INTERNSHIP REPORT

ON

# DHAKA POLLI BIDYUT SAMITY-1

By

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# TO WHOM IT MAY CONCERN

This is to certify that Md. Rezaul kabir tutul, SID 2008-1-80-032, K.M Shikhul islam, SID 2007-2-86-010. Sad bin hakim. SID 2007-2-80-002 have successfully completed their internship from Dhaka Palli Bidyut Samity-1. (DPBS-1) from 20th August to 11September 2011. They have completed 100 hours of their internship on power generation, transmission, distribution and protection system of the various sub-station equipments of Dhaka Palli Bidyut Samity -1 and Summit Power Generation. During the tenure of their training with us all the students put their best effort to comprehend the overall of Power Distribution system.

The undersigned on behalf of Dhaka Palli Bidyut Samity-1.(DPBS-1), recommending this work as the fulfilment of the requirements of EEE 499(Indutrial training) of the East West University,Dhaka.

I wish their success in life.

03.12.2011

Engr. Prasanta Kumar Sutradhar

Assistant general manager

Construction Operation & Maintenance

Dhaka Palli Bidyut Samity-1

## ACKNOWLEDGEMENT

First of all we would like to thank almighty Allah for giving us the chance to complete the internship successfully and all those who helped us and provided us with support in making this internship successful. Without their assistance we could not have completed our internship.

We would like to bring up the name of Dr. Anisul Haque, respected Chairperson and Professor of the Department of Electrical and Electronic Engineering for his excellent guidance throughout the last four years and neverending support.

We would like to show gratitude to Ms.Tahseen Kamal, Senior Lecturer, Department of Electrical and Electronic Engineering, East West University, for her imperative direction on total internship program and also for her guidance in preparing this report.

We would like to thank Md. A.Z.M Azad, General Manager of the Dhaka Polli Bidyut Samity-1 for allowing us to complete this internship successfully.

Our thanks goes to Engr. Prasanta Kumar Sutradhar Assistant General Manager of Dhaka Polli Bidyut Samity-1 whose supervision lead us to acquire practical knowledge on power systems through our internship. We show our appreciation to all the respected officers and employees of Dhaka Polli Bidyut Samity-1 for their endless support.

## EXECUTIVE SUMMARY

We have completed our undergraduate internship in Dhaka Polli Bidyut Samity-1, Polashbari, Nobinagar, Savar, Dhaka. Dhaka Polli Bidyut Samity-1 (DPBS-1) plays a vital role in power transmission and distribution in Dhaka city. The mission of DPBS-1 is to ensure long term uninterrupted supply of quality power to the consumers in future. In Bangladesh the demand of power is approximately 5800MW. Public and private sector produces 63% and 37% of electricity respectively. Public sector produces electricity through Bangladesh Power Development Board (BPDB) and Electricity Generation Company of Bangladesh (EGCB). On the other hand private sector such as United Power Generation and Distribution Company Limited and Summit Power Limited produces power. Dhaka Polli Bidyut Samity-1 is not able to produce power by itself. So it purchases power from United Power Generation and Distribution Company Limited and Summit Power Limited. Summit Power Limited produces 317MW electric power and supplies to the national grid. In near future to contribute more in power sector this company has plan to setup more branches of power station. The internship in Dhaka Polli Bidyut Samity-1has given us experience to power generation system (at United Power Generation and Distribution Company Limited and Summit Power Limited) and also the transmission and distribution system (of DPBS-1). During our internship in DPBS-1, we were taught about the power plant management system in the power station. This report is the elaborate description of our practical experience.

| Day | Topic | Mentor | Time Duration | Training Hour |
|---|---|---|---|---|
| 03.09.2011 | Finance Section of DPBS-1 | AGM of finance Section | 8:30 am – 1:30 pm | 5 |
| | | | 2:30 pm – 5:30 pm | 3 |
| 04.09.2011 | Consult Service and Member Service of DPBS-1 | AGM of Consult Service and Member Service | 8 am – 1 pm | 5 |
| | | | 2 :30 pm – 5:30 pm | 3 |
| 05.09.2011 | Gas Turbine, control System of Gas turbine plant | Engr. Md. Habib Plant Manager | 8 :30 am – 1:30 pm | 5 |
| | | | 2 :30 pm – 5:30 pm | 3 |
| 06.09.2011 | Turning Gear, Combined Cycle introduction, Gas Turbine. | Engr. Md. Habib Plant Manager | 8:30 am – 1:30 pm | 5 |
| | | | 2:30 pm – 5:30 pm | 3 |
| 07.09.2011 | Motor Winding, Motor test, Sensors for protection of Gas Turbine vibration | Engr. Md. A.S.M. Ahsan Habib Plant Manager | 8:30 am – 1:30 pm | 5 |
| | | | 2 :30 pm – 5 :30 pm | 3 |
| 08.09.2011 | Generator Protection, Condenser, Turbine protection | Engr. Md. A.S.M. Ahsan Habib Plant Manager | 8:30 am – 1:30 pm | 5 |
| | | | 2:30 pm – 5:30 pm | 3 |
| 10.09.2011 | Summerized all the topics. | Engr.Prashanta kumar sutradhar Assistant general manager DPBS-1 | 9.00 am- 2.00pm | 5 |
| | | | Total | 106 Hour |

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# 1. INTRODUCTION

Internship is the part of the undergraduate degree in EEE department of the East West University. Internship is merged the theoretical and practical knowledge which is important in our future life. For developing the practical knowledge we all have to do internship. We have been completed our major area in Power Engineering.

We have completed our internship in Dhaka Polli Bidyut Samity-1. Through our internship we have learned about the practical field of power generation, distribution and transmission. Rural Electrification Board or Polli Bidyut Samity is the leading electricity distribution company in rural and industrial area in Bangladesh. Dhaka Polli Bidyut Samity-1 has given us the best support for developing the practical knowledge based on the theoretical knowledge. In our internship we have learned how power plant generates power, about the distribution system and process for Power Distribution Company and other relevant topics. Our internship supervisor is Ms. Tahseen Kamal, Seniour Lecturer, Electrical and Electronic Engineering department. She has given us enough support to complete the internship and prepare the final internship report. The objective of the internship report will be the important source for them, who want to thesis in power sector or power distribution system. Throughout this report we will discuss the experience we had during the industrial training.

## 1.1. Company Profile

With a Presidential Ordinance in October 1977, the Bangladesh Rural Electrification (RE) Program was founded and established the Rural Electrification Board (REB) as the semi-autonomous government agency reporting to the Ministry of Power Energy and Minerals Resources. In 1978 rural electrification board created the Polli Bidyut Board. Each member of the Polli Bidyut Samity is the owner and servant of the Polli Bidyut Samity. REB is the first who electrifying rural and industrial Bangladesh. Today the number of Polli Bidyuit Samity is seventy (70), which bring service to approximately 79, 00,000 new connections being made and more than 14,000 kilometers of line being constructed each year. Electricity is now available to

operate 86,766 IRRIGATION pumps, 62,875 small and COTTAGE INDUSTRY units, 373,119 commercial setups and 8,733 other establishments in the rural areas. The total number of the member of Dhaka Polli Bidyut Samity-1is two lacks ninety four thousand. [1] The overall view of DPBS-1 given below:

**Table 1.1: Overall view of DPBS-1**

| | |
|---|---|
| Area covered | 1412 Sq. Km |
| No. of villages | 1111 |
| Date of energization | 02.06.1980 |
| No. of villages energized | 700 |
| No. of population | 1,535,000 |
| No. of population benefited by electricity | 1,048,000 |
| No. of household | 287,000 |
| No. of family benefited by Electricity | 209,750 |
| Per capita consumption | 249 KWH |
| Directors | 11 |
| Village Advisors | 591 |
| Energized line (Km) | 3007 |
| No. of substation | 19 |
| System Loss | 9.68% |
| Maximum Demand | 98 MW |
| Bill Collection | 99% |

### 1.1.1. Vision, Mision & Corporate Philosophy of DPBS-1

**Vision:** To be a role model electric supply company in the region using most dependable technologies and being a development partner in the continuous welfare of the society.

**Mission:** Service to the utmost satisfaction of consumers through reliable and uninterrupted

power supply and provide value for money. Provide congenial working environment for employees.

**Corporate Philosophy:** Service excellence with integrity and corporate social responsibility.

## 1.2. Objective of Internship

The first objective of the internship is fulfilling the partial requirement of EEE program. In this intern report, we have attempted to give an overview of Dhaka Polli Bidyut Samity-1.Our aim is to obtain some purposes which are necessary for our future prospects. Regarding this we have to understand the management systems of the company first. Since the company deals with power system, so it is very important to acquire the knowledge of Generation process and their control unit including the substation equipment's and their protection schemes. Understanding the maintenance of all the technical activities and risk management involved them is one of the fundamental concerns.

## 1.3. Scope and Methodology

This report is based on the internship program where we reviewed about power generation, transmission and distribution system and establishment of switchgear. We also reviewed the operation of Generator and the protection system of generator and transformer. The report contains relevant information about a substation as was observed during the internship program. This report is written on the basic of two ways information collection, one is talking and discussing with technicians and employee and personal observation and another resource is company web site and manuals.

# 2. POWER GENERATION

## 2.1. Introduction

Dhaka Polli Bidyut Samity-1 has no power generation capability. United Power Generation Distribution Company Limited and Summit Power Limited generate power and provide that power to DPBS-1. Through internship we got opportunity to observe the power generation system of both of this power plant. The power generation process of both of this plant is same and both of these plants are gas plant. Both of this plants use natural gas as their generator fuel. United Power Generation and Distribution Company Limited can produce 22MW to 25MW and supply that in Dhaka EPZ and DPBS-1. United Power Generation and Distribution Company Limited use natural gas as a generator fuel to produce electricity that is supplied from TITAS. Natural gas is normally used here because of its availability in our country .

## 2.2. Overview of United Power and Summit Power Limited

From January 2007 United Power Generation & Distribution Co. Ltd. (formerly known as Malancha Holdings Ltd.) was born out of the necessity for uninterrupted, quality power supply to the industries housed within the Export Processing Zones (EPZ) of Bangladesh. All engines are Wartsila (Finland) and Mtube product. Each of Wartsila (Finland)'s capacity is 8.73MW each generator of used four engines and Mtubes' capacity is also being 1.95MW each generator and it consists three generators. So the total capacity is near to 41MW. [2]

Summit Power Limited (SPL), sponsored by Summit Group, is the first Bangladeshi Independent Power Producer (IPP) in Bangladesh in private sector providing power to national grid .Summit Power Limited was incorporated in Bangladesh on March 30,1997 as a Private Limited Company. On June 7, 2004 the Company was converted to Public Limited Company under the Companies Act 1994. Summit Power Limited in the year 2001, has successfully established three power plants of 11MW capacity each, for sale of electricity to Rural Electrification Board (REB) on Build, Own and Operate basis at Savar, Narsingdi and Comilla. During 2006 and 2007 in

each of the above three places, 2nd unit was commissioned enhancing the capacity of SPL to 105 MW. In 2009 SPL with its 99% owned two subsidiaries has established 4 new power plants raising its capacity to 215 MW.[3] In 2011 SPL has commissioned another power plant of 102 MW capacity at Narayanganj under Summit Narayanganj Power Limited.


