AN INTERNSHIP REPORT
ON
POWER DISTRIBUTION SYSTEMS

A Project and Thesis submitted in partial fulfilment of the requirements for the Award of Degree of
Bachelor of Science in Electrical and Electronic Engineering

Submitted by

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NOVEMBER-2018

CONCERN LETTER

DHAKA ELECTRIC SUPPLY COMPANY LIMITED

POWER IS YOURS

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Certificate no-402/2017

To Whom It May Concern

This is to certify that ***Md. Tipu Sultan*** *S/O- Md. Khejer Ali, Student ID: 132-33-1529, Department of Electrical & Electronic Engineering, Daffodil International University, Dhaka, Bangladesh, has successfully completed* ***Internship Program*** *in Dhaka Electric Supply Company Limited (DESCO) from July 30, 2017 to August 30, 2017.*

Manager (Current Charge)
Training & Development.

Deputy General Manager (Current Charge)
HRM Division.

Issue date: September 25, 2017

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Manager (Current Charge)
Training & Development.

Deputy General Manager (Current Charge)
HRM Division.

Issue date: September 25, 2017

CERTIFICATION

This is to certify that this internship entitled "An internship report on power distributionsystems" is done by the following students under my direct supervision and this work has been carried out by them in the Rupnagar S & D division of Dhaka Electric Supply Company Limited and laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of 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 -2017.

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iv
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DEDICATED TO

OUR PARENTS

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All praises go to Allah, the almighty, for the successful completion of this internship and fulfillment of ours dream into reality. However, thanks and gratitude are also due to the following persons for their continuous support in completing this internship and in preparing thisreport.

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ABSTRACT

Electricity plays a vital role in the socio-economic development and poverty alleviation. It is considered as the driving force of all development activities. To alleviate poverty in the face of resource limitations and high population density, Bangladesh requires an economic growth rate of about 10% p.a. to provide employment to its rapidly growing labor force that cannot be absorbed by agriculture. In order to achieve this growth rate, availability of a reasonably priced and reliable source of electricity is a prerequisite.The power sector in Bangladesh faced numerous problems characterized by lack of supply capacity, frequent power cuts, unacceptable quality of supply, and poor financial and operational performance of the sector entities. The customer service is not praiseworthy. There have been a number of reforms in the power sector in Bangladesh since her independence, but most of these reforms failed to bring desired improvements in the power sector. The most pressing problem in the power sector has been with the distribution system, which is characterized by heavy system loss and poor collection performance; however, the distribution system seldom got the priority in reform initiatives.

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LIST OF ABBREVIATIONS

CT	Current Transformer
PT	Potential Transformer
SCADA	Supplementary Control And Data Acquisition
GIS	Gas Insulated Switchgear
REF	Restricted Earth Fault
CB	Circuit Breaker
L.A	Lightening Arrester
HRC	High Rupturing Capacity
CRP	Control Relay Panel
MMF	Magneto Motive Force
PB	Push Bottom
NO	Normally Open
NC	Normally Close
TC	Trip Coil
PR	Protective Relay
PE	Protective Earth
BERC	Bangladesh Energy Regulatory Commission
DESCO	Dhaka Electric Supply Company Limited
OMF	Overall multiplication factor
AIS	Air Insulated Switchgear
PFI	Power Factor Improvement

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Bangladesh's energy infrastructure is quite small, insufficient and poorlymanaged. The per capita energy consumption in Bangladesh is considered low by global standards. Noncommercial energy sources, such as wood fuel, animal waste, and crop residues, are estimated to account for over half of the country's energy consumption. Bangladesh has small reserves of oil and coal, but very large natural gas resources. Commercial energy consumption is mostly natural gas (around 66%), followed by oil, hydropower and coal.

Electricity is the major source of power for most of the country's economic activities. Bangladesh's total installed electricity generation capacity (including captive power) was 15,351 MW as of January 2017. As of 2014, only 62% of the population had access to electricity with a per capita availability of 321 kWh per annum. Problems in the Bangladesh's electric power sector include corruption in administration, high system losses, delays in completion of new plants, low plant efficiency, erratic power supply, electricity theft, blackouts, and shortages of funds for power plant maintenance. Overall, the country's generation plants have been unable to meet system demand over the past decade.

On 2 November 2014, electricity was restored after a day-long nationwide blackout. A transmission line from India had failed, which "led to a cascade of failures throughout the national power grid," and criticism of "old grid infrastructure and poor management." However, in a recent root-cause analysis report the investing team has clarified that fault was actually due to Lack in electricity management & poor Transmission & Distribution health infrastructure that caused the blackout.

1.2 History of Power Sector in Bangladesh

In 1957, the government of East Pakistan took over all private power generation houses and distribution lines and established Power Development Board (PDB) in 1959 as an associate of the East Pakistan Water and Power Development Authority (EWPDA). It became an independent body in 1972 and it's headquarter was in Dhaka. Its responsibility was to control power plant s and distribution network throughout Bangladesh.

At first BPDB used to generate transmit and distribute power. BPDB started generating power; transmission responsibility was given to PGCB. BPDB used to distribute power to mainly the urban areas except the metropolitan city of Dhaka. The responsibility of distributing power in Dhaka was given to Dhaka Electric Supply Authority (DESA). Later, DESA went through lots of controversies and corruption. Then Bangladesh government formulated National Energy Policy in 1996 and segregated power generation, transmission, and distribution functions in to separate services. Government created a new subsidiary named Dhaka Electric Supply Company Ltd. (DESCO) and provided the responsibility of electricity distribution in Mirpur, Gulshan, Baridhara and Uttara area of Dhaka. In 2005, Dhaka Power Distribution Company Limited (DPDC) was born.

The first effort to structure a legal framework for the industry came in 1910 with the enactment of the Indian Electricity Act, 1910. This Act sought to regulate the business of industry still based on the old concept of isolated privately owned distribution networks fed by small generation stations & essentially defined the rights & obligations of the supplier and the consumer.

In 1947, at the time of independence of India & Pakistan, the installed generating capacity in the then East Pakistan was only 21 MW. Electricity was available to only small elite in the district and sub-divisional headquarters. The distribution networks in these cities were isolated and were fed by coal fired steam power plants or diesel generation. In an effort to expeditiously augment generation capacity to feed a development economy, the Government of Pakistan issued and ordinance in 1959 creating the East Pakistan Water and Power Development Authority (EWAPDA). The Ordinance essentially provided for the Governments takeover of allgeneration, Transmission and distribution facilities from the private sector, thereby creating a total Government monopoly in the sector. During 1960 to 1970 the generation capacity of the then East Pakistan rose from 88MW to 475 MW, supplied largely by natural gas and oil fired, steam power and hydro plants. The networks of Dhaka and Chittagong and then been interconnected albeit with weak 132 KV links.

Shortly after the creation of an independent Bangladesh, in 1972, the first Government of Bangladesh, in an effort to speed up the investment in the sector issued an Ordinance creating the Bangladesh Power Development Board (BPDB) as the successor organization of the power side of EWAPDA. The Ordinance recognized the divergence of energy related issues in development. During 1972 to 1995, BPDB has increased the generating capacity in the country to 2818 MW, and the length of its 230 and 132 KV transmission networks to 419 KM and 2469 KM.

For the first time in December 1982, the eastern and western halves of the country were electrically connected through the commissioning of double circuit 230 KV transmission line across the Jamuna River energized at 132 KV between Ishwardi and Tongi called the first East-West Interconnector. Generation sources were diversified to include a 230 MW hydropower station at Kaptai on the Karnaphuli River and natural gas and imported fuel based, open and combined cycle power plants at different locations of Eastern and Western part of the country. The distribution networks of all major towns and cities had been linked through 230 KV and 132 KV inter-ties.

In order to intensify the pace of rural electrification, the Government issued as ordinance in 1977 establishing the Rural Electrification Board (REB), a semi-autonomous agency charged with the responsibility of planning, developing, financing and construction of rural distribution networks, promoting the establishment of Rural Electric Cooperatives (Palli Bidyut Samities), handing over the constructed rural networks to them, assisting the PBSs to operate and maintain the rural networks and monitoring their financial performance. The REB has so far constructed over 46,000 Km of distribution lines and provided over 950,000 consumers connections in the rural areas (As of June, 1995.

1.3 Structure of Power Sector in Bangladesh

Power Division is responsible for formulating policy relating to power and supervise, control and monitor the developmental activities in the power sector of the country. To implement its mandate the Power Division is supported by a number of organizations, related with generation, transmission and distribution. The organizational linkage is as follows:

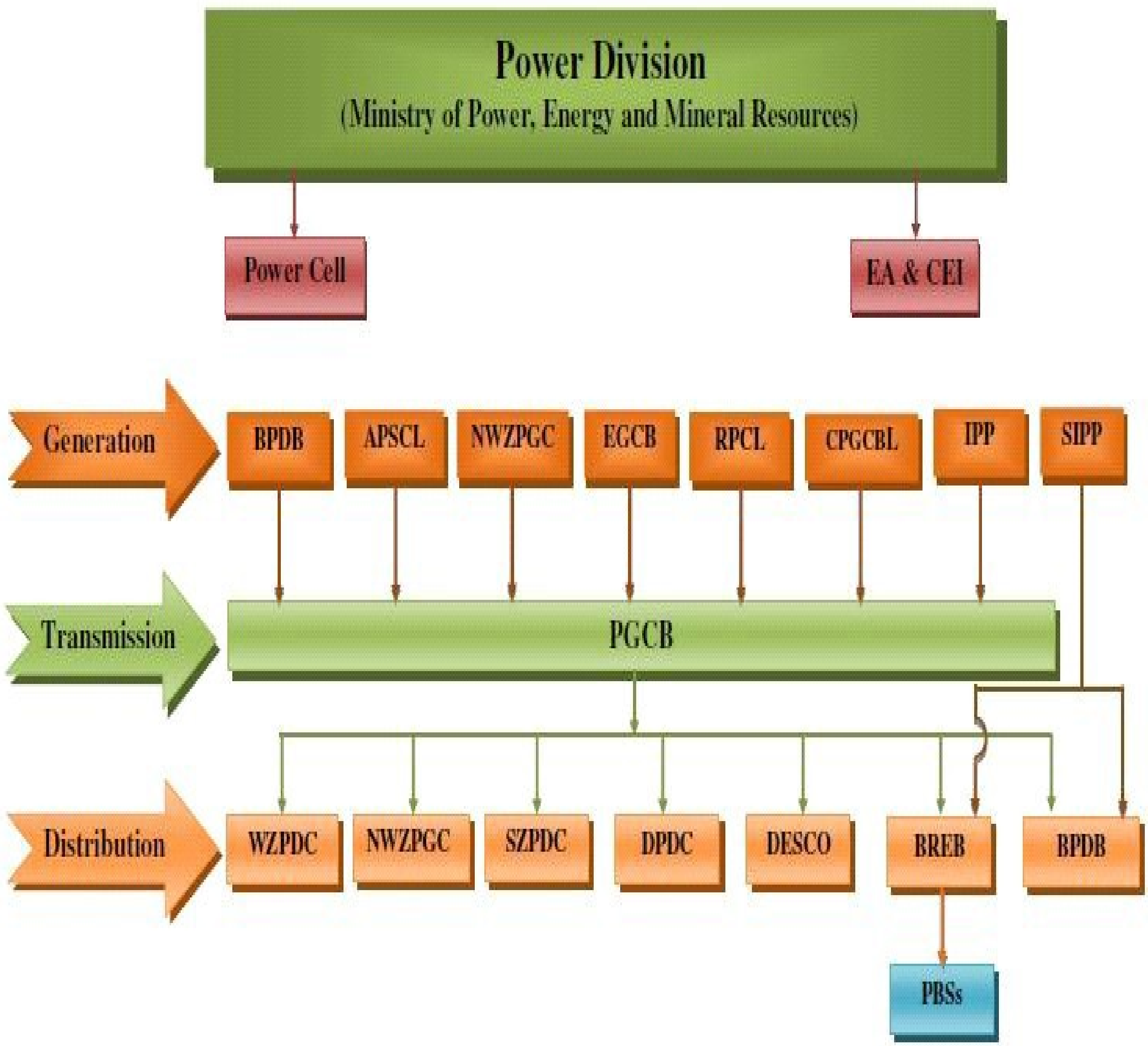

Figure 1.1: Power Sector Structure

1.4 OBJECTIVE

1.4.1 Broad Objective

The main objective of the report has been done to show the total working procedure of power transmission, distribution, substation operation, controlling and various protection systems.

1.4.2 Specific Objective

The specific objective of this report includes.

- ✓ To study operation of 33/11KV substation.
- ✓ To study the process of power transmission and distribution.
- ✓ To make an analysis of total power consumption, various losses.
- ✓ To specify the fault and their protection systems.

1.5 Scopes of Dhaka Electric Supply Company Limited (DESCO)

1.5.1 Vision:

To be an enabler of economic development and social progress by providing safe, reliable and sustainable electricity.

