSIS FOR UPGRADING OF THE CONDUCTOR, INSTALLATION OF INSULATOR AND CAPACITOR BANK OF THE TOWN ON Ⅲ FEEDER

Cost of Material						
A. Cost of Materials including overhead cost(according to the price list on dated 01/01/2019 from account department)						
Sl. No.	**Code No**	**Description of Materials**	**Qty.**	**Unit**	**Unit Price in TK**	**Total Amount in Tk.**
1	201.161	Three Phase Terminal Cross Arm	8	Nos	526.65	4213.23
2	201'163	HT Cross Arm	2	Nos	1,771.00	3542.00
3	600'101	11KV Pin Insulator	20	Nos	370.27	7405.31
4	601.103	11 KV Tension Clamp/Suspension	5	Nos	1,037.63	5188.17
5	201'124	5 spool wire rack(Angel)	1	Nos	2,027.80	2027.80
6	600'103	LV Spool Insulator	2	Nos	22.51	45.01
7	201'131	Guy set	2	Nos	3,629.57	7259.15
8	201'158	Two way Clamp	8	Nos	457.56	3660.50
9	100'107	Al Binding Wire (Insulated)	0.15	Km	16,788.10	2518.22
10	100.108	Al Binding Wire (Bare)	0.15	Km	19,257.08	2888.56
11	100'103	ACSR Merlin conductor	2.2	Km	165,593.96	364306.71
12	102'107	Preformed armour rod for Merlin	60	Nos	660.41	39624.60
13	101.128	Crimpits	20	Nos	257.34	5146.71
14	301'102	DOFC	1	Nos	1,796.30	1796.30
15	201'135	Earthing Rod	5	Nos	1,042.28	5211.40
16	106.107	Ins. Tension Connector 70 / 70 mm for phase	3	Nos	472.65	1417.95
17	106.110	End Cap for 3*70 mm +1*54.5 mm	4	Nos	530.15	2120.60
18	101'130	Service Bail	3	Nos	81.10	243.29
19	101'131	Service Bail Crimpit 100/25	3	Nos	85.33	255.99
20	101'115	Mid Span Joints For Merlin	12	Nos	535.91	6430.92

21	101'117	Mid Span Joints For Ant	3	Nos	202.73	608.20
		Total				**465910.61**

Sl. No.		Description of Materials	Qty.	Unit	Unit Price in TK as 2014	Total Amount in Tk.
1		11KV Pin Insulator with pin	20	Set	163.00	3260.00
2		5 spool wire rack	1	Nos	403.00	403.00
3		LV Spool Insulator	2	Set	147.00	294.00
4		Down Guy set	2	Nos	479.00	958.00
5		DOFC	1	Nos	223.00	223.00
6		AAC Ant/Gnet Conductor	0.55	Km	7262.00	3994.10
7		ACSR Merlin conductor	2.2	Km	9869.00	21711.80
8		Muffling	6	Cu.M	9498.00	56988.00
9		Crimpit	20	Nos	79.00	1580.00
10		Mid Span Joints	15	Nos	399.00	5985.00
		Total				95396.90

C. Cost of Recovery (according to Uniform Rate Schedule-2019)

Sl. No.		Description of Materials	Qty.	Unit	Unit Price in TK as 2014	Total Amount in Tk.
1		Steel Pole 15 Meter		Nos	1,975.00	0.00
2		SPC Pole 15 Meter		Nos	2,597.00	0.00
3		SPC/RCC Pole 12 Meter		Nos	2,307.00	0.00
4		SPC /RCC Pole 9/10 Meter		Nos	1,578.00	0.00
5		12M Pole 350/600 dan/Htsteel		Nos	1,689.00	0.00
6		LT Steel / 330dan Steel Pole		Nos	1,246.00	0.00
7		Lay pole (HT/LT)		Nos	1689.00	0.00
8		33 KV tower		nos	6789.00	0.00
9		33 kv Pin insulator 1 set=3 pcs)		set	145.00	0.00
10		33 KV disc Insulator, 1 set=9 pcs		set	207.00	0.00
11		33 KV HT Cross arm		Each Pole	805.00	0.00
12		11KV Pin Insulator with pin, 1 set = 3 pcs		Set	204.00	0.00
13		Top & Side Mount Bracket		Set	351.00	0.00
14		11 KV Cross arm		Nos	443.00	0.00
15		11KV Disk insulator		Set	405.00	0.00
16		Down Guy set		Nos	412.00	0.00
17		Over Head Guy Set		Nos	375.00	0.00
18		X-former Platform Angel		Nos	473.00	0.00
19		L.A		Nos	130.00	0.00
20		DOFC		Nos	130.00	0.00
21		Fuse Mount Channel		Nos	421.00	0.00