**Figure 2.1: Summit Power Limited**

## 2.3. Electric Gas Generator

An electrical generator is a machine which converts mechanical energy into electrical energy (or power). The source of mechanical energy may be a reciprocating or turbine steam engine, water falling through a turbine or waterwheel, an internal combustion engine, a wind turbine, a hand crank, or any other source of mechanical energy .The energy conversion is based on the principle of the production of dynamically (or motional) induced e.m.f. whenever a conductor cuts magnetic flux dynamically, induced e.m.f is produced in it according to faraday's laws of electromagnetic induction. This e.m.f causes a current to flow if the conductor circuit is closed.

Hence, two basic essential parts of an electrical generator are:

a) A magnetic field and

b) A conductor or conductors which can move as to cut the flux.

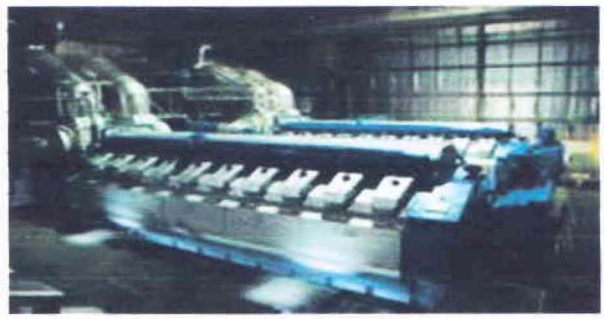

**Figure 2.2: Generators of Summit Power Limited**

Summit Power Limited and United Power Generation and Distribution Company Limited (UPGD) are covered the generation part of REB (Rural Electrification Board). So Summit Power Limited provides 46 MW for REB. Each four engine consumes 8.73MW individually and another three engines also provide 3.73MW each generator. Hence most of the Circuit Breakers (CB) is provided from Energy Pac. At first of 2000 Summit Power Limited provides 11MW for REB later in 2008 this supply capacity was extended to 35MW. In Summit Power Limited has 20v (twenty) type cylinder. This provides 7 (seven) generator and all are the gas engine. It has 20 airs resume tank, these tanks are used to cool the engine. For cooling the engine it also has the radiator, radiator works to cool the engine. It also consisting 20 exhaust lines, 2 tube chargers, 5 water lines, 4 engine control panel etc. and all this information is given to our internship supervisor.

### 2.3.1. Major Parts of Generator

Description of the major parts of electric gas generator we have seen is given below:

**Field:** The field in an AC generator consists of coils of conductors within the generator that receive a voltage from a source (called excitation) and produce a magnetic flux. The magnetic flux in the field cuts the armature to produce a voltage. This voltage is ultimately the output voltage of the AC generator

**Armature:** The armature is the part of an AC generator in which voltage is produced. This component consists of many coils of wire that are large enough to carry the full-load current of the generator.

**Rotor:** The rotor of an AC generator is the rotating component of the generators. The rotor is driven by the generator's prime mover, which may be a steam turbine, gas turbine, or diesel

engine. Depending on the type of generator, this component may be the armature or the field. The rotor will be the armature if the voltage output is generated there; the rotor will be the field if the field excitation is applied there.

**Stator**: The stator of an AC generator is the part that is stationary. Like the rotor, this component may be the armature or the field, depending on the type of generator. The stator will be the armature if the voltage output is generated there; the stator will be the field if the field excitation is applied there. In the generators of Summit Power Limited the stator is used as the output voltage generator.

**Slip Rings**: Slip rings are circular rings, similar to a tube, that are connected to the armature and rotate with it, if it is rotating. Slip rings are usually made of nonferrous metal (brass, bronze or copper); iron or steel is sometimes used. Slip rings usually do not require much servicing. The wearing of grooves or ridges in the slip rings is should be bright and smooth, polishing can be performed with fine sandpaper and honing stone.

**Brushes**: Brushes are in contact with the slip rings and the resistive load. Their job is to conduct the electricity from the slip rings to the load.

**Figure 2.3: Picture of Brush**

### 2.3.2. Synchronization of generators

Synchronization is the process of connecting a 3-phase synchronous (ac) generator to another generator or to a power grid.

There are four conditions must be met before the generator can be connected to the grid. These are:

**Frequency:** The generator must be driven by the prime mover at a speed such that the generated power frequency is equal to the grid's frequency.

**Voltage:** The stator line voltage must be equal to the line voltage of power grid. This is achieved by controlling rotor current.

**Phase sequence:** The phase sequence of the generator must be the same as the phase sequence of the grid. If the grid sequence is R-Y-B, then the generator's sequence must be also R-Y-B.

**Phase angle:** The phase angle of the generator must be equal to the phase angle of the grid. The stator angle can be adjusted by adjusting the field current.

### 2.3.3. Generator protection of SPL & UPGD

In Summit Power Limited and United Power Generation and Distribution Limited there are 15 types of generator protection included. They are –

a) Over current under voltage protection
b) Earth fault
    i. Stator earth fault
    ii. Rotor earth fault
c) Loss of Field Excitation Protection
d) Under frequency protection
e) Over frequency protection
f) Reverse power protection
g) Negative phase sequence protection
h) Generator differential protection
i) Winding temperature protection
j) Over voltage protection
k) Backup earth fault protection
l) Rotor overload protection
m) Rotor temperature protection
n) Stator temperature Protection

## 2.4 Gas Turbine

A gas turbine is also a combustion turbine, is a type of internal combustion engine. It has an upstream rotating compressor coupled to a downstream turbine, and a combustion chamber in between. Energy is added to the gas stream. In the combustor, where fluid is mixed with air and ignited in the high pressure environment of the combustor, combustion of the fuel increases the temperature. The products of the combustion are forced into the turbine section. There the high velocity and volume of the gas flow is directed through a nozzle over the turbine's blades. Spinning the turbine which powers the compressors and for some turbines, drives their mechanical output .The energy gives up to the turbine comes from reduction in the temperature and pressure of the exhaust gas.

### 2.4.1. Working Principle of Gas Turbine

Working principle of gas turbine is given below:

a) The compressor draws air from the atmosphere and supplies is under pressure to the combustion chamber.
b) The fuel which can be natural gas is injected into the combustion chamber in atomized form and burnt.
c) The hot gas formed in the combustion chamber expands through the turbine, producing mechanical power.

### 2.4.2. Compressor

Compressor is a device in the gas turbine section which is used to compress the air which is needed to expand by the help of combustion of fuel to create mechanical energy to rotate the turbine. The compressor used in the plant is generally rotator type. The air at atmospheric pressure is drawn by the compressor via the filter which removes the dust from air. The rotator blades of the compressor push the air between stationary blades to raise its pressure. Thus air at high pressure is available at the output of the compressor.

### 2.4.3 Combustion chamber

The combustion chamber in gas turbines is called the combustor. The combustor is fed high pressure air by the compression system, adds fuel and burns the mix and feeds the hot, high pressure exhaust into the turbine components of the engine or out the exhaust nozzle. The oil is injected through the burner into the chamber at high pressure. Here the temperature is also very high.

**Figure 2.4: Combustion Chamber Combusted Gas and Fresh Air**

The main parts of combustion chamber are given below-

a) Combustion casing

b) Liner

c) Primary fuel nozzle

d) Secondary fuel nozzle

e) Spark plug

f) Flame detector

## 2.5. Memic Diagram of Power Station

Memic diagram is required for the overall view of the power station with bus-bar arrangement which is shown in figure 2.5. Every power station has the memic diagram in the station and it is used in various ways such as it indicates the total feeder number, arrangement of the feeders, transformers, circuit breakers, current transformers, potential transformers etc. A memic diagram was provided to us by the plant manager of the UPGD and it is given below:

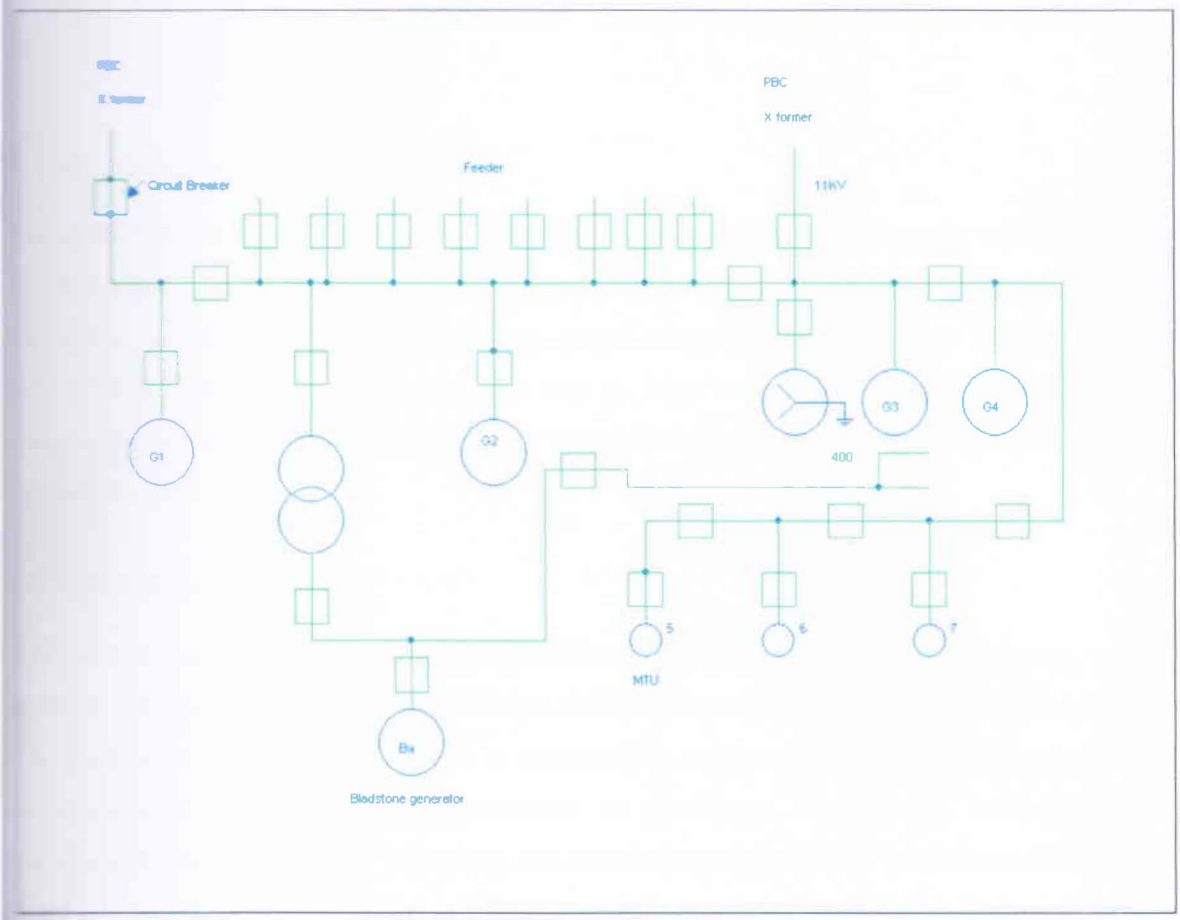


**Figure 2.5: Memic Diagram of the Power Station**

## 2.6 Conclusion

In this chapter the gas turbine power plant of United Power Generation and Distribution Company Limited and Summit Power Limited has been described. United Power Generation and Distribution Company Limited generates 41MW and Summit Power Limited generates 46MW that covers the generation part of DPBS-1. The generators which are used in producing power are also described along with protection system. The memic diagram is also described in this chapter that gives the overall view of power station.

# 3. SUBSTATION

## 3.1 Introduction

September 23, 2011 was the third day of our internship. We visited a substation which is situated in Hemnagor near to Jahangirnagor University. We were supervised by Engr. Prasanta Kumar Sutradhar, AGM (CO&M). In the beginning we got an appointment with Engr. Md. Saiful Islam, ASE(CO&M). He gave an orientation and a brief explanation about those substation, transformers uses in this substation, bus bar connection, transmission line and protection system of this substation.

## 3.2 Substation

The assembly of apparatus used to change characteristics of electric power supply e.g. voltage, ac to dc; frequency etc. is called a substation. Substations are important part of the power system. The continuity of supply depends to a considerable extent upon the successful operation of substations. A Substation is interconnected to generators, transformer, transmission and distribution lines and all other protecting and maintaining equipment's. Transformation of power from one voltage level to another switching for alternate connections and isolation of failed or overloaded lines and equipment; controlling system voltage and power flow; suppression of over voltage; and detection of faults, monitoring, recording of information, power measurements, and remote communications. It is, therefore, essential to exercise extreme care while designing and building a substation. There are some important points which must be kept in view while lying out of a substation

These points are given below:

- It should be located at a proper site. As far as possible, it should be located at the center of gravity of load.

- It should be provide safe and reliable arrangement. Due safety, consideration must be given to the maintenance of regulation clearances, facilities for carrying out repair and maintenance abnormal occurrences such as possibility of explosion or fire etc.
- It should be easily operated and maintained.
- It should be involve minimum capital cost.

### 3.3 Classification of Substations

There are several ways of classifying substations. However, there are two most important ways of classifying the substations. These classifications are given below:

a) On the basis of service requirement

b) On the basis of constructional features.

c) On the basis of operating voltage

### 3.3.1 According to Service Requirement

A substation may be called upon to change the voltage level or improve power factor or convert ac power into dc power etc. according to the service requirement substation may be classified as:

**Transformer Substations:** These substations which are changing the voltage level of electric supply are called transformer substations. These substations are receiving power at same voltage and delivering at another voltage. Obviously, transformer will be the main component in such substations.

**Switching Substations:** Switching substation is an intermediate station between two other substations or between substation at load end and generating station. At switching station incoming power line and outgoing power lines have same level of voltage it means there is no transformer to step down the voltage to connect the load. Switching stations are created just for purpose of controlling important parameters in power system and control of voltage rise due to capacitive effect or voltage drop due to reactive effect or both.

**Power factor correction Substations:** This variation of substation is used in the control of the transmission line receiving end voltage and power factor. Such substations are generally located at the receiving end of the transmission lines. These substations generally use synchronous condensers as the power factor improvement equipment.

**Frequency changer Substations:** Those substations are changing the supply frequency are known as frequency changer substations. This substation is found where two or more power system is operating at different frequencies. Frequency change may be needed for industrial purpose.

**Converting Substations:** Those substations which change ac power to dc power are called converting substations. These substations receive ac power and convert into dc power or it receives dc power and converts it into ac power.

**Industrial Substations:** Those substations which supply power to individual industrial concerns are known as industrial substations.

### 3.3.2 According to constructional feature

A substation has many components which must be housed properly to ensure continuous and reliable service. For the constructional feature the substations are classifying is given below:

**Indoor Substations:** In such substations the apparatus is installed within the substation building. Such substations are usually for a voltage up to 11 KV but can be erected for the 33 KV and 66 KV when the surrounding atmosphere is contaminated with impurities such as metal corroding gases and fumes, conductive dust etc.

**Outdoor Substations:** For voltages beyond 66KV, equipment is invariably installed outdoor. It is because for such voltages, the clearances between conductors and the space required for switches, circuit breakers and other equipment becomes so great that it is not economical to install the equipment indoor. These substations are further subdivided into:

a. **Pole mounted Substations:** Such substations are erected for distribution of power in localities. Single stout pole or H-pole structures with suitable platforms are employed. It is the cheapest form of substation for voltages not exceeding 11KV or some

extraordinary case in 33KV. Electric power is almost distributed in localities through such substations.

b. **Foundation Mounted Substations:** For transformers of capacity above 250 KV the transformers are too heavy for pole mounting. Such substations are usually for voltages of 33,000 volts and above.

**Underground Substations:** Where the population growth rate is high and the space is not available for the substations, underground substations are applicable for those areas.

### 3.3.3 According to Bassis of Operating Voltage

The substations on the basis of operating voltage may be classified into:

**High Voltage Substations (HV Substations):** High Voltage Substations involving voltages between 11 KV and 66 KV.

**Extra high voltage substations (EHV Substations):** Extra high voltage substations (EHV Substations) involving voltages between 132 KV and 400 KV

**Ultra high voltage substations (UHV Substations):** Ultra high voltage substations (UHV Substations) operating on voltage above 400 KV.

### 3.3.4 Transformer Substation

The majority of the substations in the power system are concerned with the changing of the voltage level of electric supply. Transformer substations are four types depending on the purposed or used. Classification of these transformer substations are given below:

**Step-up Substation or Primary Substations:** Where from power is transmitted to various load centers in the system network and are generally associated with generating stations. Step-up substation is being situated at end of the generator side. In our internship we have been visited two power stations. Both of the stations supply 11KV at end of the generator side.

**Grid Substation:** From the step-up substation, electric power at 220KV or 132KV etc. is transmitted by 3-phase. 3 wire overhead system to the outskirts of the city. Here electric power is

received by the primary grid substation which reduces the voltage level to 66KV or 33 KV or any another type for secondary transmission. Generally grid substation is of outdoor type.

**Step-up and Step-down or Secondary Substations:** It may be located at generating points where from power is fed directly to the loads and balance power generated is transmitted to the network for transmission to other load centers. At a secondary substation the voltage is further stepped down to 11 KV. The 11 KV lines run along the important road sides of the city. It may be noted that big consumers are generally supplied power at 11 KV for further handling with their own substations. The secondary type substations are also called outdoor type substations.

**Step down or Distribution Substation:** Distribution Substations receives power from secondary substations at extra high voltage and step down its voltage for secondary distribution. The electric power from 11 KV lines is delivered to distribution substations. These substations are located near the consumer's localities and to 400V or 230V, 3-phase or 4-wire for supplying to the consumers. The voltage between any two phases is 400V and between any phase and neutral it is 230V. [4]

## 3.6 Equipment of the Substation

The equipment's required for a substation which is depend on the type of the substation and service requirements. However a transformer has the following equipment's below:

### 3.6.1 Transformer

Transformers are static devices made up of one or more windings, in which those with two or more windings are coupled, and may be manufactured with or without a magnetic core. They are used in induction of currents, producing a coupling between two circuits. Transformers typically change values of voltage and current and are always used in transferring power through electromagnetic induction between circuits at the same frequency. A Transformer's output (neglecting losses due to resistance or other manufacturing and physical factors) will be predictably computed by the general formula:

V2/V1=N2/N1

The proportion between N1 and N2 determines the exact final output V2 as V1 will have to follow the same proportion with V2 as a result. Simply put, where V equals voltage and N equals

number of windings, and V1 and N1 are different than V2 and N2 respectively. There are different types of transformers that we have seen while internship in PBS-1 is described below.

**Power Transformers**: A power transformer is used in a substation to step- up or step down the voltage. It is important part for a substation. Power transformer is required for any type of substation. Except at the power station, all the subsequent sub-station use step-down transformers to gradually reduce the voltage of electric supply and finally deliver it at utilization voltage. The step up transformer primary are DELTA connected and secondary are STAR connected the voltage of step up transformer are 15.6/132kv and 15.6/230kv.The modern practice is to use 3-phase transformers in substation, although 3 single phase bank of transformers can also be used. The use of 3-phase transformer (instead of 3 single phase bank of transformers) permits two advantages. Firstly, only one 3 phase load tap changing mechanism can be used. Secondly, its installation is much simpler that the three single phase transformers. Power transformer is gradually installed upon lengths of rails fixed on concrete slabs having foundation 1 to 1.5 m deep. For rating up to 10 MVA, naturally cooled, and oil immersed transformers are used. For higher ratings, the transformers are generally normal and forced air cooled.

**Figure 3.1: Picture of a Power Transformer**

**Instrument Transformer**: The function of these instruments of these instrument transformers is to transfer voltage or currents in the power lines to values which are convenient for the operation of measuring instruments and relays. There are two types of instrument transformation viz.

a. Current Transformer (C.T)

b. Potential Transformer (P.T)

**Current Transformer (C.T)**: A current transformer is a step-up transformer which steps down the current to a known ratio. When current in a circuit is too high to directly apply to measuring instruments, a current transformer produces a reduced current accurately proportional to the current in the circuit, which can be conveniently connected to measuring and recording instruments. The functions can be seen in a current transformer is to reduce the line current, isolate the measuring instruments, protect measuring instruments against short circuit currents, sense abnormalities in current and to give current signals to protective relays. It is designed to provide a current in the secondary winding which is proportional to the primary winding current. Suppose in the Fulbaria grid substation, a current transformer rated at 100:5 A is connected in the line to measure current. If the current the line is 100 A, then current in the secondary will be 5A.