1.5.2 Mission:

Bringing comfort to customers, supporting business and commerce and building strong communities. Achieving and maintaining the highest degree of efficiency, reliability and responsiveness for variety of customers.

1.5.3 Corporate Philosophy:

We will Achieve our vision through our core corporate principle.

Safety: Placing the safety of our communities, customers and employees first;

Customer Focus: Providing superior service to help customers more effectively manage their use of electricity;

Operational Excellence: Incorporating continuous improvement to deliver safe and dependable electricity at affordable prices;

Performance Driven Culture: Fostering a strong values and performance based culture designed to attract, develop and retain best talents.

1.6 Internship

Internship is such an opportunity to learn those activities that are related to our real engineering world. During my internship period, I have been able to gather some knowledge on sub-substation, transformer and their maintenance and the power factor improvement which are closely relatedto my study materials. I have also observed their administrative activities of control room; complain room operation, IT (Information & Technology) and one point operation which will surely help me to visualize the effectiveness in my practical life.

1.7 Internship Report Outline

This Internship report is organized as follows:

Chapter 1 Introduction.

Chapter 2 Dhaka Electric Supply Company Limited (DESCO).

Chapter 3 Operation of Substation.

Chapter 4 Equipment & Operation of a Transformer

Chapter 5 Maintenance & Protection of Substation.

Chapter 6 Numerical Data Analysis

Chapter 7 Result and Discussion.

Chapter 8 Conclusion

CHAPTER 2

COMPANY PROFILE

2.1 History of DESCO

Dhaka Electric Supply Company Limited (DESCO) is a Public Limited Company which distributes electricity at the Northern parts of Dhaka City Corporation area. The company was created on November 1996 under the companies Act 1994 as a Public Limited Company with an authorized capital of Tk. 5.00 billion, due to improve power sector, to provide better service and to improve revenue collection specially in Dhaka city. However, the operational activities are at DESCO's field level commenced on September 24, 1998. The company is now under the Power Division of the Bangladesh Ministry of Power, Energy and Mineral Resources and serving a total no of 6,60,000 consumers as of February 2015.

2.2 Structure of The DESCO

DESCO incorporated under the Companies Act 1994 with its own Memorandum and Articles of Association. The company as a whole owned by Government of Bangladesh and DESA representing government by acquiring 100% shares. DESCO managed by a part time Board of Directors appointed by its shareholders, they are responsible for policy decisions. The Board of Directors appointed managing Director and two full time Directors and they were also members of the Board Directors after appointment. The organizational of the company is as follows:

- The Chairman DESA being the Board of Directors on his nominee till such time DESA owns the majority of the shares in DESCO.
- The Managing Director acts as the Chief Executive Officer of the company and responsible for overall management of the company.

- The Director (Technical) responsible for development planning supply demand management and operation and maintenance of the system.
- The Director (Finance) responsible for all financial matters and commercial operations of the company.

2.3 Start UP to the DESCO

DESCO was constituted to provide uninterrupted & stable power supply, better consumer service, improve system loss & CI ratio and accordingly DESCO starting its operational activity since September 24, 1998 by taking over of Mirpur area from DESA. Following are the initial activity of DESCO which includes:

- Operation & Maintenance of Sub-Stations & Lines;
- Commercial functions i.e. billing, consumer accounting, disconnection & re-connection of consumers, testing & installation of consumer meters etc.
- Planning, Design and installation of Sub-stations & lines etc.

The service territory of DESCO is as follows where the above services provided:

2.3.1 1st Phase:

Mirpur area bounded by Rokeya Sarani and low lying area in between Mirpur and Cantonment in the East, Agargaon road in the South, Mirpur Road and Turag river in the West and low lying areas in the North. The proposed area is shown in the enclosed map. The area covered under the 1st phase was taken over by DESCO on September 24, 1998 from DESA.

2.3.2 2nd Phase:

Gulshan Circle including Mirpur Area bounded by Balu River in the east, Turag River in the west and Turag and Balu River in the Nort and Mirpur Road, Agargaon Road, Rokeya Sarani, Progoti Sarani, New Airport Road, Maymenshing Road, Mohakhali Jheel, Rampura Jheel connected with Balu River in the South (Map enclosed). The additional area covered under the 2nd phase was taken over by DESCO on April 09, 2003 from DESA.

DESCO recruited its employees through open advertisement. The qualification and experience requirement were fixing up according to the requirement for performing their duties and responsibilities against the respective post. Mainly those who have sufficient experience in the field of utility organization are selected on a merit basis. They were employed on long-term contracted basis under the DESCO's service rules approved by its Board of Directors.

2.4 Project Financing of DESCO

It is suggested that DESCO initially be financed on a debt equity ratio of 50:50. This conservative leveraging has been suggested since DESCO being a new organization handling a fairly complex project in a not-so-successful area in the power sector. Hence investor confidence is likely to be low. However, as DESCO demonstrates its capabilities in project execution and operations, this confidence level will increase and then the leveraging of capital may be made less conservative. The Government provided the first infusion of equity of DESA in DESCO from its Annual Development Budget 1996-97.

Out of the total Project cost of Taka 126.06 Crores, the foreign exchange portion amounts to Taka 80.60 Crores (65%) and the local cost portion Taka 45.45 Crores (35%). The Asian Development Bank financed under the Loan No. 1505-BAN (SF): Ninth Power Project (DESCO Component for Mirpur area) in first phase and under the Loan No. 1731-BAN (OCR) they were again financed for Dhaka Power System Upgrade Project: Tenth Power Project Loan for Gulshan area. Local costs, which would constitute about 30% (thirty percent) of the total project cost will be met from the equity part of DESCOS's finances. Arrangement will be made for arranging funding for remaining part of the project from other donors.

2.5 Organization & Service Area of DESCO

The company is run by a small management team headed by the Managing Director under the guidance of a Board of Directors and 16 numbers of sales and distribution (S & D) division and above two numbers of grid-substations. DESCO always visualizes running the system efficiently and economically keeping minimum overhead cost with minimum number of skilled manpower. The area is about 250 square kilometers comprises the areas bounded by the Mirpur Road, Agargaon Road, Rokeya Sarani, Progati Sarani, New Airport Road, Mymenshing Road, Mohakhali Jheel, Rampura Jheel connected with Balu River in the south, Balu River in the east and Turag River in the west and areas under Tongi Pourashava in the north. It may be mentioned that "Purbachal Model Town" a Rajuk project, situated on the east side of Balu River, adjacent to Dakkhinkhan area, has been decided to be included under DESCO.

2.6 Milestones of DESCO

1996
- November 3, 1996- Certificate of Incorporation
- December 19, 1996 - First Board Meeting

1998
- September 24, 1998 - Takeover of Mirpur area from DESA
- Commencement of Commercial Operation

2003
- April 9, 2003 - Takeover of Gulshan Circle from DESA

2004
- February 15, 2004- Establishment of Sales and Distribution (S & D) Divisions

2005
- September 7, 2005- Inauguration of Prepaid Metering System

2006
- June 18, 2006- Company goes Public

2007
- March 3, 2007- Takeover of Tongi Pouroshova Area
- November 15, 2007- Distribution License from BERC

2008
- November 11, 2008- Inauguration of DAS (Data Acquisition System)

2010
- June 4, 2010 - Introduction of Online Bill Payment System

2012
- February 23, 2012 -Online Application for New Connection

2013
- July 22, 2013- Online Application for Recruitment

2.7 Operational Zone and Sales & Distribution Division

The Superintending Engineer is in-charge of a zone who supervises the Executive Engineers, the key responsible person of each S&D Division. Each Executive Engineer accomplishes his duties by two Sub-Divisional Engineers, one for system related activities and another for commercial related activities. Two Assistant Engineers act as assisting body under each Sub-Divisional Engineer**.**

System related activities include scheduled maintenance, trouble shooting and breakdown maintenance of substation and switching stations, trouble shooting of customer complaints, line & equipment maintenance etc. Commercial related activities include meter reading, distribution of monthly electricity bills, service disconnection of the defaulter consumer, customers' house wiring inspection, new electric connection, meter installation, change of old or unserviceable meteretc.

2.8 Name of Zones and S&D Divisions

Name of zone	Name of S&D division
Gulshan	Badda, Baridhara, Joarshahara, Gulshan
Mirpur	Agargaon, Kafrul, Monipur, Pallabi, Rupnagar, Shah Ali
Uttara	Dakshinkhan, Tongi (East), Tongi (West), Uttara (East), Uttara (West), Uttarkhan

2.9 Substation and Sales & Distribution Division

2.9.1 It consists of two functions:

- Commercial operation.
- Systems Operation.

2.9.1.1 Commercial Operation:

- Disconnection / Reconnection – Metering.
- One-point service center.
- Billing /collection.

2.9.1.2 System Operation:

- New connection
- Load sanction & load retention
- Load management
- Control room activity
- Power factor monitoring &upgrading
- Substation operation & maintenance
- Line maintenance
- Wireless & telecommunication
- DAS maintenance etc.

2.10 Fiscal Year Wise Operational Data

Monthly Operational Data

Sl. No.	Particulars	Feb-17	Jan-17	Dec-16	Nov-16	Oct-16	Sep-16	Aug-16	Jul-16
01.	Energy Purchase (MKWh)	305.688	302.914	316.096	364.044	491.004	443.75	503.827	439.675
02.	Energy Sales (MKWh)	286.547	289.255	305.242	358.902	458.524	425.063	473.447	424.766
03.	System loss(%)	6.26	4.51	3.43	1.41	6.61	4.21	6.03	3.39
04.	Purchase Rate (Tk.)	6.13	6.13	6.13	6.13	6.13	6.13	6.13	6.13
05.	Selling Rate (Tk.)	7.26	7.16	7.16	7.52	7.16	7.24	7.12	7.29
06.	Billing Amount (MTk.)	2081.65	2071.22	2184.14	2699.89	3283.65	3078.78	3368.91	3097.32
07.	Bill Collection (MTk.)	2092.4	2366.24	2780.19	3223.19	3238.96	3025.2	3243.02	2563.9
08.	Collection Billing Ratio (%)	100.52	114.24	127.29	119.38	98.64	98.26	96.26	82.78
09.	C.I Ratio (%)	94.22	109.09	122.92	117.7	92.11	94.12	90.46	79.97
10.	No of Consumer	799922	791223	784592	780627	776985	771917	768912	764126

Table 2.1: Fiscal year wise operational data.

2.11 Fiscal Year Wise System Loss Graph

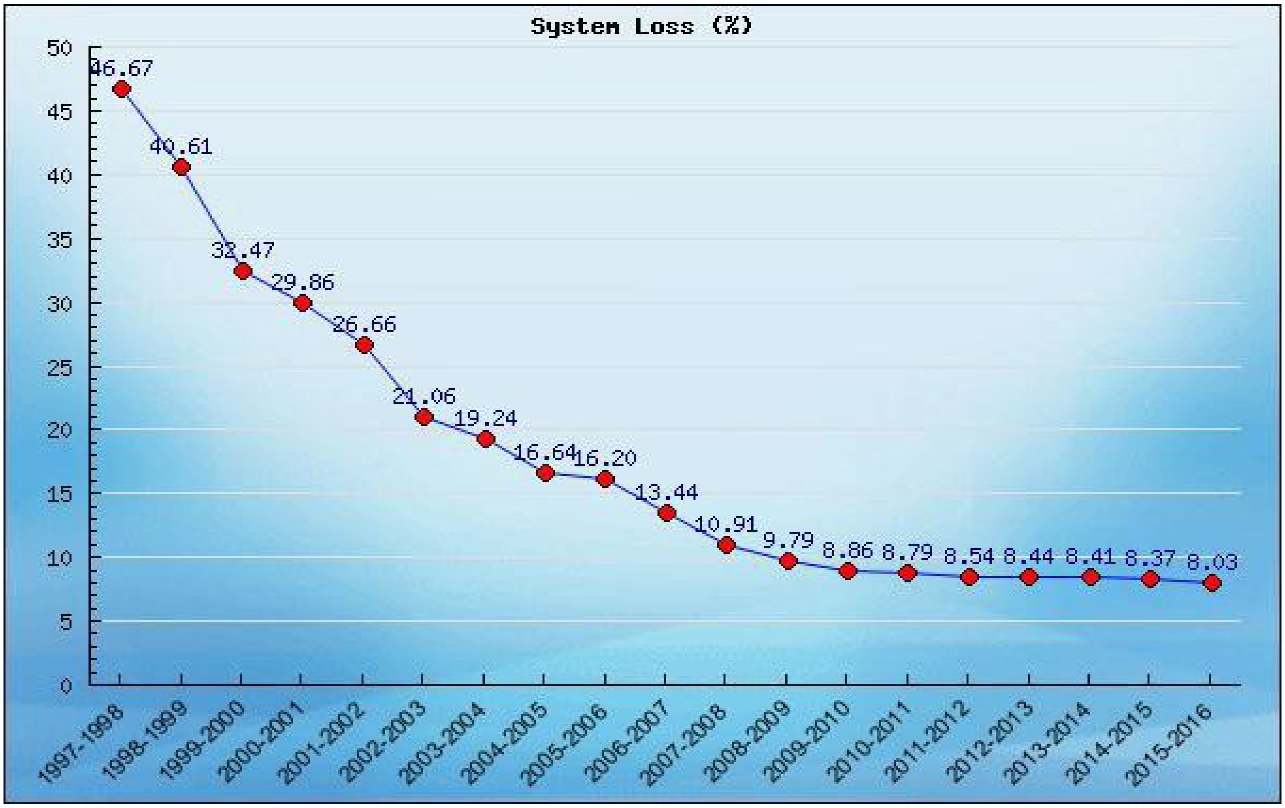

Table 2.2: Fiscal year wise system loss.