22		X-former (3-ph) upto 250 KVA		Nos	9687.00	0.00
23		X-former (1-ph) upto 75 KVA		Nos	1384.00	0.00
24		LV Spool Insulator(400 V shackle)		Set	184.00	0.00
25		MCCB with box, 200A		Nos	533.00	0.00
26		HT/LT Out Rigger		Set	351.00	0.00
27		5 spool wire rack		Nos	301.00	0.00
28		ACSR Wolf/Merlin		Km	3513.00	0.00
29		HT ABC *		Km	2418.00	0.00
30		LT ABC *		Km	2164.00	0.00
31		Wasp/Dog Conductor		Km	2893.00	0.00
32		Ant/Rabbit conductor		Km	2418.00	0.00
33		Gnet conductor		Km	2164.00	0.00
		Total				**0.00**

D.	**DESCO's service charge 20% of (B+C)=**	19079.38
	Grand Total = (A+B+C+D)=	**580387**

In words: Five Lakh Eighty Thousand Three Hundred Eighty Seven TK Only.

5.7 Conclusions

By changing the conductor size / type of feeder, the power loss at 11kV kallyanpur area feeder at overall all substation distribution feeder, Dhaka are found to be reduced from 11.23 to 5.70. If this technique applied on all the company feeders can result in large saving of power and can be very effective in addressing the power shortage in Dhaka city. The restructuring strategy developed using CYME Power software is proved to be an effective tool to bridge the demand and supply gap of power in Dhaka or Bangladesh. On the whole, therefore, it is proposed that this innovative technique should be applied at all the feeders to meet the growing demand of electricity. As in terms of energy “A unit saved is equal to a unit earned”. If the proposed measures are adopted then certainly we will be able to achieve the target of “Power for all in 2020”.

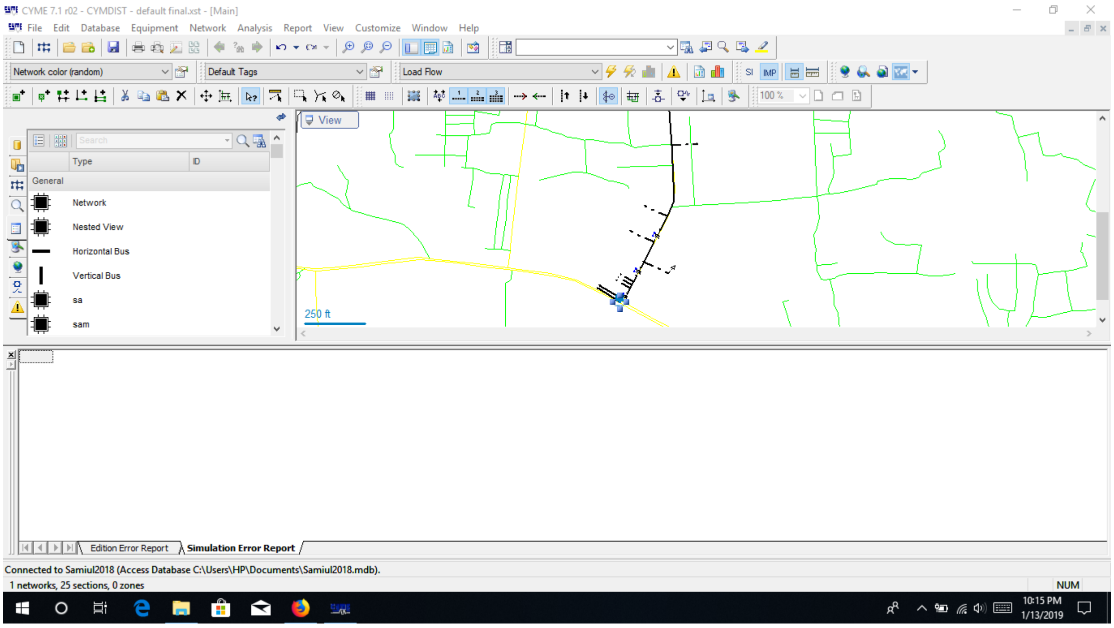
CHAPTER 06

SIMULATION & RESULT

6.1 Introduction

Power load-flow analysis is executed to find the sensitivity of feeder status with variation of power loading, conductor length, and total capacity of distribution transformers. They are used to ensure that electrical power transfer from generator to consumers through the grid system is stable, reliable and economical. To overcome the computational problems of power-flow solution using load-flow iterative technique Newton Rap son and Gauss Siedel as contained in, one best method to see a system is by making model and doing simulation. To make a good simulation, it needs a model based on real condition. The making of this model must be based on real and valid data so the model can represent real condition. By using simulation, the expected result can be seen in every point and changes can be made in the model to improve the weak points. Model is a representation of a system and electricity distribution is also a system. So the paper is for the simulation and result of electrical distribution grid on a Computer system are conducted with the aim of improving the voltage profile of some weak feeder.