**Figure 3.2: Current transformer**

Similarly, it current in the line is 50A, and then secondary of C.T will have a current of 2.5A. Thus the C.T under consideration will step down the line current by a factor of 20.

**Potential Transformer (P.T):** The instrument potential transformer (P.T) steps down voltage of a circuit to a low value that can be effectively and safely used for operation of instruments such as ammeters, voltmeters, watt meters, and relays used for various protective purposes.

The primary of this transformer consists of a large number of turns of fine wire connected across the line. The secondary winding consists of a few turns and provides for measuring instruments and relays a voltage which is a known fraction of the line voltage. Suppose in the Fulbaria grid substation, a potential transformer is rated at 132KV/33KV is connected to a power line. If line voltage is 132KV, then voltage across the secondary will be 33KV.

**Figure 3.3: Potential Transformer**

### 3.4.2 Bus-bars

Bus-bars is necessary when multi lines are operating at the same voltage have to be directly connected electrically, bus-bars are used as the common electrical component. Perhaps due to their commonness with omnibuses that does not have any conductor and do only transport of electricity. All the bars are copper or aluminum bars. All the incoming and outgoing lines are connected to the bus-bars.

**Figure 3.4: Bus-Bar**

In upper figure 3.4 shows the bus-bar which is necessary because it consists of incoming line and outgoing line. There are 3(three) types of the bus-bars arrangements. According to the theory types of the arrangements of the bus-bars is given below:

**Single bus-bar arrangement:** In figure 3.5 consists of a single bus-bar and all the incoming and outgoing lines are connected to it. In a single bus-bar switchboard the bus bar can be split into sections and transformers are connected to one bus bar only. The advantage of single bus bar

is low cost. The main disadvantage is that there is a complete interruption of the supply during routine maintenance or replacement.

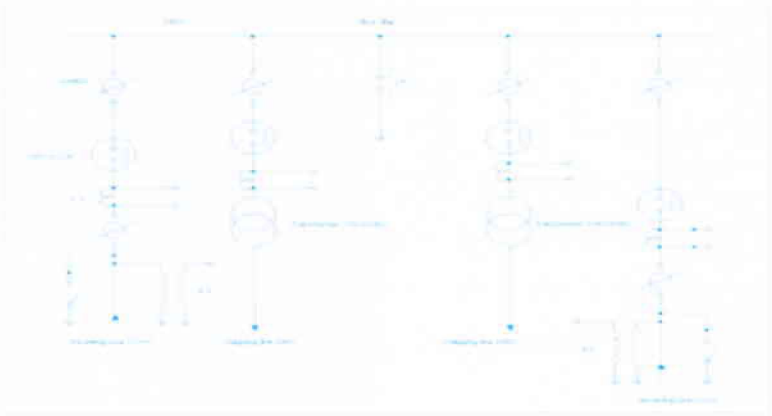

**Figure 3.5: Single Bus-Bar Arrangement**

**Single bus-bar system with Synchronization**: In this arrangement, the single bus bar arrangement is divided into section and load is equally distributed among all the sections which are showing in figure 3.6. Any two sections get connected by a circuit breaker and isolators. The advantage of this arrangement is that if a fault occurs on any section of the bus bar. That section can be isolated without affecting the supply from the other section and repair and maintenance of any section of the bus bar can be carried out by de-energizing that section only

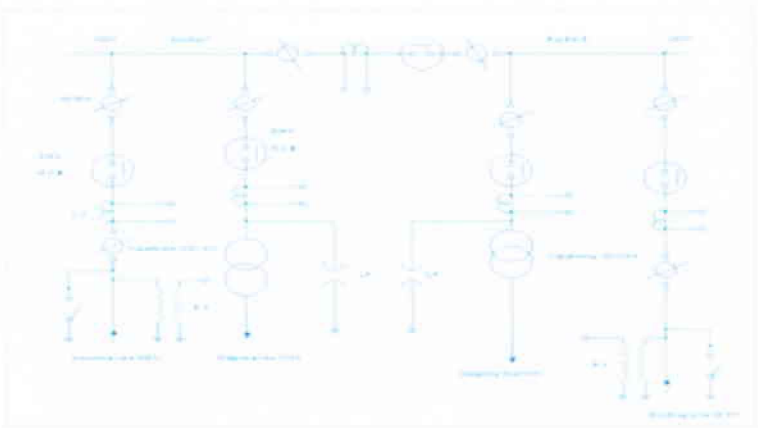

**Figure 3.6 Single Bus-Bar system with Synchronization**

**Double bus-bar arrangement:** In figure 3.7 double bus-bar arrangements consisting of the two bus-bars, a main bus-bars and a spare bus-bar. Incoming and outgoing both have multi-line bus-

bars, they are connected in separates lines. The advantage of this bus bar is that in case of replacement on the main bus bar, the continuity of supply to the circuit can be maintained by transferring the load to the spare bus bar.

**Figure 3.7 Double Bus-Bar Arrangement**

### 3.4.3 Isolating Switches

In substation, it is often desired to disconnect a part of the system for general maintenance and repairs. This is accomplishing by an isolating switch or isolator. An isolator is essentially a knife switch which is designed to open a circuit under no load. In other words, isolator switches are operated only when the lines in which they are connected carry no current.

**Figure 3.8 An Isolator which is used for Maintenance Purpose**

### 3.4.4 Circuit Breaker

A circuit breaker is equipment which can open or close a circuit under normal operation as well as fault condition. Circuit breaker is an automatic switch that stops the flow of electric current in a suddenly overload otherwise abnormality stressed electric circuit. In other word a circuit breaker is an automatically operated electrical switch design to protect an electrical circuit. From damage caused by over load or short circuit. This kind of circuit breaker will be costly in the since of the high cost of the $SF_6$ gas. But it is environment friendly because it cannot deposit the high amount of carbon. And it also low maintenances cost and the light foundation requirement. Over all in this grid substation has ensure that the protection is valid and it is user friendly

In Fulbaria grid substation, all the circuit breaker is $SF_6$ type. In closed position of the breaker, the contacts remain surrounded by $SF_6$ gas and the pressure of the gas is 2.8 $kg/cm^2$. When the breaker operates the pressure of the gas is goes to $14kg/cm^2$.

We have seen the following types of circuit breaker at the substation

a) Oil circuit breaker
b) $SF_6$ circuit breaker

Now the description of these types of circuit breaker is given below.

**Oil Circuit Breaker:** In PBS-1Substation, they use Oil Circuit Breaker. The oil in OCBs serves two purposes. It insulates between the phases and between the phases and the ground, and it provides the medium for the extinguishing of the arc. When electric arc is drawn under oil, the arc vaporizes the oil and creates a large bubble that surrounds the arc. The gas inside the bubble is around 80% hydrogen, which impairs ionization. The decomposition of oil into gas requires energy that comes from the heat generated by the arc. The oil surrounding the bubble conducts the heat away from the arc and thus also contributes to deionization of the arc. Main disadvantage of the oil circuit breakers is the flammability of the oil, and the maintenance necessary to keep the oil in good condition.

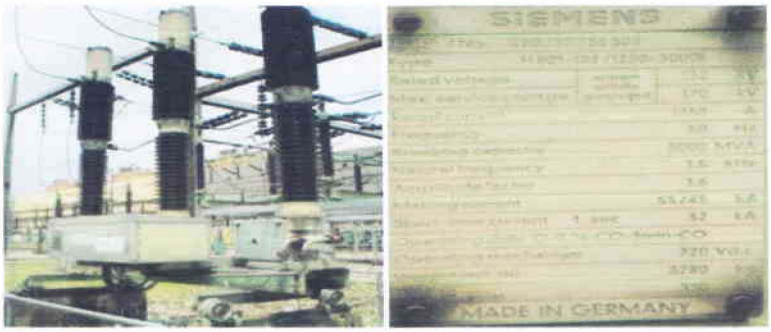


**Figure 3.9 Oil Circuit Breaker with Rating**

**SF6 Circuit Breaker:** Sulphur hexafluoride ($SF_6$) gas is used as the arc quenching medium in this circuit breaker. The $SF_6$ gas is an electro negative gas and has a strong tendency to absorb free electrons. The contacts of the breaker are opened in a high pressure flow of $SF_6$ gas and an arc is struck between them. The conducting free electrons in the arc are rapidly captured by the gas to form relatively immobile negative ions. This loss of conducting electrons in the arc quickly builds up enough insulation strength to extinguish the arc. The $SF_6$ circuit breakers are very effective for high power and high voltage service. In PBS-1Substation use 36 kV and 230 kV rated $SF_6$ circuit breakers. Temperature range of the circuit breaker is -25 ° C to +55° C


**Figure 3.10 $SF_6$ Circuit Breaker of used for High Voltage Protection**

**Advantages of $SF_6$ CB:** Following advantages can be found using $SF_6$ CB:

a) $SF_6$ breakers can interrupt much large currents.
b) The $SF_6$ circuit breaker gives noiseless operation due to its closed gas circuit.
c) There is no moisture problem as the closed gas enclosure keeps the interior dry.
d) $SF_6$ breakers have low maintenance cost

### 3.4.5 Relays that are used in PBS-1 Subststion

A relay is an electrically operated switch. Many relay use an electromagnet to operate switching mechanism mechanically, but other operating principles are also wide. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. Now the descriptions of different types of relays are given below.

**Buchholz relay:** A Buchholz relay is a safety device sensing the accumulation of gas in large oil-filled transformers, which will alarm on slow accumulation of gas or shut down the transformer if gas is produced rapidly in the transformer oil.

**Over current relay:** An over current relay is a type of protective relay which operates when the load current exceeds a preset value In a typical application the over current relay is connected to a current transformer and calibrated to operate at or above a specific current level. When the relay operates, one or more contacts will operate and energize to trip (open) a circuit breaker.

**Distance relay:** The most common form of protection on high voltage transmission systems is distance relay protection. Power lines have set impedance per kilometer and using this value and comparing voltage and current the distance to a fault can be determined

**Percentage differential relay**: This type of relay is capable to identify internal fault only. There are two current transformers (CT) connected to the two end point of the protection part. The difference between two CTs current passes through the operating coil of the percentage differential relay. If difference is greater than zero then relay will operate.

**Pilot relay:** Pilot relay is used for sending signal to the fault part. If any kind of fault occurs in any zone of transmission line, immediately the fault should be cleared by using a signal, which comes from pilot relay. Microwave type pilot relay and power line carrier type pilot relay used for protecting the transmission line.