CHAPTER 3

OPERATION OF SUBSTATION

3.1 Operation of Substation

Substation is an interrelated network for delivering electricity from suppliers to consumers. The DESCO has no power plant. Therefore, they purchase power that is transmitted from Power Development Board (PDB) via Power Grid Company of Bangladesh (PGCB) at different places of Dhaka city. A Substation transforms voltages from high to low by using Power Transformers. A Substation that has a step-down distribution Transformer decreases the voltage while increasing the current for domestic and commercial uses of electricity. During my internship period, I have visited following:

Substation:

- Digun Substation (33KV/11KV).

3.2 Rupnagar S&D at a Glance

Consumers	58029
Import (KWh)	16134173
Sales (KWh)	15201950
Import (Tk)	85267443
Vat (Tk)	5502090.45
Billing Amount (Tk)	120041809
Collection Amount (Tk)	119724227
Selling Rate (Tk)	6.79
System Loss (%)	-7.06
Collection Ratio (%)	117.89
C.I Ratio (%)	126.20

Table 3.1: Rupnagar S&D At a Glance

This information has been taken for one month from August 2017. At Digun Substation, there are three incoming sources from Uttara 132KV bus, 132KV bus, bus PT-1 (potential transformer), bus PT-2 (potential transformer), 132KV bus coupler and the insulator of Digun Substation are shown in figure (3.1)

Figure 3.1: Power Transformer (132/33) at Digun Substation

HT Bushing, potential transformer (PT), lighting arrester (L.A), current transformer and 132KV incoming source from Uttra Grid to Digun substation are shown in figure 3.2

Figure 3.2: 132KV incoming source from Uttara Grid, CT, L.A, PT, HT Bushing

Actually single line diagram is the basic configuration to understand the basic operation of substation. It has been shown that how 132KV incoming sources are connected to the Digun substation and then how it transforms from 33KV to 11KV. Initially 132 KV incoming sources from Uttara Grid is connected to Digun substation via UG/OHL (UG means underground and OHL means overhead line), then safety equipment L.A. (Lighting Arrester), potential transformer (PT), HT Bushing, Isolator, current transformer (CT) are connected to 33KV bus. Then 33KV bus coupling is used to run or to keep active both 33KV bus and 33KV bus. Then again PT, Isolator, CT, L.A. and Power transformer- T1 & T2 which are transformed the voltages from 33KV to 11KV. Subsequently 11KV is also connected with 11KV bus via VCB (Vacuum circuit breaker). Here also 11KV bus coupling is used to run both 11KV bus and 11KV bus-2.

3.3 Equipment of Substation

There is various equipment at substation such as:

- ✓ Power transformer,
- ✓ Circuit breaker (Air blast, Vacuum CB),
- ✓ Instrument transformer (CT & PT),
- ✓ Isolator,
- ✓ Earth switch,
- ✓ Lightening arrester,
- ✓ Auxiliary transformer,
- ✓ Bus bar (main bus bar and reserve bus bar),
- ✓ Battery and battery charger,
- ✓ Control relay panel,
- ✓ Ac & dc distribution panels and
- ✓ Voltage regulator etc.

3.4 Power Transformer

Transformer is a device which transforms electric power from one circuit to another circuit without changing in frequency. The electric power of transformer is created by electromagnetic induction between the windings or circuits. Depending upon the size of the windings, values of voltage and current are changed from primary (source) to secondary (load) with constant frequency. At DESCO, I have observed power transformer to transform power from 132 KV to 33 KV and 33KV to 11KV where 132 KV is supplied by PGCB. Most of the power transformers are made by Energy Pack and maintained by them as well.

At Digun substation, three transformers transform voltages from 33KV to 11KV which is indicated by TR4, TR5 &TR6 (20/28 MVA ranged transformers are used). Power Transformer.

Figure 3.3: Power Transformer T4 & T5

Actually single line diagram is the basic configuration to understand the basic operation of grid substation. In figure (3.3), it is shown that how 132KV incoming sources are connected to the Digun grid-substation and then how it transforms from 132KV to 33KV. Also 33KV transforms to 11KV. Initially 132KV incoming sources from Uttara grid is connected to Digun substation via

UG/OHL (UG means underground and OHL means overhead line), then safety equipment L.A. (Lighting Arrester), potential transformer (PT), wave trap, isolator, current transformer (CT), SF6 gas circuit breaker are connected to 132KV bus. Then 132KV bus coupling is used to run or to keep active both 132KV bus and 132KV bus. Then again PT, isolator, CT, L.A. and grid-transformer which transforms the voltages from 132KV to 33KV. Subsequently 33KV is also connected with 33KV bus via SF6 gas circuit breaker. Here also 33KV bus coupling is used to run both 33KV bus and 33KV bus. Last of all VCB (Vacuum Circuit Breaker) is also connected to 33KV bus and then grid-transformer, which transforms the voltages from 33KV to 11 KV. Subsequently 11KV is also connected with 11KV bus via VCB and then active fourteen numbers of 11KV outgoing feeders are connected to different sectors of Rupnagar.

In our country, the voltage transmissions are 400KV, 230KV, 132KV respectively. But at DESCO the step down transmission voltages are 132KV to 33KV, 33KV to 11KV and 11KV to 415V. At Digun grid-substation the step down voltage is 132/33/11 KV.

Chapter 4

TRANSFORMER

(EQUIPMENTS & OPERATION)

4.1 General Equipment

There is various equipment at Digun substation which I have observed and acquired knowledge such as power transformer, switchgear/circuit breaker, SF6 gas circuit breaker, vacuum circuit breaker, current transformer, potential transformer, isolator, line isolator, earth switch, wave trap, lightening arrester, auxiliary transformer, bus bar (main bus bar and reserve bus bar), battery and battery charger, control relay panel, ac & dc distribution panels and voltage regulator etc.

4.2 Operational Equipment

4.2.1 Transformer at DESCO

Power Transformer: During my internship period at Digun grid-substation (33/11KV), I have acquired knowledge about transformer. Actually a transformer is a static device whichtransforms electric power from one circuit to another circuit without changing in frequency. The electric power of transformer is created by electromagnetic induction between the windings or circuits. Depending upon the size of the windings, values of voltage and current are changed from primary (source) to secondary (load) with constant frequency. At DESCO, I have observed power transformer to transform power from 132 KV to 33 KV and 33KV to 11KV where 132KV is supplied by PGCB. Most of the power transformers are made by Energy Pack and maintained by them as well. At Digun grid-substation, there are three grid (power) transformers indicated as GT1, GT2, and GT3. The image of GT1 power transformer is given in figure (4.1).

Figure 4.1: 132/33 KV Power transformer (GT1) at Digun Sub-station.

At Digun grid-substation, three transformers transform voltages from 132KV to 33KV which is indicated by GT1, GT2 & GT3 (50/75 MVA ranged transformers are used).

4.2.2 Transformer Specification

There are various types of transformer available. But at DESCO, they prefer oil based transformers, imported from China. China provides transformers at a lower cost than Bangladeshi companies. So, China has totally captured this market. The main reason of using oil based transformers is availability and reasonable price compare to other types oftransformers.

4.2.3 Transformer Component

During my internship at Digun substation, I have acquired some knowledge about transformer component such as winding, main tank, conservator tank, breathing system, cooling system, transformer oil, oil level indicator meter, on load tape changer, silica gel, insulator, radiator, oil temperature meter, and winding temperature meter, buchholz relay and pressure relief device.

4.2.3.1 Winding: In figure (4.2), the primary winding is 33KV and secondary winding is 11KV. In this case it is step-down transformer and that is why primary winding is Δ (delta) connected and secondary winding is Y (wye) connected. The ac source is known as primary winding. The load which is taken from the source is called secondary winding. The transformer consists of soft iron core or the silicon steel core. Also two windings attached to it, they are primary winding and the secondary winding. The windings are insulated from one another. The conducting material (a conductor is a material which contains movable electric charges) used for the windings, depends upon the application. But in all cases, each turns must be electrically insulated from each other to ensure that the current travels throughout every turn.

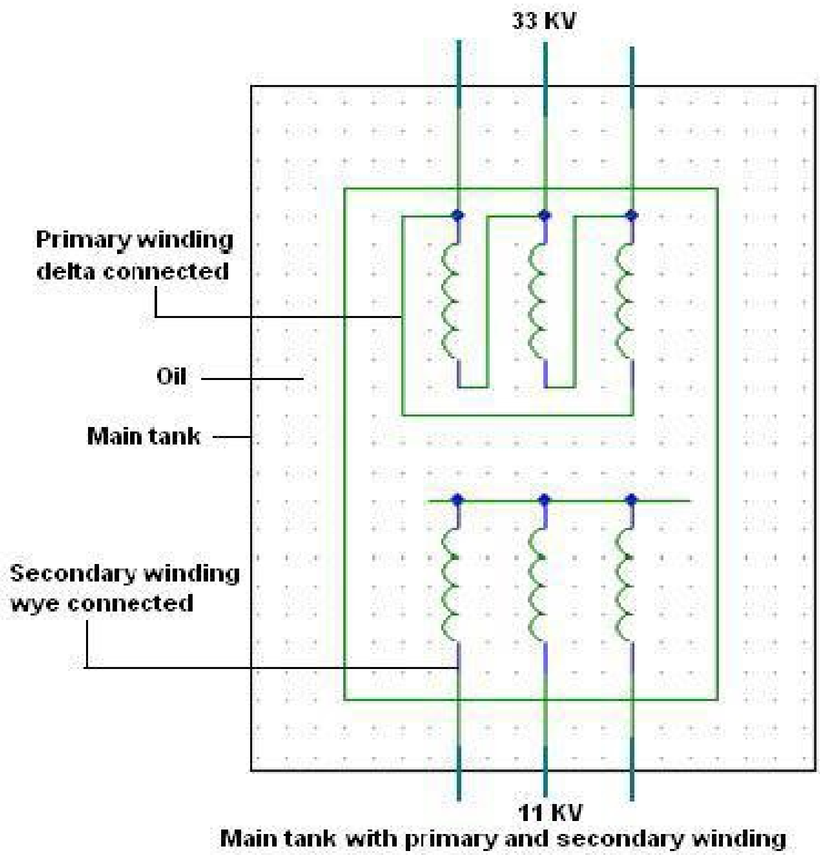

Figure 4.2: Main tank with primary & secondary winding

4.2.3.2 Main Tank: Main tank is such type of protective element for the primary winding and secondary winding. The end edge of the primary winding is connected from one side of the main tank. And the starting edge of the secondary winding is connected from opposite site of the main tank. Main tank is filled up with oil. And oil is used to provide insulation between the main tank and the windings. The image of main tank along with primary and secondary winding is given in figure (4.2).

4.2.3.3 Conservator Tank: During the expansion of oil due to internal fault of transformer or when load increases, windings (both primary and secondary winding) produce more heat. As a results oil volume can expand. And expansion of oil volume can enter from main to conservator tank via buchholz relay. Actually the tank is designed as an expansion reservoir which allows the expansion of the oil during operation. The image of conservator tank is given in figure (4.3).

Figure 4.3: Conservator tank at Digun Substation.

4.2.3.4 Buchholz Relay: Buchholz relay is a protective element of transformer. It is installed at the middle position of the transformer tank and the conservator tank. When gas is produced inthe main tank due to a minor fault, oil volume expands and can enter to conservator tank via buchholz relay. If oil's motion is very rapid, then at 1st, it gives the signal to the control room. If the fault is very big then it trips the transformer. The image action of buchholz relay is given in figure4.4.