6.2 Simulation



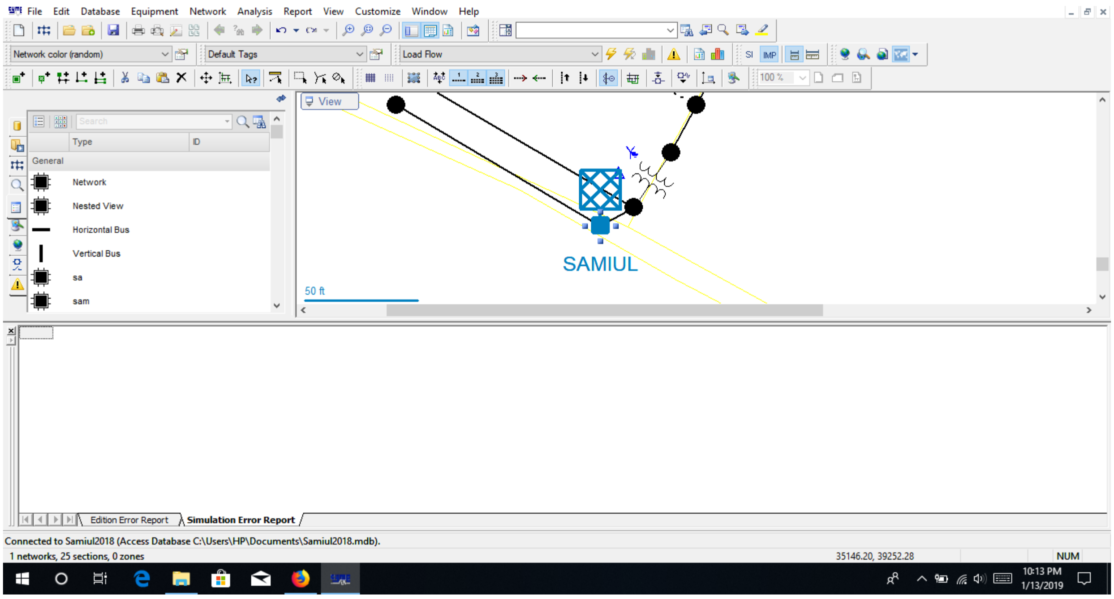


Figure 6.1: Simulation of Feeder Ⅲ

6.3 Result

Unit price list of 11kv in DESCO:

Residential Flat = 8.00 tk

Business & office Flat = 8.40 tk

Industrial Flat = 8.15 tk

Under construction Flat = 11 tk

General Flat = 8.05 tk

Others = 15 tk

Total = (8.00+8.40+8.15+11+8.05+15)

= 58.60 tk

Average unit price = $\frac{58.60}{6}$ tk

= 9.77 tk

Loss improvement:

I^2R loss in Rabbit conductor = $(90^2 \times 1.015)$

Unit loss in Rabbit conductor = $(\frac{90^2 \times 1.015 \times 24}{1000})$ KW

= 197.316 KW

Rabbit loss in Taka = (197.32×9.77) Taka

= 1928 Taka.

I^2R loss in Merlin conductor = $(90^2 \times 0.19)$

Unit loss in Merlin conductor = $(\frac{90^2 \times 0.19 \times 24}{1000})$ KW

= 36.936 KW

Merlin loss in Taka = (37×9.77) Taka

= 360 Taka

Total improvement Power = (198-37) KW

= 161 KW

Total improvement in Taka = (161×9.77) Taka

= 1573Taka

Monthly improvement power = (161×30) KW

= 4830 KW

Monthly improvement in Taka = (4830×9.77) Taka

= 47189 Taka

Annual improvement in power = (161×365) KW

= 58765 KW

Annual improvement in Taka = (58765×9.77) Taka

= 574134 Taka

6.4 Conclusion and Recommendation

In literature different approaches has been utilized to improve positively on the distribution network. The task takes stringent steps in achieving the aim as in this research work. The materials and methods employed here are technically direct, using a load flow approach as the simulation tool to investigate the different scenarios/ sections of the principal algorithms regarding the objectives of the research work. The Ⅲ feeder has been the longest feeder with a load capacity of 28MVA and was not effective in its operational capability due to very low voltage experienced at the end of the feeder.

The continual increase in electric power demands without corresponding increase in generation will persistently cause a drawback in a technologically driven economy. The consequence by which a country is under developing is the issues of incessant power interruption, inadequacy, unreliability and unclean power supply. Developed countries are associated with continual research for improvement in the power sector as it affects all sectors of life.

To relieve the central generation and control of electric power, and its transmission pressures, we recommend that:

- Modeling of kallyanpur substation Ⅲ feeder
- Restructuring the 11 kV feeder Parameters
- Installation of Capacitor
- Establishment of new Distribution Center
- Improvement of revenue collection efficiency
- Detection and control of theft

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