**Classical relay:** Classical relay is the first protection device. It is the most guaranteed relay. There are several types of classical relays in power system, but at substation they use electromagnetic attraction type double quantity classical relay. This relay has instantaneous

operation, means operation time is constant. The construction of this relay is very simple and operating current can be adjusted easily. This type of relay uses most of the cases.

**Electrical relay:** This type relay is not modern relay. In this relay need to adjust the tripping condition manually. Suppose this relay is trip in one second when flow 5 amp fault current. For making this operation you need to set the value in time and amp manually.

**Figure 3.11 Electrical relay**

### 3.4.6 Lightning Arrester and Earthling

Lightning is a huge spark and takes place when clouds are charged to such a high potential with respect to ground or earth. In a grid substation lighting arrester, absorber and earthling is important factor for protecting it. Lighting arrester or surge diverter is a protective device which conducts the high voltage surges on the grid substation to the ground. These devices work under three conditions. These three conditions are given here. Under normal operation, on the occurrence of the over voltage and nonlinear operation of the arrestor are the three different conditions. And there is various type of the lighting arrestor which we use in different purpose of the grid substation. Lighting arrestor are five types and these difference is only possible for constructional details. With respect to the difference, the main purpose of the lighting arrestor is same but there have some advantage and disadvantage which we describe in below in tabular form:

**Table 3.1: Description about different type Arrestor**

| Name | Description |
|---|---|
| Rod type arrestor | Very simple type and consists of the two rods. One is connected to the circuit and another is connected to the earth. |
| Horn type arrestor | Consists two rods with a small air gap. One of the ends is connected to the line through resistance and inductor on the other hand another end is connected to the ground. |
| Multigap arrestor | Consists of a series of metallic cylinders insulated from one another and separated by small intervals of air gaps. |
| Expulsion type arrestor | Also called protector tube and used in mainly operating upto 33KV. |
| Valve type arrestor | Important for nonlinear resistors and operating at high voltages. |

**Figure 3.12 Picture of Lightning arrester**

### 3.4.7 Transmission & Distribution Line

Transmission line is a material medium or structure that forms a path for directing the transmission of energy from one place to another, such as electromagnetic waves or acoustic waves, as well as electric power transmission. Overhead lines are used for transmission. The main feature of a Transmission and distribution of an overhead line which can be described as follows-

Overhead lines has some components, these are

a) Conductors
b) Line Supporters
c) Insulators

**Conductor:** Conductor carries electrical power from sending end to receiving end. Conductor cost is the most vital cost of the total transmission cost. Therefore proper choice of the material and size of the conductor is considerable Importance. So, the conductor used for transmission and distributions of electrical power have the following properties:

- High electrical conductivity.
- High tensile strength in order to withstand mechanical stress.
- Low cost so that it can be used for long distances.

The transmission of electric power is through the ACSR (Aluminum Conductor Steel Reinforced) conductor. These are highly conductive. So the line losses are low compared to other conductor. This conductor offers low cost and high tensile strength in order to endure mechanical stress.

**Line supporters:** The supporting structures for overhead line conductors are various types of poles and towers called line supporters. Line supporters should have the following properties:

- High mechanical strength to withstand the weight of conductors and wind loads etc.
- Light in weight without the loss of mechanical strength.
- Cheap in cost and Economical to maintain.
- Longer life.
- Easy accessibility of conductors for maintenance.

### 3.4.8 Insulator

The insulator resists the current to be flown from the supports to the conductor. Three different type of insulator is used in transmission line which is depends on the amount of voltage range.

a) Suspension type insulator

b) Pin type insulator

c) Strain insulator

**Pin Type Insulator:** Pin type insulators are used for transmission and distribution of electrical power at voltages up to 33kv.Beyond operation of 33kv, the pin type insulators become too bulky and hence uneconomical.

**Figure 3.13: Pin Type Insulator used for Low Range**

**Suspension Type Insulator:** This type of insulator is cheaper than pin type insulator beyond 33 KV. The desired number of disc can be connected in series for suspension type insulator.

**Figure 3.14: Suspension Type Insulator used for Medium Range**

**Strain Insulator:** A strain insulator is an insulator that provides both large electrical insulation and a large load-bearing capacity. For high voltage transmission lines, strain insulators consist of an assembly of suspension insulators. The disc of strain insulators are used in the vertical plane.

**Figure 3.15: Strain Insulation used for High Range**

### 3.4.9 Cable

A cable must fulfill the following necessary requirements:

- Copper and aluminum conductor for good conduction (aluminum is chipper then cupper)
- Economic cross-section
- Proper insulation thickness
- Armoring may be required for better mechanical strength
- Should not be corrosive

**Classification of Cables:**

Cables can be classified by their transmission ability. Some classifications are given below:

a) Low tension(LT)cables-up to 11kv

b) High tension(HT) cables-11kv to 22kv

c) Supper tension(ST)cable-22kv to 33kv

d) Extra high tension(EHT)cable-33kv to 66kv

e) Extra super high tension(ESHT)cable-beyond 132kv

**Underground Cables:** An underground cable essentially consists of one or more conductors covered with suitable insulation and surrounded by a protecting cover.

**Figure 3.16: Underground Cable for 132kv Line**

**Coaxial Cable:** It is an electrical cable with an inner conductor surrounded by a flexible, tubular insulating layer, surrounded by a tubular conducting shield.

**Figure 3.17: Coaxial Cable**

### 3.4.10 Wave Trap

Wave trap is connected in series with the transmission line. It blocks the high frequency carrier waves (24 KHz to 500 KHz) and let power waves (50 Hz - 60 Hz) to pass through. It is basically an inductor of rating in mH. This is relevant in Power Line Carrier Communication (PLCC) systems for communication among various substations without dependence on the telecom company network. The signals are primarily teleportation signals and in addition, voice and data communication signals.

**Figure 3.18: Wave Trap used for Communication**

### 3.4.11 Tower

Tower is used to support overhead electricity conductors for electric power transmission. Many different type of tower is used in substation and distribution area for transmitting the electricity. This different type of tower is depends on the range power. Most commonly used supporters used in transmission lines are wooden poles, steel poles, and RCC poles.

**Wooden poles:** These are made of seasoned wood and are suitable for lines of moderate cross-sectional area and of relatively shorter spans say up to 50meters.such supporters are cheap easily available, provide insulating properties and therefore are widely used for distribution purposes in rural areas as an economical proposition. But these types of supporters are not suitable all cases because of smaller life, cannot be used for voltage higher than 20kv, less mechanical strength.

**Steel poles:** The steel poles are often used as a substitute for wooden poles. They possess greater mechanical strength, longer life and permit longer span to be used. Such poles are generally used for distribution purposes for cities. This type of supports need to be galvanized or pained in order to prolong its life.

**RCC (reinforced concrete poles) poles**: These types of poles are very popular and widely used as line supports in recent year. They have greater mechanical strength, longer life and permit longer spans than steel poles. Moreover, they give good outlook; require little maintains and have good insulating properties. The holes of the poles are used to climbing of poles and at the same time reduce the weight of line supports. The main difficulty with the use of these poles is

the high cost of transport owing to their heavy weight. Therefore, such poles are often manufactured at the site in order to avoid heavy cost of transportation.

**Steel tower:** In practice, wooden poles, steel poles and RCC (reinforced concrete poles) poles are used for distribution purposes at low voltages say up to 11kv.however, for long distance transmission at higher voltage, steel towers are invariably employed. Steel tower have greater mechanical strength, longer life, can withstand most severe climate condition and permit the use of longer span. This minimizes the lighting travel as each tower acts as a lighting conductor.

**Figure 3.19: High Voltage Tower**

### 3.5 Grid Substation

During our internship period we have visited a grid substation which is situated at Savar, Fulbaria. In this substation 132 KV voltages come from the step-up transformer and it reduced the voltage level to 33 KV. In this substation it has 16 (sixteen) feeders and among of this sixteen feeders they only use two feeder because of insufficient supply. PGCB (Power Grid Company of Bangladesh) cannot able to supply enough power to grid substation. The feeder number L-37 and L-39 is used for supply power to the distribution substation. Both feeders are receiving the same amount of load which the grid distributed. On the other hand, other feeders are also ready for distribution. The capacity of the transformer is 50(fifty) MVA without cooling and 75(seventy five) MVA with cooling. In this grid substation, all the instruments that have been used came from the China. Bangladeshi engineers and China engineers jointly established this grid substation. In these substation all the connection of the transformers are delta connections. Here, the peak demand of the output of the grid substation is only 44 (forty four) MW (mega watt) but unfortunately this substation can supply only 14 (fourteen) to 15 (fifteen) MW (mega watt).

That's why PBS-1 is not being able to fulfill the demand of consumer. For the protection of this system they use 33/0.415 KV transformer. This transformer is use for their necessity of the grid substation. In the grid substation we have seen battery room which is too much sensitive for the grid substation because this room is essential for PLC meters to save from any kind of accident. This battery room is needed to protect or backup the PLC (programmable logic control) meters. Each voltage of the battery is 1.2V and the number of the batter is 92 (ninety two) and the voltage of the battery room is 110V. The normal capacity of the each battery is 250 Ah. In this substation we have seen conservator, which is necessary to collect the heated oil and this is an essential part of a transformer. In a transformer there we have seen silica gels tray which is needed to gather the vapors or rust. When the silica gels tray will be destroyed then it goes to the brown color. For protecting or well service, oil testing is needed in every year. This oil is different from transformer oil. The dielectric strength of this oil is minimum 36KV which we learn from their engineers. In this substation they use SF6 vacuums type of circuit breaker. In this grid substation the grounding of the substation is 70 (seventy) feet and there they use solid or effective type of earthlings. This grid substation is the property of the PGCB but the total financial support has been provided by the Polli Bidyut Samity-1 with the help of an agreement.