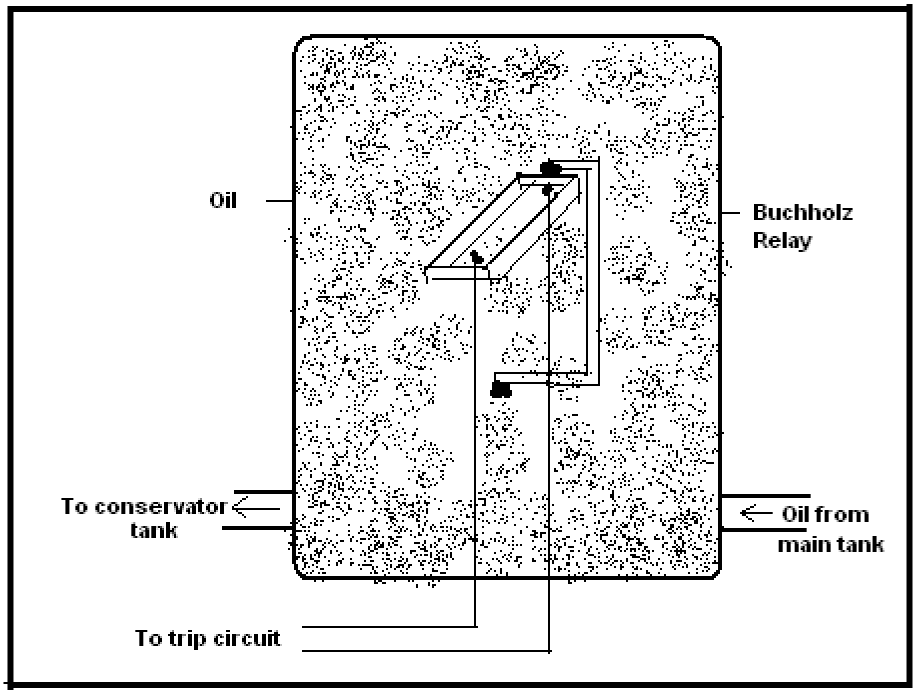

Figure 4.4: Action of buchholz relay at Digun substation.

4.2.3.5 Cooling Equipment: The cooling equipment such as radiator collects the hot oil from the top of the main tank and returns cooled oil lower down on the side of the main tank.

4.2.3.6 Winding Temperature and Oil Temperature Indicator: Winding temperature indicator (meter) indicates the appropriate temperature of winding (The normal position of winding temperature is 75 degree centigrade). Oil temperature indicator (meter) indicates the appropriate temperature of oil (The normal position of oil temperature is 65 degree centigrade). The image of oil temperature and winding temperature indicator is given in figure (4.5).

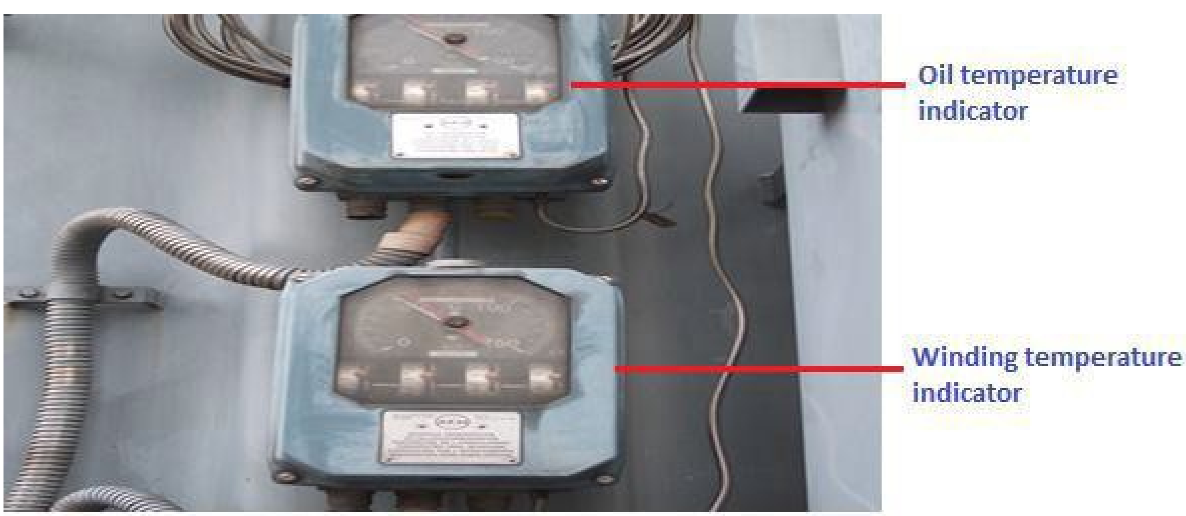

Figure 4.5: Winding temperature and oil temperature indicator.

4.2.3.7 On Load Tap Changer: On load tap changing is a mechanism that usually used in case of any disturbance of primary winding or in case of any fault of actual incoming voltages to the primary winding. In figure (3.6), the primary winding is 33KV and secondary winding is 11KV. If 33KV is reduced at 28KV then on load tap changer is used to increase from 28KV to 33KV. The image of on load tap changing mechanism is given in figure (4.6).

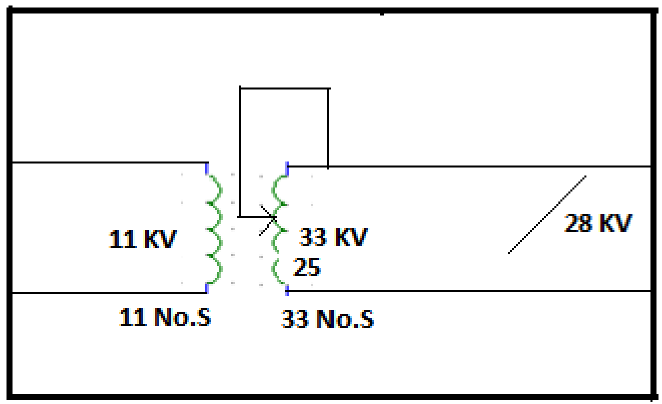

Figure 4.6 : Tap changing mechanism.

4.2.3.8 Transformer Oil: Transformer oil is used to provide insulation between the transformer main tank and the windings (both primary windings and secondary windings) and for keeping cool the transformer. The transformer oil also provides high dielectric strength to the coils and core which are submerged. This allow transformer to be more compact and cost efficient.

4.2.3.9 Breathing System: Transformer breathing system is controlled by silica gel. It is used to absorb moisture. During the injection of oil into transformer tank some air can enter or exit in the conservator tank depending on expansion and extraction of the oil of main tank and silica gel is used to absorb the moisture from that air. The image of silica gel is given in figure (4.7).

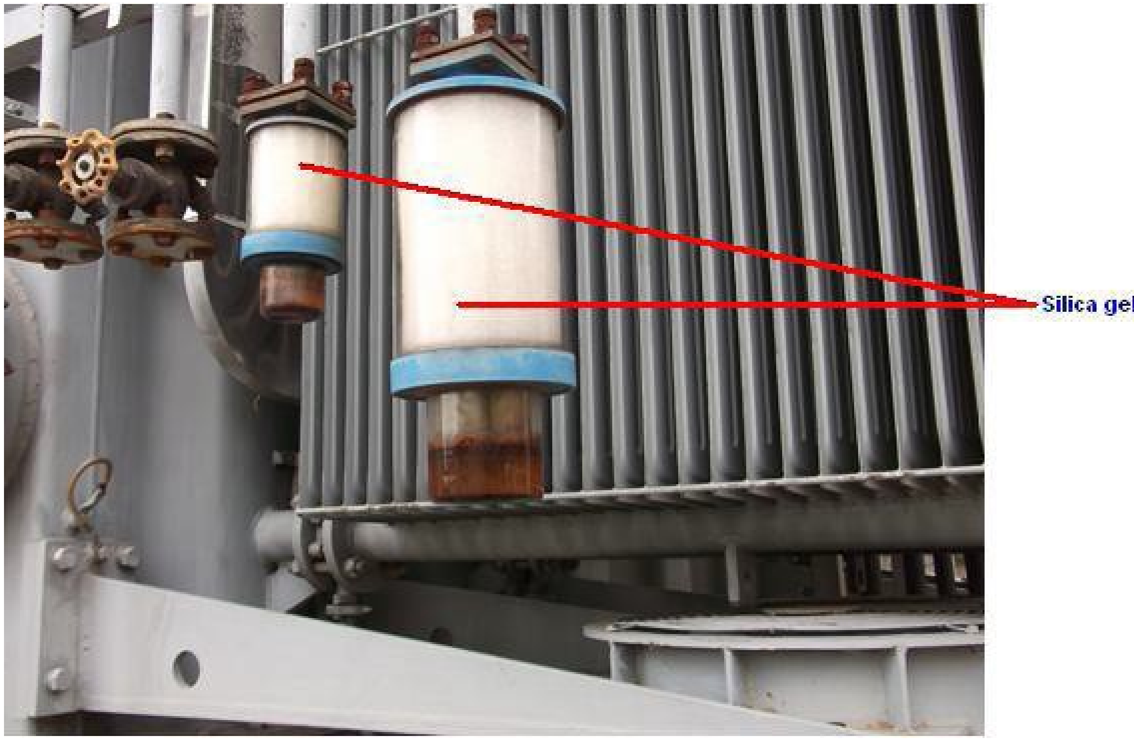

Figure 4.7: Transformer breathing system (silica gel) used at DESCO.

4.2.4 Losses in Transformer

During my internship period at Digun grid-substation, I have acquired knowledge about transformer losses. These are as follows:

Iron Losses: In actual iron cores, in-spite of lamination, some heat is still produced by the eddy currents.

Copper Losses: In actual practice, coils of the transformer possess some resistance. So a part of energy is lost due to heat produced by the resistance of the coils.

Hysteresis Losses: The alternating current in the coils repeatedly takes the iron core through complete cycle of magnetization. So energy is lost due to hysteresis.

4.2.5 Protection Systems for transformer

The principal relays and systems used for transformer protection at DESCO's grid-substation are described below.

- Buchholz devices providing protection against all kind of incipient fault i.e. slow – developing faults such as insulation failure of windings, core heating, fall of oil level due to leaky joints etc.

- Earth-fault relays providing against earth-faults only.
- Over current relays providing protection mainly phase-to-phase faults and overloading.
- Differential system (or circulating current system) providing protection against both earth and phase fault.

4.2.6 Auxiliary Transformers

During my internship period at Digun grid-substation, I have seen two auxiliary transformers and acquired knowledge about these. The grid-substation itself has a maintenance room beside it, so the power supply of that household is provided through this auxiliary transformer. It provides the supply to the auxiliary service which includes lighting, low voltage power supplies and ventilation. The auxiliary service may be three-phase 440V or single phase 230V (Typical voltage rating 33KV/440V).

4.2.7 Circuit Breaker

A circuit breaker is a switching device which can open and close a circuit in a small fraction of second under normal as well as during fault condition. Basically, it is automatically operated by electrical switch which is designed to protect an electrical circuit form damage caused by overload or short circuit and its basic function is to detect a fault condition.

4.2.7.1 SF6 Gas Circuit breaker: During my internship period at Digun grid-substation, I have seen four Sulphur Hexafluoride (SF6) gas circuit breaker and acquired knowledge about these. A SF6 (Sulphur Hexafluoride) gas circuit breaker is a high voltage circuit breaker. Basically Sulphur Hexafluoride (SF6) is an inert, heavy gas, having good dielectric and arc extinguishing properties. It has high die-electric strength and outstanding arc quenching characteristics.

The followings are the advantages of SF6 gas circuit breaker:

- ✓ Due to the superior arc quenching property of SF6, such breakers have very short arcing time.
- ✓ Since the dielectric strength of SF6 gas is 2 to 3 times that of air, such breakers can interrupt large currents.
- ✓ The SF6 gas circuit breaker gives noiseless operation due to its closed circuit.
- ✓ There is no risk of fire in such breakers because SF6 as is non-inflammable.
- ✓ The SF6 breakers have low maintenance cost, light foundation requirements and minimum auxiliary equipment.

The image of SF6 gas circuit breaker is given in figure (4.8).

Figure 4.8: SF6 gas circuit breaker at Digun grid-substation.

4.2.7.2 Vacuum Circuit Breakers

At Digun grid-substation, I have observed two vacuum circuit breaker and acquired knowledge of them. Vacuum circuit breaker is a low voltage circuit breaker with rated current up to 2500 A. These breakers interrupt the current by creating and extinguishing the arc in vacuum container. These are generally applied for voltages up to about 35000 V, which corresponds roughly to the medium-voltage range of power systems.

4.2.8 Potential Transformers

At Digun grid-substation, I have observed twelve (12) potential transformers (PT). These are connected in parallel with the bus bar. Potential transformer or voltage transformer is used for reducing ac voltage from higher value to lower value for measurement, protection and control purpose. At Digun grid-substation the ratio of potential transformer is 132KV to 110V. The image of potential transformer is given in figure (4.9)

Figure 4.9: Potential transformer at Digun grid-substation.

4.2.9 Current Transformers

At Digun grid-substation, I have observed twelve (12) current transformers (CT). These are connected in series with the bus bar. Current transformers (CT) are also used for reducing ac current from higher value to lower value for measurement, protection and control purpose. At Digun grid-substation the ratio of current transformer is (1800/900/1) Ampere. The image of current transformer is given in figure (4.10).

Figure 4.10: Current transformer at Digun grid-substation.

4.2.10 Lighting Arresters

At Digun grid-substation, I have seen six (6) lighting arresters. Lighting arrester is a device, used on grid-substation to protect the insulation on the grid-substation from the damaging effect of lighting. The typical lightning arrester also known as surge arrester has a high Undergraduate voltage terminal and a ground terminal. When a lightning surge or switching surge travels down the power system to the lighting arrester, the current from the surge is diverted around the protected insulation in most cases to earth. Lighting arrester is installed on many different pieces of equipment such as power poles and towers, power transformers, circuit breakers and bus structures in substation. The image of lighting arrester and GT-2 is given in figure (4.11).

Figure 4.11: Lighting Arrester and GT-2 at Digun grid-substation.

Figure 4.12: Lighting arrester indicator at Digun grid-substation.

4.2.11 Isolators

At Digun grid-substation, I have seen different types of isolators. These are line isolator, bus isolator, earth isolator, pin isolator and post isolator. Isolators are used to break the 3 phase power circuit under no load condition. These are (mostly in substation) installed before and after the transformer maintenance purpose. Basically it is used to disconnect a component of electrical systems from the power source. Isolator switch is used to make sure that an electrical circuit can be completely de-energized for service or maintenance. It operates only on “no load” condition since there is no ability for arc extinguishing.

4.2.12 Bus Bars and Bus Coupler

At Digun grid-substation, I have seen three (3) bus bars. These are 33 KV reserve bus, 33 KV main bus, and 11KV bus. Actually bus bar is a strip of copper or aluminum that conducts electricity within a switch board, distribution board, substation or other electrical apparatus. The size of the bus bar determines the maximum amount of current that can be safely carried. Generally, it consists of two bus-bars a main bus bar and a reserve bus bar. The incoming and outgoing lines can be connected together in bus bar. However, in case of repair of main bus-bar or fault accusing on it, the continuity of supply to the circuit can be maintained by transforming it to the reserve bus-bar. Bus coupler is used to run the both bus (main bus and reserve bus) at the same time. The image of bus bar and bus coupler is given in figure 4.13.

Figure 4.13: 132 KV bus bars and bus coupler at Digun grid-substation.

4.2.13 Battery and Battery Charger

Battery is the heart of Substation. Battery is a storage device. It is required for back-up dc supply to ensure protection. Battery supplies 110V dc voltage to the control and protection circuit when ac fails or charger fails. In a substation, dc Voltage is required for protection, control and signaling. Battery charger rectifies the 400V ac into 110V dc and supplies the dc voltage to control panels for the mentioned purpose as well as charges the batteries. The image of battery and battery charger is given in figure 4.14.

Figure 4.14: Battery backup system of 132/33/11KV Digun grid-substation.

CHAPTER 5

MAINTENANCE & PROTECTION OF SUBSTATION

5.1 Maintenance and Inspection of Substation

During my internship period at DESCO, I have got various ideas about substation's equipment maintenance and practically observed maintenance period of Digun substation. Basically there are many inspections of substations, but DESCO implements inspection of substation's equipment on monthly and half-yearly basis. At Digun substation there are three 33 KV incoming sources and twenty one outgoing feeders. Some transformers directly transform voltages from 33KV to 440V and some transformers transform voltages from 33KV to 11KV. At Digun Substation there have fourteen numbers of 11KV outgoing feeders are active.

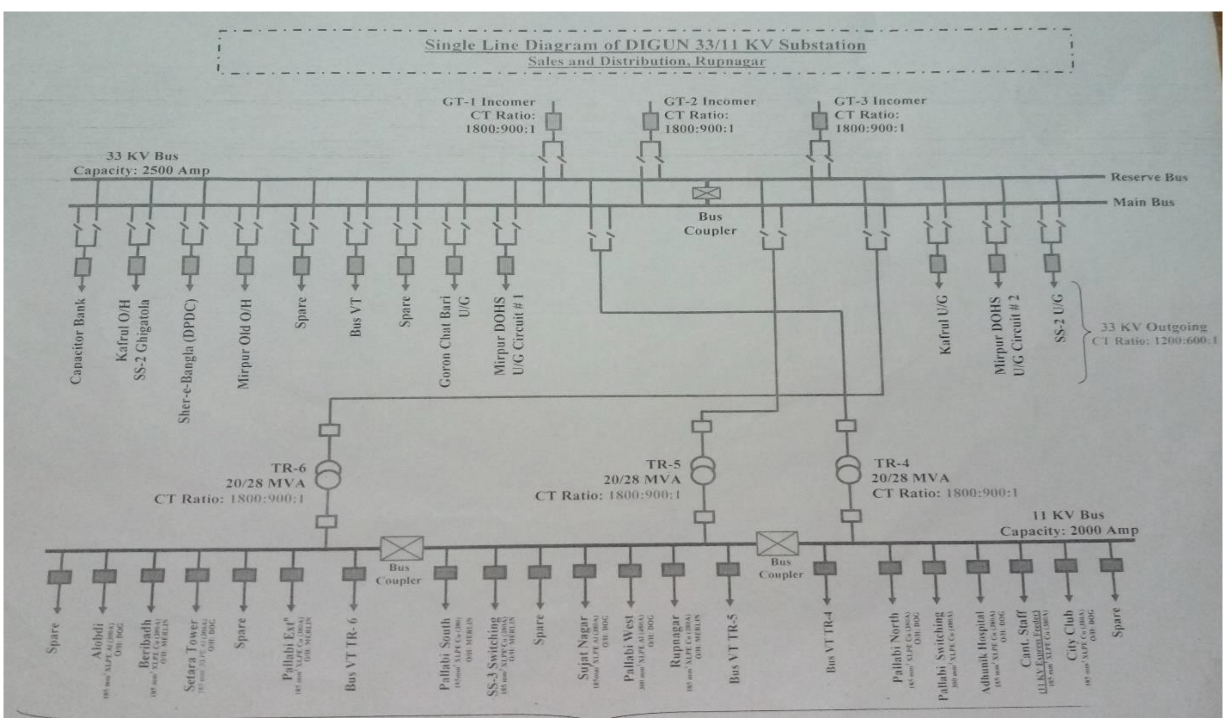

Figure 5.1: Single Line Diagram of Digun Substation.

During the period of monthly inspection at Digun substation, I have collected the picture whichis given in figure (5.2).

Figure 5.2: Maintenance of Digun 33/11 KV substation.

5.2 Transformer Maintenance

Transformer maintenances at Digun grid-substation are given below. :

- ✓ Overall cleaning or washing of transformers.
- ✓ Check insulation resistance between each winding and ground.
- ✓ Check the control system and driving mechanism of OLTC.
- ✓ Change the oil of OLTC (OLTC means On Load Tap Changer).
- ✓ Check toughness of low terminal and high terminal.
- ✓ Check the performance of oil temperature & winding temperature meter.

The images of maintenances of transformer at Digun grid-substation are given in figure (5.3, 5.4). The explanations of the images (while they were doing at maintenance period) are mentioned above.

Figure 5.3: Checking insulation resistance between each winding & ground by using megar meter.

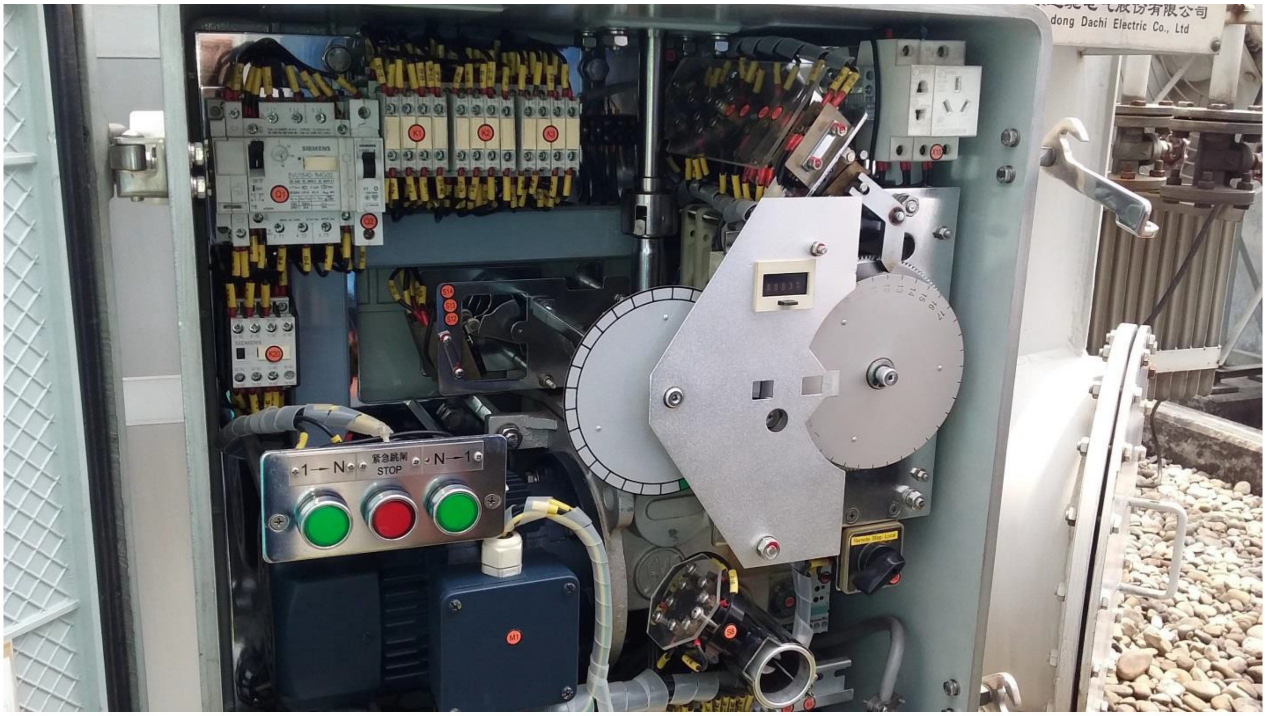

Figure 5.4: Checking control system & driving mechanism of On Load Tap Changer.

5.3 Transformer Fault Detection and Repairing

On August 28, 2017, I have visited the transformer repairing section at Digun substation with Sub-divisional Manager, Md.Kamrul Islam (Rupnagar Sales & Distribution division). He explained me about the common faults of transformer which are given below:

- ✓ Transformer coil burn.
- ✓ Drop off fuse.
- ✓ Low dielectric strength in transformer oil.

5.3.1 Transformer Coil Burn:

Coil burn process happens when distribution transformer runs under overload for long days. For detecting transformer fault, at first the 'insulation tester' is used. This insulation tester measures the resistance of transformer insulation. This tester has a prime mover, mega Ω meter and two probes. To test the transformer insulation, one probe is connected to high side and another one to low side. Then the prime mover is rotating by 120 rpm (rotating per minute) and produces very low current follow like 100V. If the meter shows the resistive value less than 5 MΩ, it means coil is burned, otherwise the tester shows more or equal to 30 MΩ. The image of distribution transformer is given in figure 5.5.

Figure 5.5: The 11KV/440KV distribution transformer.

5.3.2 Drop off Fuse:

Drop off fuse is a protection to protect transformer from burning. It is used, when transformer's distribution or feeder lines falls in short circuit or ground fault.

Figure 5.6: Drop out Fuse under Digun Feeder.

5.3.3 Low Dielectric Strength:

One kind of oil is used in transformer to isolate the coil-container and to keep cool the transformer. This oil is a dielectric material. If the oil dielectric value decreases, the core can be burned or a serious accident could be occurred. So, DESCO usually checks the oil dielectric strength in every two or three years ever since the transformer is installed.

5.4 Power Factor Monitoring & Upgrading

Power factor monitoring is one of the most important factors in power system. Because poor power factor imposes low effects on power generation. At substation I have seen the power factor was about 0.97≈0.98, but usually the average is about 0.95. Inductive load is responsible to degrade the power factor. We know that power factor is defined as the ratio of KW to KVA. But we can see that the cause of low power factor is large KVAR. And we know that the magnitude of KVAR is proportional to inductive load. All big factories, industries and workshops are main sources of inductive loads. Inductive load includes: Transformer, Induction motor and Energy saving light. Reactive power increases the amount of apparent power. This increases the reactive power and as a result apparent power creates large angle (θ) between KW and KVA and larger angle produces poor power factor ($pf = \cos\theta$).

5.4.1 Effect of Low Power Factor:

Poor power factor affects the power distribution system, loss in distribution network and voltage drop in feeder line. Excessive voltage drop may cause over heating in distribution network. Poor power factor also affects the generation plant. The power generators act as an induction machine. The reactive power comes from these power generators. Poor power factor means more reactive power. More reactive power overloads the generators.

5.5 Control Room Activity

I have spent four hours at Mirpur section-6 substation’s control room. Actually control room is very important in power system. This control room is open for 7 days and 24 hours. The basic operations of a control room are as follows:

- Communicates with other control rooms or grids.
- Communicates with line maintenance teams.
- Manage load shedding.
- Maintain VIP feeder with intentness.

- Record data (Supply load, Demand load, Load Shedding time, Trip timing, Visitor etc).