### 3.6 Distribution Substation

During our internship period we have visited a distribution substation which is located in the main office of the Polli Bidyut Samity-1. In this distribution substation, 33KV voltages come from the step-up transformer and it reduced the voltage level to 230V. Under PBS-1 there are 19 distribution substations and this substation is among them. In this distribution substation here we saw the PT (Potential Transformer) rating 33KV:240V and this rating is fixed in the substation. And we have also observed the CT (Current Transformer) rating 150:5 which is variable. There are two distributing unit and the capacity of one of these unit is 20MW and the other unit capacity is 10MW. Here all the transformers are single phase and the number of the transformer is 6 (six). We knew in here the rating of the power transformer is 3.33 MVA. Here we have seen the use of the voltage regulator. Voltage regulator is use for 10% voltage increase or decrease of the whole system and we also saw the use of filter valve, filter valve is used to maintain level of the oil. Oil is an important factor of the transformer and transformer oil must be changed when it could be ruined. Temperature of the transformer must have below 60°C because of the

protection. For 33KV bus-bar here need 6 lighting arrestor and all of the lighting arrestor is horn type. In a substation there are more than 4 (four) numbers of feeders but in this substation there are 6 (six) feeders because of the good service providing. In figure 3.20 we have been shown the block diagram of the distribution substation. This figure consists of the circuit breaker which is operated by SF6 gas, bus-bar which is double bus-bar arrangement, CT, PT, power transformer etc. All this information will be provided by our internship supervisor during internship. [4]

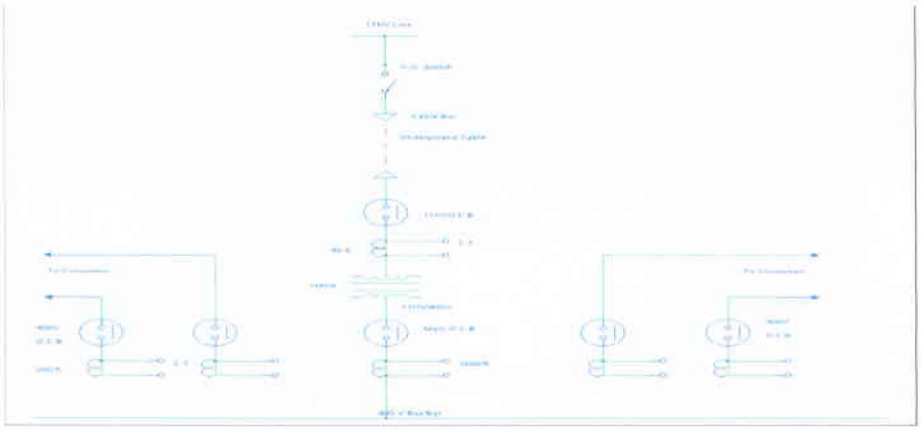

**Figure 3.20: Typical View of Distribution substation**

Now we show the overall view of the distribution substation in figure 3.21 and consisting parameter description in above:

**Figure 3.21: Overall View of the Distribution Substation**

Already we mention that the in distribution substation they use single phase transformer and these transformer is manufactured by the Toshiba Company and now we show the nameplate of these transformer in figure 3.22:

**Figure 3.22: Nameplate of the Transformer**

### 3.7 Load Distribution

Polli Bidyut Samity-1 import electricity from six grid substations. These six grid substations provided electricity from the consumer premises but these grids cannot able to provide sufficient power. Here we show the total imported load at peak hour from different grid in July, 2011 is given below in table 3.2 consists of the demand, supply and the percentage of the supply:

**Table 3.2: Imported load from the Grid at peak hour**

| Serial | Name of the Grid | Demand in MW | Supply in MW | Percentage of the Supply |
|---|---|---|---|---|
| 1 | Kobirpur Grid | 3688 | 1442 | 29.62% |
| 2 | Kollanpur Grid | 351 | 236 | 4.86% |
| 3 | Tongi Grid | Not available in service | Not available in service | 0 |
| 4 | Savar Grid | 685 | 501 | 10.31% |
| 5 | Joydebpur Grid | 136 | 89 | 1.83% |
| 6 | Power Plant | | 529 | 10.59% |

| | | | | |
|---|---|---|---|---|
| | Total | 4860 | 2797 | 57.56% |

The pie-chart will show the percentage of the total load supply at peak hour of this month with the help of the figure 3.23 and these data will be taken from above table 3.2:

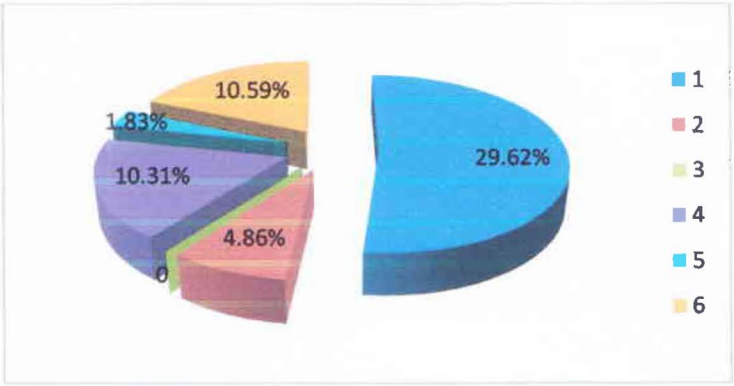


**Figure 3.23: Pie-Chart of the total supply load at peak hour**

Now we show the total imported load at off peak hour from different grid in July, 2011 is given below in table 3.3 consists of the demand, supply and the percentage of the supply:

**Table 3.3: Imported load from the Grid at off peak hour**

| Serial | Name of the Grid | Demand in MW | Supply in MW | Percentage of the Supply |
|---|---|---|---|---|
| 1 | Kobirpur Grid | 3183 | 1335 | 31.06% |
| 2 | Kollanpur Grid | 341 | 228 | 5.3% |
| 3 | Tongi Grid | Not available in service | Not available in service | 0 |
| 4 | Savar Grid | 651 | 531 | 12.36% |
| 5 | Joydebpur Grid | 123 | 93 | 2.16% |
| 6 | Power Plant | | 548 | 12.75% |
| | Total | 4298 | 2735 | 63.64% |

The pie-chart will show the percentage of the total load supply at off peak hour of this month with the help of the figure 3.24 and these data will be taken from above table 3.3:

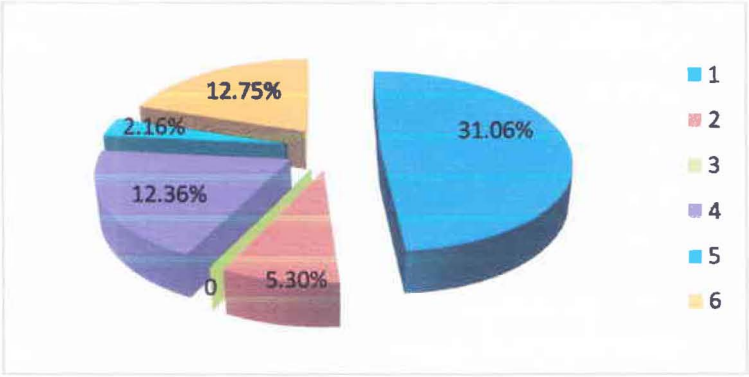


**Figure 3.24: Pie-Chart of the total supply load at off peak hour**

## 3.8 Conclusion

Substation is the gateway to transmit the power to the grid. This chapter gives an overview about the substation equipment's like- transformer, circuit-breakers, isolators, earthling switches, surge arresters, CT, PT, neutral grounding equipment, substation yard etc. The proper maintenance in the substation equipment's in DPBS-1 has made it possible to supply power to the local area uninterruptedly. During any emergency condition the substation isolates the total power station from the grid. The precaution is that peoples in the substation are restricted to walk in some predefined path as there underground cables are installed.

# 4. SWITCHGEAR, SYSTEM PROTECTION & CONTROL

## 4.1 Introduction

One of the most important features of power system is Switchgear, protection and control systems, starting from power generation to users are connected all together in our power systems. So it is very essential to make sure that any flow can be disastrous it does not matter wherever it is been located-the fact is that whenever a flow is been detected it has to be taken seriously to solve the problem and regarding this the total safety measure is detected by using electrical apparatus like relay, circuit breaker, isolator, lightning arrester for switching controlling and protecting from any harm. When we started our internship at Polli Bidyut Samity-1 we saw that their protecting systems are mainly installed in three categories which will be discussed according to our learning.

## 4.2 Generator Protection

Polli Bidyut Samity-1 has no power generation for their own, but they have some supplier. One of them is the United Power Generation, where we visited to learn about the generator protection systems. Since the generator protection of generators involves the consideration of more possible abnormal operating conditions than the protection of any other system element. In unattended stations, automatic protection against all harmful abnormal conditions should be provided, but much difference of opinion exists as to what constitutes sufficient protection of generators in attended stations. Such difference of opinion is mostly concerning the protection against abnormal operating conditions, other than short circuits, that do not necessarily require the immediate removal from service of a machine and that might be left to the control of an attendant. While our working time we could not experience any kind of abnormality but according to the attendant the common abnormality were described which they have faced.

### 4.2.1 Over Current Under Voltage Protection

A sudden trip of a generator can create a fluctuation in current while using multiple generators, which will decreases the terminal voltage. Automatic voltage regulator is connected to adjust these voltages so that the system can be stabilized.

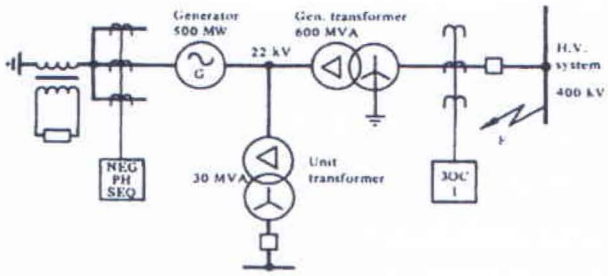


**Figure 4.1: Figure for over current under voltage protection.**

Over current protection normally uses circuits in the high voltage circuit breaker.

a) Direct connection to star-connected current transformer where the relay is supplied with the phase currents.

b) Connection to star-delta current transformer where the relay is supplied with phase difference currents to avoiding zero sequence currents in the primary fault current.

### 4.2.2 Stator Earth Fault Protection

Through high impedance when generator neutral is earthed, differential protection does not protect the complete alternator stator winding against with earth faults; hence a separate sensitive earth faults protection is necessary. The method for sensitive earth fault protection depends upon the generator connection. The alternative methods are employed for neutral connection.

- The neutral connection through resistor which limits the maximum earth fault current to much lower value than full load current fig: 4.2(a) this method is preferred for large units.
- The neutral connected through a voltage transformer. The earth fault current is limited to the magnetizing current of the voltage transformer plus the zero sequence current of generator fig : 4.2(b)

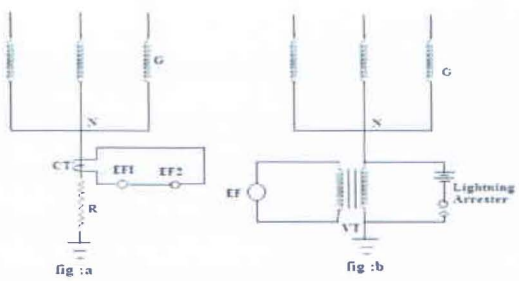


**Figure 4.2: Sensitive Earth Fault Protection of Generator**

### 4.2.3 Back-up Earth Fault Protection

Inverse definite minimum time (IDMT) relays are usually fixed to grant back-up over current and earth-fault protection of a generator. The minimum permissible relay setting is determined by the requirement that tripping must not occur for external HV system faults which may be more discriminatively cleared by other forms of protection. The relay setting should be chosen to provide adequate grading margins with negative phase sequence back-up protection. [5]

### 4.2.4 Generator Differential Protection

Differential protection is used for protection of the generator against phase to earth and phase to phase fault. Differential protection is based on the circulating current principle. In this type of protection scheme currents at two ends of the protection system are compared. Under normal conditions, currents at two ends will be same. But when the fault occurs, current at one end will be different from the current at the end and this difference of current is made to flow through relay operating coils. The relays then closes its contacts and makes the circuit breaker to trip, thus isolate the faulty section.