Figure 5.7: Control room at substation

Control relay panels facilitate centralized control of the related controlled equipment in power stations, switching stations and industrial plant. The panels are bolted together to form a board. This approach permits replacements, extensions and rearrangement when necessary. The panel incorporates control switches and indicator lamps for remote control of controlled equipment. A "remote/ supervisory" selector switch is also provided for selection of supervisory control from remote control center.

5.6 Incoming Panels or Lines

The equipment of 33KV incoming panels are trip circuit supervision relay-1, trip circuit supervision relay-2, trip relay, bus isolator, ac alarm, dc alarm, on lamp, off lamp, line isolator, earth isolator, dir. O/C and E/F relay, multifunction meter, KWH meter and also indicator signal. The image of 33KV incoming panel with relay protection is given in figure (5.8).

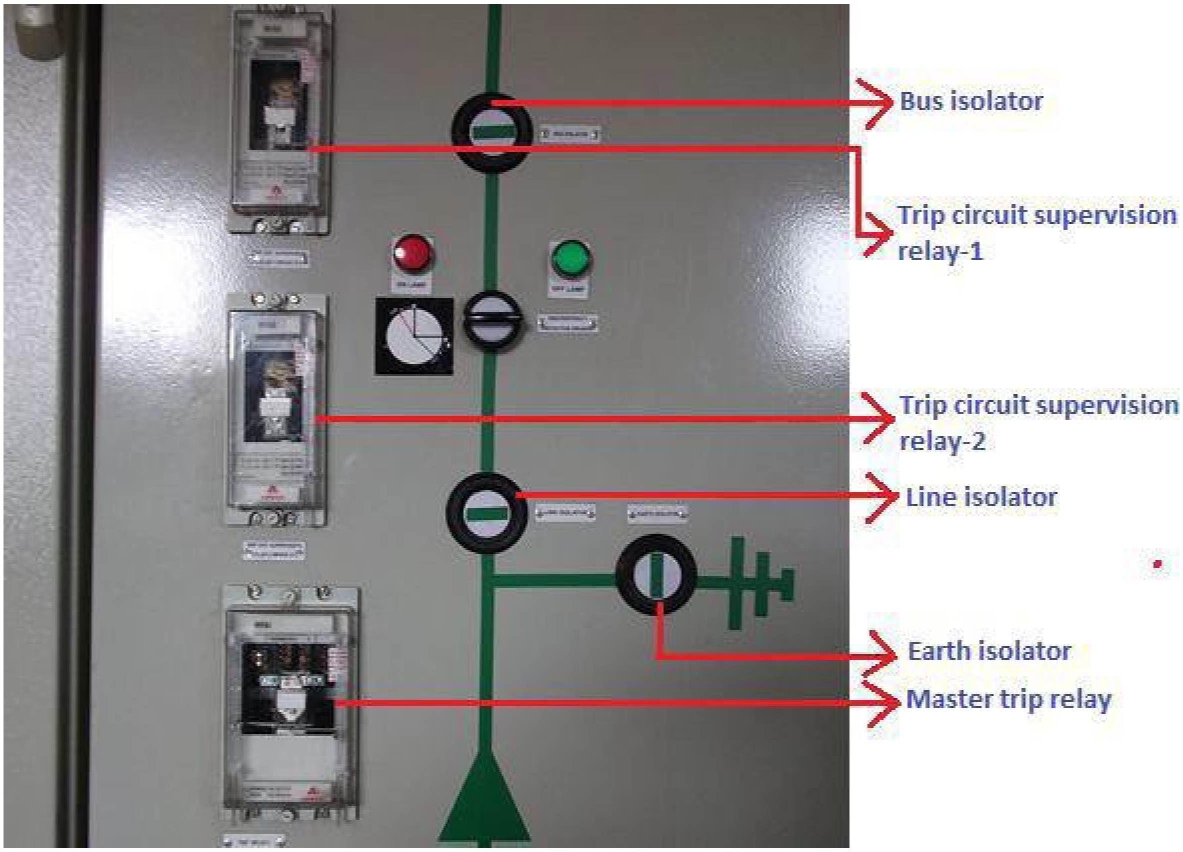

Figure 5.8: The relay protection on 33KV incoming line at Digun substation.

5.6.1 Relay Protection on 33KV Incoming Line:

At Digun substation's control room inside the 33KV incoming panel there are two trip circuit supervision relays, one trip relay, one bus isolator, one-line isolator and one earth isolator which I have observed and acquired knowledge during my internship period. Trip circuit supervision relay-1 is the relay which supervises the trip circuit of the circuit breaker. It tests whether dc supply is under proper condition or not. It also provides alarm for loss of dc supply, faults in trip coil or cables, faults on the breaker auxiliary contacts and faults in the relay itself. Trip circuit supervision relay-2 is also used for same objective. Bus isolator is used to isolate the bus from incoming line due to the maintenance or service purposes of bus. Line isolator is used to isolate the incoming line due to the maintenance or service purpose of substation.

5.6.2 Earth Isolator:

After closing the bus isolator and line isolator, some electric charge remains present in cables. Actually earth isolator is used to discharge the electric charge from the cables. Master trip relay is the main and backup for protection relay for trip circuit supervision relay.

5.7 The 33 KV Transformer Control Panels

At Digun substation, I have observed three transformer control panels. These are transformer control panel-1, transformer control panel-2 and transformer control panel-3. The equipment at 33KV transformer control panel are differential relay, sensitive earth fault relay (p-120), O/C and E/F relay (p-120), multifunction meter, energy (KWH) meter, spring charge lamp, trip lamp, trip coil-1, healthy lamp, trip coil-2, healthy lamp, dc-1, dc-2, spare, trip relay-1, trip relay-2, trip circuit supervision relay-1, trip circuit supervision relay-2, auxiliary relay-1 (BZ main tank and PRD main tank), auxiliary relay-2 (WTT and OLT), auxiliary relay-3 (BZ OLTC and PRD OLTC). The image of digital relay protection is given in figure 5.9.

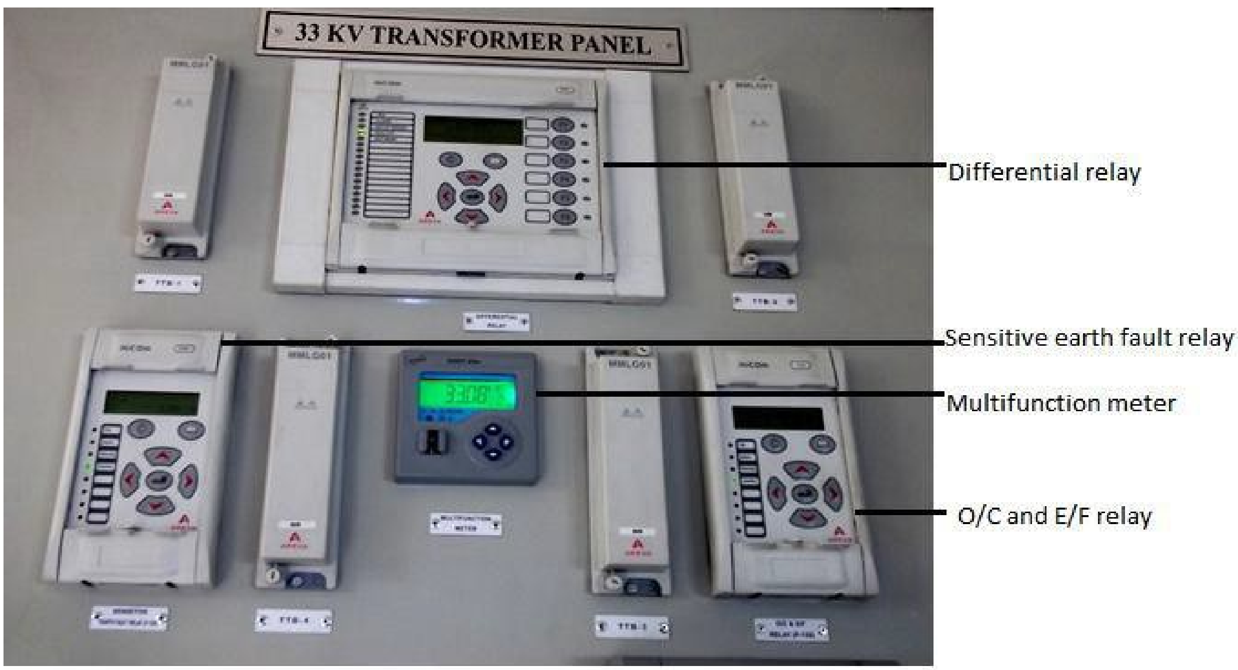

Figure 5.9: The digital relay protection on 33KV transformer panel.

During my internship at Digun substation, I have observed and acquired knowledge about the differential relay, sensitive earth fault relay multifunction meter and O/C (over current) and E/F (earth fault) relay of transformer control panel. Actually transformer differential relay is a relay that checks for current balance between the primary and the secondary side of a transformer. It also acts as a protective element to protect cables which finds the fault or the difference between the primary and secondary current. The sensitive earth fault relay of power transformer is a protective device that works by measuring the amount of lick current which discharges to the earth such as for any small lick at underground cables and some current are discharging to the ground of earth. But it has a limitation. If it crosses the limit current, the sensitive earth fault relay trips the transformer. Multifunction meter is a meter which can display voltage, current, power factor, line to line voltage, phase to phase voltage and phase to neutral voltage. O/C means over current relay and E/F earth fault relay. O/C relay, if there is any imbalance in the 3 phase current then the over current relay trips the circuit. During storms, if the phase falls down to the earth, then the earth fault relay trips the circuit. The image of relay protection on 33KV transformer panel is given in figure 5.9.

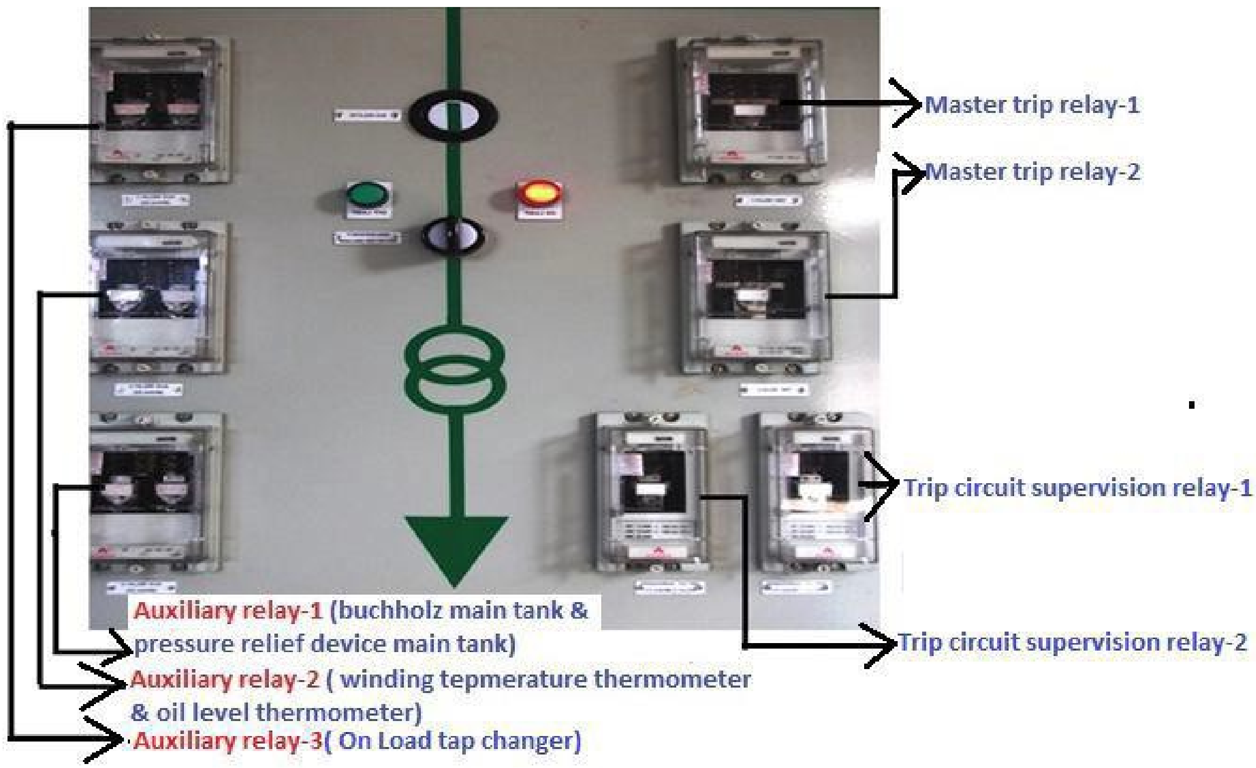

Figure 5.10: The relay protection on 33KV transformer panel at Digun substation.