**Figure 4.3: Figure for generator differential protection**

### 4.2.5 Negative Phase Sequence Protection

Negative phase sequence protection device is a power transmission equipment and electrical device specially designed to give protection from single phasing, overload and unbalanced voltage i.e. too high and too low voltage that lead to loss and low power delivery. This electrical device and the voltage regulator, comes in various operating voltage, weights and are popularly known for sensing and checking negative sequence components of voltage that cause rise in temperature. This electrical

equipment gives protection under adverse voltage conditions and provide supervision when any overload occurs or in any internal faults. This protection device comes in wide variety such as negative sequence over current relays, negative sequence voltage relays and many more in order to increase electrical reliability and solve difficulty in electrical transmission.

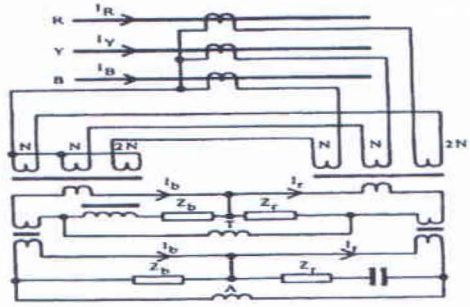


**Figure 4.4: For negative phase sequence protection**

Negative sequence current interacts with normal positive sequence current to induce a double frequency current (120 Hz). Current (120 Hz) is induced into rotor causing surface heating.

### 4.2.6 Under Frequency Protection

Under frequency occurs due to the access of overload. Generation capability of the generator increases and reduction in frequency occurs in under frequency condition. The power system survives only if we drop the load, the generator output becomes equal or greater than the connected load. If the load increases the generation, then frequency will drop and load need to shed down to create the balance between the generator and the connected load. The rate at which frequency drops depend on the time, amount of overload and also on the load and generator varies the frequency changing. Frequency decay occurs within the seconds so we cannot correct it manually. Therefore automatic load shedding facility needs to be applied. These schemes drops load in steps as the frequency decays. Generally load shedding drops 20% to 50% of load in four to six frequency steps. Load shedding scheme works by tripping the substation feeders to decrease the system load. Generally automatic load shedding schemes are designed to maintain the balance between the load connected and the generator. The present practice is to use the under frequency relays at various load points so as to drop the load in steps until they declined frequency return to normal. Nonessential load is removed first when decline in frequency occurs. The setting of the under frequency relays based on the most probable condition occurs and also

depend upon the worst case possibilities. During the overload conditions, load shedding must occur before the operation of the under frequency relays. In other words load must be shed before the generators are tripped. [5]

### 4.2.7 Over Voltage Protection

Over voltage occurs because of the increase in the speed of the prime mover due to sudden loss in the load on the generator. Generator over voltage does not occur in the turbo generator because the control governors of the turbo generators are very sensitive to the speed variation. But the over voltage protection is required for the hydro generator or gas turbine generators. The over voltage protection is provided by two over voltage relays have two units – one is the instantaneous relays which is set to pick up at 130% to 150% of the rated voltage and another unit is IDMT which is set to pick up at 110% of rated voltage. Over voltage may occur due to the defective voltage regulator and also due to manual control errors.

## 4.3 Transfomer Protection

Transformer is one of the most important equipment in power system, so it is very essential to take care of transformers from any harm to perform its actual activities. Transformers may suffer only from winding short circuits, open circuits, or overheating. In practice relay protection is not provided against open circuits because they are not harmful in themselves. Automatic tripping of the transformer breakers is not generally practiced. An exception is when the transformer supplies a definite predictable load. External-fault back-up protection may be considered by some a form of overload protection, but the pickup of such relaying equipment is usually too high to provide effective transformer protection except for delayed short circuits. There remains, then, only the protection against short circuits in the transformers or their connections, and external-fault back-up protection.

### 4.3.1 Coolant

Larger dry type transformers have cooling fans to remove the waste heat produced by losses. The windings of high-voltage transformers are immersed in transformer oil. The oil cools the transformer, and provides the electrical insulation between internal live parts. These Oil-filled power transformers are equipped with Buchholz relays.

**Figure 4.5: A transformer with cooling fan**

### 4.3.2 Unit Transformer Protection

The scheme of generator transformer unit protection compromises the primary protection and back-up protection of generator, primary and back-up protection of main transformer, primary and back-up protection of unit auxiliary transformer and combined protection for generator and main transformer. The protection of unit transformer can be divided into three groups:

- Protective relays to detect faults or abnormal conditions external to the unit.
- Protective relays to detect faults internal to the unit.
- Devices associated with the over speed safeguards, temperature measuring devices for bearings, windings etc. some of these wound an alarm and some cause tripping.

### 4.3.3 Protection of Grounding Transformer

The CT secondary is delta connected. An over current relay with time lag is inserted in the delta. The zero sequence currents circulate in this delta. The time setting of this relay is selected to co-ordinate with thermal rating of the earthling resistor or with time setting of the earth fault relays. The earthling transformer is disconnected by operating the circuit-breaker, on a persistent earth fault. The other three relays provide protection against faults in the grounding transformer. These are instantaneous relays, set between 25 to 50 percent of continuous current-rating of grounding transformer.

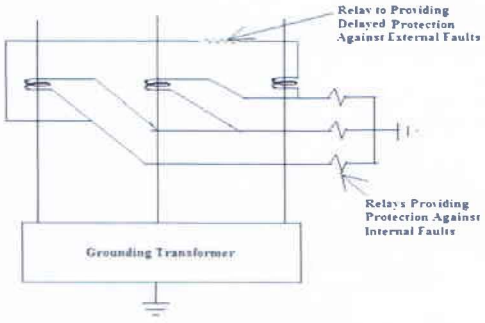


**Figure 4.6: Protection of Grounding Transformer**

### 4.3.4 Differential Protection of Three Winding Transformer

The principle of differential protection can be adopted for three winding transformer. To achieve current balance in pilot wires, ratio adjusting (current balancing) transformers are, used in some schemes. The relay units used in such protection have three restraining coils and one operating coil.

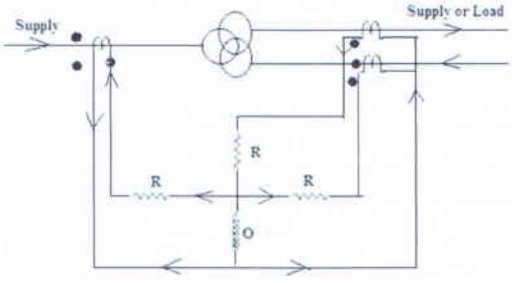


**Figure 4.7 : Differential Protection of Three Winding Transformer**

### 4.3.5 Earth Fault Protection

When the current flows through earth return path, the fault is called earth fault. Other faults which do not involve earth are called phase faults. Since earth faults are relatively frequent, earth fault protection is necessary in most cases. When separate earth fault protection is not economical, the phase relays sense the earth fault currents. Hence separate earth fault protection is generally provided. Earth fault protection senses earth fault current.[6] Following forms of earth fault protection such as

- Restricted earth fault protection by differential protection.

- Additional restricted earth fault protection.
- Leakage to frame protection.
- Neutral current relays.

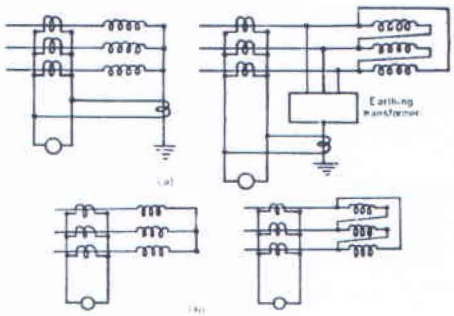

**Figure 4.8: For Earth fault protection for transformer**

### 4.4 Transmission Line Protection

Transmission lines are protected by different kind of relaying equipment, depending on the requirements. Transmission lines protection is required to make sure that the power transmission is running swiftly. These protections are generally used for phase and ground-fault protection on service station and distribution circuits in electric utility and in industrial systems, and on some sub transmission lines. For most transmission lines primary ground-fault protections, ground back-up protection and also relaying for primary protections are required.

#### 4.4.1 Auto Reclosing Relay

The auto reclosing relay is used in high transmission line for line protection when fault is occurred in the line the relay will trip. After clearing the fault the line connection is very difficult to operate manually because it's a high transmission line and here has an extra charge between the lines conductors which is harmful for a man. For this reason auto reclosing relay is used. On the other hand if fault is occurred in a substation, nearest relay will clear this fault. If this nearest relay fails then auto reclosing relay will trip. The relay may be adjusted to provide several recloses at pre-determined time intervals, so that in case the breaker does not remain closed after the first reclosure additional reclosures will be made.

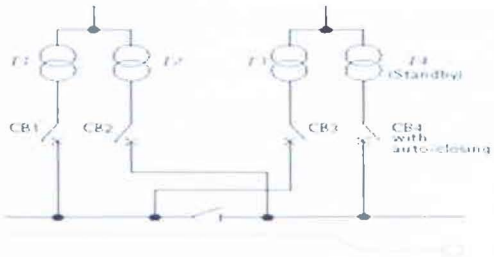


**Figure 4.9: Auto reclosing circuit diagram**

### 4.4.2 Directional Earth Fault Relay

Directional earth fault relay consists of one current coil feed by current of neutral path of current transformer, and voltage coil feed by open delta core of voltage transformer. In the directional over-current protection the current coil of relay is actuated from secondary current of line CT. whereas the current coil of directional earth fault relay is actuated by residual current. In directional over-current relay, the voltage coil is actuated by secondary of line PT. In directional earth fault relay, the voltage coil is actuated by the residual voltage. Directional earth fault relays sense the direction in which earth fault occurs with respect to the relay location and it operates for fault in a particular direction.