Relay Protection on 33KV Transformer Panel: At Digun substation's control room inside the 33KV transformer panel, there are two trip circuit supervision relays, two trip relays and three auxiliary relays which I have observed during my internship period. Trip circuit supervision relay-1 is the relay which supervises the trip circuit of the circuit breaker. It controls the dc supply of trip circuit. It also provides alarm for loss of dc supply, faults in trip coil or cables and faults on the breaker auxiliary contacts. Trip circuit supervision relay-2 is also used for same objective. The auxiliary relay-1 trips the transformer when there is fault inside the buchholz's main tank and pressure relief device's main tank. The auxiliary relay-2 trips the transformer when there is fault inside the winding temperature thermometer and oil level thermometer. The auxiliary relay-3 trips the transformer when there is fault inside the on load tap changer. Master trip relay is the main and backup protection relay for trip circuit super vision relay. If the trip circuit supervision relay-1 and relay-2 are unable to detect the fault or unable to sense the fault, then the master trip relay must detect the fault and trip the transformer.

5.8 Outgoing Feeders

At Digun substation there are eighteen numbers of 11KV outgoing feeders. But four numbers of 11KVoutgoing feeders are closed or spare for requirement of future generation, two number of outgoing feeders are switching station and twelve numbers of 11KV outgoing feeders are active for the distribution of electricity.

CHAPTER 6
NUMERICAL DATA ANALYSIS

6.1 Introduction

Numerical Data Analysis is very important and only main progress for a sub-station because Analysis of data is a process of inspecting, cleaning, transforming, and modeling data with the goal of discovering useful information, suggesting conclusions, and supporting decision-making. Data analysis has multiple facets and approaches, encompassing diverse techniques under a variety of names. during our internship period we have collect different type of data of Digun 33/11KV substation. they are given below

6.2 Monthly Energy Statement

Name of The Substation: Digun 33/11 KV, 3X20/28 MVA Substation, Month: July-2017

Table 6.1: Monthly Energy Statement

SL NO.	S/S	NAME OF THE CIRCUITS AND FEEDER	METER LOCATION	METER NO	OMF	READING AT 24.0 Hrs OF THE MONTH LAST DAY		REAL ENERGY/ IMPORT/EXPORT (KWHr)	SUB TOTAL (KWHr)
						PREVIOUS (KWHr)	PREVIOUS (KWHr)		
	(2)	(3)	(4)	(5)	(6)	**(7)**	**(8)**	(9) = (8-7)*6	(10)
1.		T-1,132/33 kV, 50/75 MVA	33 KV Panel (GIS) BPDB	50146658	540000	**1036.900**	**1073.634**	19836360.0	54994410.00
2.		T-2,132/33 kV, 35/50 MVA	33 KV Panel (GIS) BPDB	50146659	270000	**1038.465**	**1068.866**	8208270.0	
3.		T-3,132/33 kV, 50/75 MVA	33 KV Panel (GIS) BPDB	50146657	540000	**952.902**	**1002.809**	26949780.0	

1.		T-4,33/11 kV, 20/28 MVA	33 KV Panel	45211304 0059	1	**149745090.0**	**159482480.0**	9737390.0	24693730.00
2.		T-5,33/11 kV, 20/28 MVA	33 KV Panel	45211304 0062	1	**242470940.0**	**251461110.0**	8990170.0	
3.		T-6,33/11 kV, 20/28 MVA	33 KV Panel	45211304 0075	1	**50105300.0**	**56071470.0**	5966170.0	
1.		Pallabi S/G	11 KV Pannel(GIS)	DHKA99 62	1	**73411100.0**	**76811100.0**	3866100.0	24954900.00
				DHKA99 65	1	**29417500.0**	**29883600.0**		
2.		Cantt staff college	11 KV Pannel(GIS)	DHK9963	1	**32975900.0**	**34627400.0**	1651500.0	
3.		Pallabi North	11 KV Pannel(GIS)	DHK9965	1	**49840900.0**	**50436800.0**	1182800.0	
				DHK9960	1	**49386200.0**	**49811200.0**		
4.		Ext. Pallabi	11 KV Pannel(GIS)	DHKA99 60	1	**49386200.0**	**49811200.0**	1867100.0	
				DHKA99 70	1	**0.0**	**1442100.0**		
5.		Rupnagar	11 KV Pannel	DHKA99 57	1	**62150000.0**	**64197900.0**	2047900.0	
6.		Sujat Nagar	11 KV Pannel	DHKA99 58	1	**29492200.0**	**30383400.0**	1232200	
				DHKA99 47	1	**29492200.0**	**27852700.0**		
7.		Alobdi	11 KV Pannel	DHKA99 61 (MC)	1	**24448800.0**	**26867300.0**	2418500.0	
8.		Pallabi South	11 KV Pannel	DHKA99 48	1	**35555800.0**	**36761800.0**	1403000	

				DHKA99 68	1	**29919900.0**	**30116900.0**		
9.		SS-3 U/G	11 KV Pannel	DHKA99 51	1	**68979500.0**	**72137300.0**	3157800.0	
1o.		Pallabi West	11 KV Pannel	DHKA99 68	1	**29093400.0**	**29919900.0**	1126500.0	
				DHKA99 58	1	**30383400.0**	**30683400.0**		
11.		Setara Tower	11 KV Pannel	DHKA99 59	1	**25408600.0**	**26399100.0**	1631300.0	
				DHKA99 49	1	**100.0**	**640900.0**		
12.		Beribadh	11 KV Pannel	DHKA99 67	1	**330400.0**	**811900.0**	481500.0	
13.		City Club	11 KV Pannel(GIS)	DHKA99 64	1	**14502900.0**	**16135400.0**	1632500.0	
14.		Adhunik Hospital	11 KV Pannel	DHKA99 66	1	**29369200.0**	**30625400.0**	1256200.0	

N.B: Transformer6 33/11 KV, 20/28 MVA, Meter Not Working Properly

6.3 LOSSES

6.3.1 losses in 11 KV side transformer-4

Name of the substation: digun 333/11 KV,3x20/28 MVA substation month: july-2017

Table 6.2: losses in 11 KV side transformer-4

SL NO.	S/S	NAME OF THE CIRCUITS AND FEEDER	METER LOCATION	METER NO	OMF	READING AT 24.0 Hrs OF THE MONTH LAST DAY PREVIOUS (KWHr)	PRESENT (KWHr)	REAL ENERGY/ IMPORT/ EXPORT (KWHr)	SUB TOTAL (KWHr)
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)=(8-7)*6	(10)
1.		T-4,33/11 kV, 20/28 MVA	33 KV Panel	452113040059	1	**149745090.0**	**159482480.0**	9737390.0	9737390.0
1.		Pallabi S/G	11 KV Pannel(GIS)	DHKA9962	1	**73411100.0**	**76811100.0**	3866100.0	9589100.00
				DHKA9965	1	**29417500.0**	**29883600.0**		
2.		Cantt staff college	11 KV Pannel(GIS)	DHK9963	1	**32975900.0**	**34627400.0**	1651500.0	
3.		Pallabi North	11 KV Pannel(GIS)	DHK9965	1	**49840900.0**	**50436800.0**	1182800.0	
				DHK9960	1	**49386200.0**	**49811200.0**		
4.		City Club	11 KV Pannel(GIS)	DHKA9964	1	**14502900.0**	**16135400.0**	1632500.0	
5.		Adhunik Hospital	11 KV Pannel	DHKA9966	1	**29369200.0**	**30625400.0**	1256200.0	

N.B 1. 11 kV Pallabi Feeder energized at 01/08/2017 Both end meter not work.

6.3.2 losses in 11 KV side transformer-5

Name of the substation: digun 33/11 KV,3x20/28 MVA substation month: july-2017

Table6.3 losses in 11 KV side transformer 5.

SL NO .	S/S	NAME OF THE CIRCUITS AND FEEDER	METER LOCATION	METER NO	OMF	READING AT 24.0 Hrs OF THE MONTH LAST DAY		REAL ENERGY/ IMPORT/ EXPORT (KWHr)	SUB TOTAL (KWHr)
						PREVIOUS (KWHr)	PRESENT (KWHr)		
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)=(8-7)*6	(10)
1.		T-5,33/11 kV, 20/28 MVA	33 KV Panel	452113040062	1	**242470940.0**	**251461110.0**	8990170.0	8990170.0
1.		Rupnagar	11 KV Pannel	DHKA9957	1	**62150000.0**	**64197900.0**	2047900.0	8967400.00
2.		Sujat Nagar	11 KV Pannel	DHKA9958	1	**29492200.0**	**30383400.0**	1232200	
				DHKA9947	1	**29492200.0**	**27852700.0**		
3.		Pallabi South	11 KV Pannel	DHKA9948	1	**35555800.0**	**36761800.0**	1403000	
				DHKA9968	1	**29919900.0**	**30116900.0**		
4.		SS-3 U/G	11 KV Pannel	DHKA9951	1	**68979500.0**	**72137300.0**	3157800.0	
5.		Pallabi West	11 KV Pannel	DHKA9968	1	**29093400.0**	**29919900.0**	1126500.0	
				DHKA9958	1	**30383400.0**	**30683400.0**		

6.4 Electricity Tariff in Bangladesh

In Bangladesh there have used both flat rate or single rate tariffs and time of use tariffs at various sector which kinds of tariffs are consideration

6.4.1 Tariff Rate

This is for information of all concerned that in accordance with the BERC Order # BERC/ Tariff/ Bitoron-10/desco/ongsho-02/3059 Dated: 27 August 2015, the new tariff rates with respect to retail sales of electricity of Dhaka Electric Supply Company Ltd. (DESCO) has been made effective from bill month September 2015 as the following:

Table6.4: Tariff Rate with Respect to Retail Sales

SL	Customer Category		Per Unit Rate (Tk.)	Minimum Charge	Demand Charge	Service Charge 1ph	Service Charge 3ph
1	Category-A : Residential						
		Life Line : From 1 to 50 units	3.33	100	15	10	30
	a.	First Step : From 1 to 75 units	3.80				
	b.	Second Step : From 76 to 200 units	5.14				
	c.	Third Step : From 201 to 300 units	5.36				
	d.	Fourth Step: From 301 to 400 units	5.63				
	e.	Fifth Step: From 401 to 600 units	8.70				
	f.	Sixth Step: Above 600 units	9.98				
2	Category-B : Agricultural pumping		3.82	125	30		40
3	Category-C : Small Industries						
	a.	Flat Rate	7.66	-	40		70
	b.	Off-Peak Time	6.90				
	c.	Peak Time	9.24				
4	Category-D : Non-Residential (Light & Power)		5.22	100	20	10	30
5	Category-E : Commercial And Office						
	a	Flat Rate	9.80	125	25	10	30
	b	Off-Peak Time	8.45				
	c	Peak Time	11.98				
6	Category-F : Medium Voltage, General Purpose (11 KV)						
	a	Flat Rate	7.57	8000	45		400
	b	Off-Peak Time	6.88				
	c	Peak Time	9.57				
7	Category-H : High Voltage, General Purpose (33 KV)						
	a	Flat Rate	7.49	80	40		450
	b	Off-Peak Time	6.82				
	c	Peak Time	9.52				
8	Category-J : Street Light and Water Pump		7.17	100	20	10	30

6.5 Date of Check: T-4 Transformer at 20/08/2017& T-5 Transformer at 21/08/17

Table6.5: Checking of Transformer

SL No.	Maintenance Work		Condition	Action taken	Remarks
1	General Cleaning			Done	Indoor Type
2	Silica gel breather		Good		
3	Silica gel Color		White	Changed	
4	Transformer Oil	a) Oil Level	Low (T-4)	01 Barrel Filled (T-4)	
		b) Dielectric Strength	51 KV(Avg.)	Tested Result another sheet	
		c) Oil Leakage	T-4 Oil leak	Repaired	
5	Oil temperature meter		Good		
6	Oil level Indicator		Good		
7	Winding temperature meter		Good		
8	Cooling fan cleaning			Done	
9	Cooling fan motor		Good		
10	H.T. Bushing	a) Physical Condition	Good		
		b) Horn gap	Good		
11	L.T. Bushing	a) Physical Condition	Good		
		b) Horn gap	N/A		
12	Radiator		Good		
13	Tap Changer mechanism		Good		
14	Lightning Arrester		Good	cleaning is done	
15	Protection System	a) Buchholtz Relay(MainTank)	Trip- OK		
		b) Buchholtz Relay (Tap changer)	Trip- OK		
		c)Winding Temp (HV)	Trip- OK		
		d) Winding Temp (LV)	Trip- OK		
		e) PRD Protection	Trip- OK		

6.6 Insulation Resistance Test

Applied voltage 5650 V, weather: sunny, Oil temp: 38˚C

Table 6.6: Test of Insulation

Name of Transformer	Mode of connection	Insulation Resistance		Remarks
		15 Sec	60 Sec	
T-4	HT-G	10.4 GΩ	4.6 GΩ	With 11 kV Cable connected
	LT-G	6.66 GΩ	11.6 GΩ	
	HT-LT	16.3 GΩ	19.8 GΩ	
T-5	HT-G	10 GΩ	23 GΩ	
	LT-G	5 GΩ	11 GΩ	
	HT-LT	14 GΩ	25 GΩ	

6.7 11 KV Breaker Test Report(Area)

6.7.1 General Check

Table 6.7: General Checking of Breaker

SL NO.	MAINTENANCE WORK	CONDITION	ACTION TAKEN	REMARK
1.	General Cleaning		Done	
2.	Position Indication Signal	Good	√	
3.	Bushing	Good	√	
4.	Operation	Good	√	
5.	Manual Operation System	Good	√	
6.	Electrical Operation System	Good	√	

6.7.2 Contract Resistance Test of 11 KV Breaker

Applied Current :100 A

Table6.8: Contract Resistance Test

SL NO.	FEDER NAME.	BREAKER SEREIAL NO.	DATE OF TEST	RESULT		
				R-R(μΩ)	Y-Y(μΩ)	B-B(μΩ)
1.	T-4,33/11 KV, 20/28 MVA	7306005006/04/17	13/08/17	58	18	30
2.	T-5,33/11 KV, 20/28 MVA	7306005009/04/20	13/08/17	54	22	32
3.	T-6,33/11 KV, 20/28 MVA	7306005008/04/19	13/08/17	50	23	33
4.	Pallabi S/G	73060052006189/51/4	13/08/17	59	42	40
5.	Cantt staff college	7306005006/6/5	13/08/17	39	47	41
6.	Pallabi North	7306005006/03/11	13/08/17	24	39	40
7.	Ext. Pallabi	7306005006/06/3	13/08/17	24	21	22
8.	Rupnagar	7306005006/04/18	13/08/17	41	47	39
9.	Sujat Nagar	7306005006/05/9	13/08/17	39	48	41

10.	Spare	7306005006/03/SPR	13/08/17	41	40	40
11.	Pallabi South	7306005006189/51/4	13/08/17	49	54	43
12.	Spare	7306005006189/50/3	13/08/17	48	41	36
13.	Pallabi West	7306005006/03/3	13/08/17	37	34	37
14.	Setara Tower	7306005006/04/7	13/08/17	37	34	37
15.	Beribadh	7306005006/04/15	13/08/17	42	30	44
16.	Spare	PF/915/09/10-11	13/08/17	59	41	58
17.	Adhunik Hospital	7306005006/05/9	13/08/17	38	36	40

6.7.3 Insulation Resistance Test of 11kv Breaker

Applied Voltage:5650 V

Table6.9: Insulation Resistance Test

SL NO.	FEDER NAME.	BREAKER SEREIAL NO.	DATE OF TEST	RESULT					
				R-R (μΩ)	Y-Y (μΩ)	B-B (μΩ)	R-E (μΩ)	R-E (μΩ)	R-E (μΩ)
1.	T-4,33/11 KV, 20/28 MVA	7306005006/04/17	09/08/17	>900	>900	>900	>900	>900	>900
2.	T-5,33/11 KV, 20/28 MVA	7306005009/04/20	09/08/17	>900	>900	>900	>900	>900	>900
3.	T-6,33/11 KV, 20/28 MVA	7306005008/04/19	09/08/17	>900	>900	>900	>900	>900	>900
4.	Pallabi S/G	73060052006189/51/4	09/08/17	>900	>900	>900	>900	>900	>900
5.	Cantt staff college	7306005006/6/5	09/08/17	>900	>900	>900	>900	>900	>900
6.	Pallabi North	7306005006/03/11	09/08/17	>900	>900	>900	>900	>900	>900
7.	Ext. Pallabi	7306005006/06/3	09/08/17	>900	>900	>900	>900	>900	>900
8.	Rupnagar	7306005006/04/18	09/08/17	>900	>900	>900	>900	>900	>900
9.	Sujat Nagar	7306005006/05/9	09/08/17	>900	>900	>900	>900	>900	>900
10.	Spare	7306005006/03/SPR	09/08/17	>900	>900	>900	>900	>900	>900

11.	Pallabi South	7306005006189/51/4	09/08/17	>900	>900	>900	>900	>900	>900
12.	Spare	7306005006189/50/3	09/08/17	>900	>900	>900	>900	>900	>900
13.	Pallabi West	7306005006/03/3	09/08/17	>900	>900	>900	>900	>900	>900
14.	Setara Tower	7306005006/04/7	09/08/17	>900	>900	>900	>900	>900	>900
15.	Beribadh	7306005006/04/15	09/08/17	>900	>900	>900	>900	>900	>900
16.	Spare	PF/915/09/10-11	09/08/17	>900	>900	>900	>900	>900	>900
17.	Adhunik Hospital	7306005006/05/9	09/08/17	>900	>900	>900	>900	>900	>900

6.8 Calculation

OMF= $\frac{\text{LLLLLLLLLLLLL CCCC.TTTT RRRRRRRRTTTTLLLRRRR} * \text{LLLLLLLLLLLLL PPPP.TTTT RRRRRRRRTTTTLLLRRRR}}{\text{MMMMLLLLTTTTLLLLRRRR CCCC.TTTT RRRRRRRRTTTTLLLRRRR} * \text{MMMMLLLLTTTTLLLLRRRR PPPP.TTTT RRRRRRRRTTTTLLLRRRR}}$

Import/ Export = Meter Reading Difference * OMF

Losses = $\frac{\text{Import} - \text{Export}}{\text{Import}} * 100\%$

6.8.1 Loss for 33 kV import and 11 kV export (11 kV side Transformer4)

For 33 KV:

Import = Meter Reading Difference * OMF

=9737390*1 KW

=9737390.00 KWH

For 11 KV:

Export1 = Meter Reading Difference * OMF

=3866100*1 KWH

=3866100 KWH

Export2 = Meter Reading Difference * OMF

=1651500*1 KWH

=1651500 KWH

Export3 = Meter Reading Difference * OMF

=1182800*1 KWH

=1182800 KWH

Export4 = Meter Reading Difference * OMF

=1632500*1 KWH

=1632500 KWH

Export5 = Meter Reading Difference * OMF

=1126500.0*1 KWH

=30625400 KWH

Total Export= Export1+ Export2+ Export3+ Export4+ Export5

=3866100+1651500+1182800+1632500+1126500.0 KWH

=9589100.00 KWH

Losses = $\frac{\text{Import}-\text{Export}}{\text{Import}} * 100\%$

Losses = $\frac{9737390-9589100}{9737390} * 100\%$

=1.53 %

6.8.2 Loss for 33 kV import and 11 kV export (11 kV sideTransformer5)

For 33 KV:

Import = Meter Reading Difference * OMF

=8990170*1 KWH

=8990170.00 KWH

For 11 KV:

Export1 = Meter Reading Difference * OMF

=2047900*1 KWH

=2047900 KWH

Export2 = Meter Reading Difference * OMF

=1232200*1 KWH

=1232200 KWH

Export3 = Meter Reading Difference * OMF

=1403000*1 KWH

=1403000 KWH

Export4 = Meter Reading Difference * OMF

=3157800*1 KWH

=3157800 KWH

Export5 = Meter Reading Difference * OMF

=1126500*1 KWH

=1126500 KWH

Total Export= Export1+ Export2+ Export3+ Export4+ Export5

=2047900 +1232200+1403000+3157800+1126500 KWH

=8967400.00 KWH

Losses = $\frac{\text{Import} - \text{Export}}{\text{Import}} * 100\%$

Losses = $\frac{8990170 - 8967400}{8990170} * 100\%$

=0.25 %

6.9 Tariff calculation in Bangladesh

Formula for tariff calculation:

Net Bill = Energy Charge + Demand Charge + Service Charge.

VAT = 5% of Net Bill.

Let 1 to 50 Units user,

Energy Charge = 5000 Tk, Demand Charge = 15 Tk

Service Charge = 10 Tk (For 1 Phase) and we consider there one hour in a day at 16.8.17

Therefore,

Net Bill = (5000 + 15 + 10) Tk

= 5025 Tk

Net Bill/Unit = 5025/1000 Tk

= 5.02 Tk/Unit

6.10 Insulation and Contact resistance calculation of Transformer & Breaker

6.10.1 Insulation resistance of Transformer T4 & T5

HT-LT = 30 MΩ (Allowable)

LT-G = 22 MΩ (Allowable)

HT-G = 66 MΩ (Allowable)

6.10.2 Insulation& Contact resistance of Breaker

Insulation Resistance > 900 μΩ (Allowable)

Contact Resistance > 100 μΩ (Allowable)

CHAPTER 7
RESULTS & DISCUSSION

7.1 Introduction

This chapter will elaborate more on the findings gathered of this project. This chapter will perform all the mechanism involved with the result refers to the theory. Base on the result occurred, we would discuss about the performance of the full sub-station and any things that related with the project.

7.2 Losses

For 33 kV import and 11 kV export (11 KV side Transformer4) loss is 1.53%

Since Import = 9737390.00 KWh, Export = 9589100.00 KWh

That's why loss coming is 1.53%

For 11 KV import and 11KV export (11 KV side Transformer5) loss is 0.25%

Since import = 8990170.00 KWh, Export = 8967400.00 KWh

That's why loss coming is 0.25%

In generally losses must be small amount but there is huge amount loss in 11 kV side of transformer4. Because 33 KV Pallabi feeder energized at end and meter not work, 11KV incomer-1 meter not working, 33 KV bus PT burnt, Can't get accurate data from meter reading. And there have various faults especially like cable fault, Bus bar fault, CT & PT burnt. Sometimes it's make no sense when take meter reading. Sometimes meter not give accurate data for something fault. So we not get desired output.

7.3 Tariff calculation

At this stage we consider an hour in a day at 16.9.2017.

Taking service charge for 1phase consumer

The result is 5.02 Taka/Unit as an example.

7.4 Insulation and Contact resistance calculation of Transformer& Breaker:

Insulation resistance of Transformer T4 & T5:

HT-LT = 14 GΩ

LT-G = 5 GΩ

HT-G = 10 GΩ

Insulation & Contact resistance of Breaker:

Insulation Resistance= 58 μΩ(R-R), 18 μΩ (R-Y), 30 μΩ (R-B).

Contact Resistance = 100 μΩ (R-R), 100 μΩ(R-Y), 100 μΩ(R-Y).

7.5 Discussion

In this section, first the data are presented in an orderly manner. Then they are discussed individually. This section is most important part of the paper and should be as convincing as possible. Here also is important to obtain some indication about how analyzable the results are. While this is hard to check, one can look at the stability of the results.

CHAPTER 8
CONCLUSIONS

8.1 Conclusions

A sub-station is very important place for an Electrical & Electronics Engineering where we can know more details like as structure of transformer and working principle, difference between CT & PT ratio and settings, bus bar system, incoming and outgoing cables, bushing, isolator, earthling system, lightning arrester, DC battery control panel system, control and relay panel, synchronizing, synchro scope, switch gear, GIS(Gas Insulated Switchgear), AIS(Air Insulated Switchgear), Incoming feeder, and full control panel system. The Demand of electricity is increasing day by day. But the rate of increase in production of electricity is not, sufficient with the demand in Bangladesh. Substation in a company like Power man Bangladesh Ltd. Is too much important not only for its own production but also it has a great impact in the economy of the whole country. Like other fast growing industry or residential area it has a good demand of power. There are some other aspects like incontinent source of energy. The local Electricity supply system is not secure to run the factory itself. So, it has become must to be self-dependent substation to control flow of power like Power man has its own. The practice should be done for the rest others ofBangladesh.

8.2 Limitations of the work

Always hardware development is not possible, Because, there always running mechanical system, and only some few times faced trouble-some problem if unnecessary worked has been done suddenly.

For rules and regulation, we can't collect some internal data because of their some internal & external system like as, if they publish the data for all, then the government rules break dawn and it is also very important that's why every company or organization should have some regulation otherwise it wouldn't possible to run properly.

They have no enough manpower for guiding to us because low policy and their losses.

We can't properly observe some equipment for restricted area because a sub-station is a very dangerous and restricted area for the high voltage electricity which is very dangerous for un experience person and outer person.

It was not possible to present a complete report like- statistics, financial involvement, costing, etc. regarding the topic or the opportunity.

It had to be taken care of that the report does not contain any company confidential information and harm the organization in their strategic stance.

8.3 Future Scopes of the Work

Have to Increase man power in substation with good performance with proper experience.

Have to Digitalizing power distribution system with digital equipment's because all digital equipment's are more benefited from analog system. Our thesis knowledge, enable us to build a substation for building, industrial etc load. By Digitalizing PFI panel on a three phase load the reactive power can be minimized. Knowledge about cost of installing a substation for a building or industrial load. We have knowledge about the protection equipment of a substation which will be necessary for installing a sub-station. We should expect that our theoretical observation can be implemented practically install in any kind of substation to increase the efficiency of the substation. During the training period we have learnt about power transmission system and distribution system, controlling and operating breakers, isolators, acknowledge of alarm observing the signal. It had also learnt about various maintenance like transformer dielectric strength of oil test, insulation test of conductors etc. Everyone thinks DESCO should continue such Internship opportunities. It will be a great help for students who are going to complete their degree of Bachelor of Science in EEE.

If government give and should have to force for sub-station training for develop knowledge and practical knowledge with good performance, then an engineering student know more with theory.

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