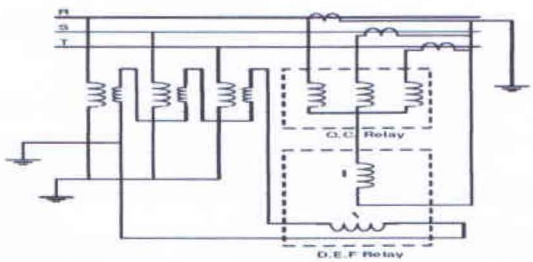


**Figure 4.10: Differential Earth Fault Relay**

### 4.4.3 Impedance Relay

Impedance relays are used whenever over current relays does not provide adequate protection. They function even if the short circuit current is relatively low. The speed of operation is independent of current magnitude. Impedance relays monitor the impedance between the relay

location and the fault. If the impedance falls within the relay setting, the relay will operate. The basic construction for impedance relays on which the principle of operation is easily explained is the balanced beam.

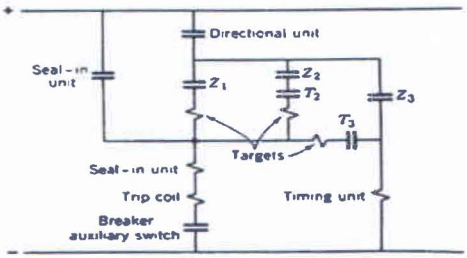


**Figure 4.11: Schematic connections of an impedance type distance relay**

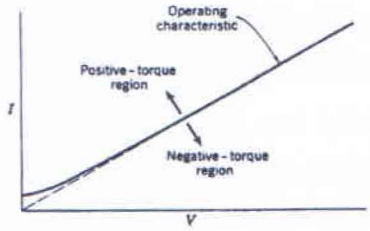


**Figure 4.12: Operating characteristics of an impedance Relay**

The relay consists of a balanced beam. At each end of the balanced beam is a coil that exerts a force on the beam at that end. One coil is connected to a current from a CT; the other coil is connected to a PT. The voltage coil functions as a restraining coil, the current coil functions as an operating coil. Under normal conditions, the contact of the relay is kept open. During a fault, the voltage drops and the current rises. The torque due to the current coil overpowers the torque due to the voltage coil, and the relay closes its contact.

### 4.4.4 Zone Protection Distance Relay

In general, distance protection includes three steps of protection, with each step reaching a fixed preset distance and operating in a preset time.

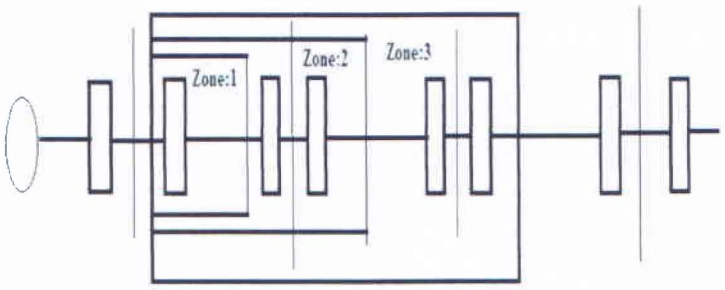


**Figure 4.13 : Zone protection using distance relay**

**Zone 1:** reaches 80 - 90% of the protected line. The tripping is instantaneous.

**Zone 2:** extends beyond the protected line up to about 50% of the adjacent line. The tripping has a time delay, usually set to a value between 0.3 Seconds to 0.5 Sec.

**Zone 3:** covers the protected line, the adjacent line, and up to 25% of the line next to the adjacent line. Tripping is delayed between 0.6 Seconds to 1.0Sec

### 4.4.5 Instantaneous and IDMT Protection

Instantaneous over current relays in conjunction with inverse definite minimum time (IDMT) relays can be used for high speed protection of redial lines. The cool of instantaneous element and IDMT element are connected in series. The instantaneous element has a characteristic like this figure:

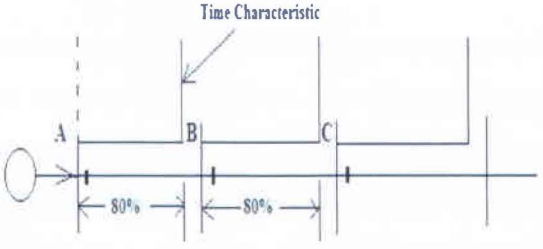


**Figure 4.14: Instantaneous Over current Protection of Line**

Such protection can be effectively applied only if the following conditions are satisfied:

- The fault level at the sending end of the line is at least thrice that at the receiving end of the line.

- The changes in the generating station do not change the fault current significantly. The instantaneous element should be set for more than 150% of maximum fault current at the end of the line section which it protects. For example, the instantaneous element at section A should be set for more than 150% at maximum fault current at section B. Such a margin takes care of transient and over-reach.

### 4.4.6 Offset Mho Characteristics

The offset Mho characteristic encloses the origin of R_X axis. The main applications off-set Mho relays are following:

- Bas bar protection
- Carrier starter unit in carrier aided distance blocking schemes
- Power swing blocking

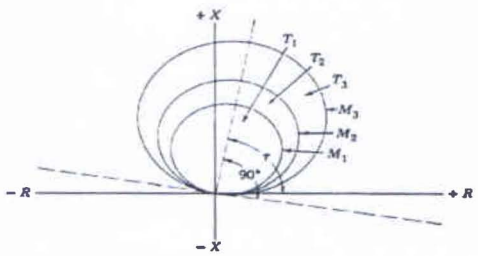


**Figure 4.15: Operating characteristics of a Mho-type distance relay**

## 4.5 Control room

Control room is needed to maintenance the whole system properly and in our internship. We also saw the entire programmable logic control units are operating the system automatically but it can be operated manually. User will be chosen what type of operating system they use. In Summit Power Limited and United Power Generation and Distribution Company Limited both they use automatic control system and we learn from this internship that automatic control system is user friendly. PLC meter is essential for the protection purpose. Most of the electrical equipment has been controlled by the PLC meter. This PLC meter is control by two different ways, one is automatically and another is manually. In UPGD and SPL, we have seen automatic PLC meter. In figure 4.16 we show the PLC meter in UPGD which can control the whole power generation unit and it also control the respective feeder of this unit.

**Figure 4.16 : Programmable Logic Control Unit**

## 4.6 Conclusion

This chapter highlights about the protection system which is a very important for transformer and generator protecton. The equipment's in the protection system are automated. They can also be operated manually. The equipment's which need the constant power supply are provided with the constant dc power supply as backup system. Through different sequential steps the control room of the substation and gas plant of SPL and UPGD are described.

# 5. SERVICES OF DPBS-1

## 5.1 Services

During our internship period we have learned about the different kind of services provided by Dhaka Polli Bidyut Samity-1. Dhaka Polli Bidyut Samity-1 has five sections which can be represents as desk job. All the activities are performed in a thread to maintain the system of working. Since it is an organization to run electrical distribution properly, our goal was to get practiced with all the sections and tries to learn how they work or how they organize it. Overviews of our working experiences are reflected in beneath discussion:

### 5.1.1 Member Service

Member service is most important part for the Dhaka Polli Bidyut Samity-1 which we leaned about when we go to the internship.Where the members of this samity can directly communicate with the establishment of one point service center. In the one point service center a member can claim any kind of difficulties. According to the claims the problems are sent to their proper section which is very effective for a consumer because they do not have to fool around their time by running one desk to another. In one point service, all the worker of this section is motivated to serve properly. In this section the designation of the employee and their underneath activities are shown in tree diagram:

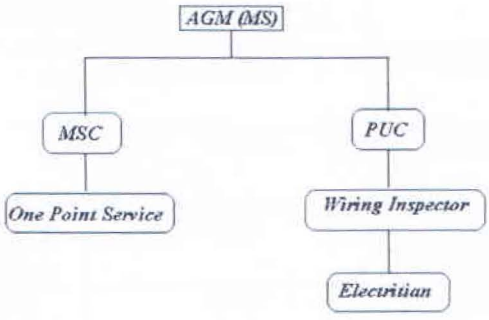


**Figure 5.1: A tree diagram of member service employee designation.**

### 5.1.2 Finance Section

Finance department is working to collect the bill from the consumer and they also record the total earning revenue from the consumer. In finance section also determine the bill per unit. In below we show the tree diagram of these sections-

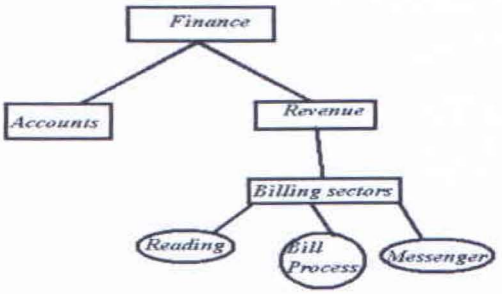


**Figure 5.2 :A tree diagram of Finance Section**

Table given below consists of the number of different type consumer, total different type revenue of this month and the percentage of the total revenue of July 2011:

**Table 5.1: Total Revenue of this month**

| Contents | Class of Service | Number of the Connections | Amount of the Revenue | Percentage of the total Revenue |
|---|---|---|---|---|
| 1 | Domestic | 1, 42,959 | 77,513,781 | 29.63% |
| 2 | Commercial | 18,769 | 26,158,667 | 10% |
| 3 | Irrigation | 3823 | 803,727 | 0.31% |
| 4 | Charity Organization | 1507 | 1,057,405 | 0.404% |
| 5 | General Power | 4489 | 91,690,070 | 35.05% |
| 6 | Large Power | 83 | 32,551,135 | 12.44% |

| | | | | |
|---|---|---|---|---|
| 7 | Street Lights | 183 | 40,094 | 0.02% |
| 8 | Resale to other PBS | 0 | 31,787,119 | 12.15% |
| | Total | 1, 71,768 | 261,601,998 | 100.004% |

Now we show the pie-chart of the percentage of the total revenue of July 2011in figure 5.3 consists of the percentage of the total revenue and these data will be taken from above table

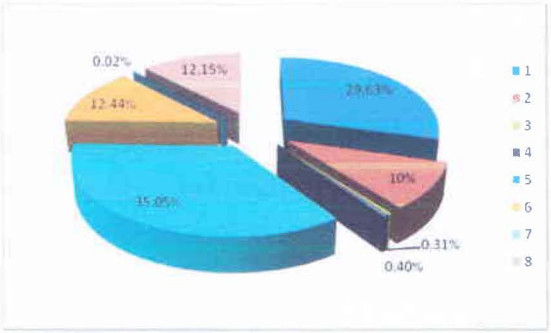


**Figure 5.3: Chart for total revenue collection**

### 5.1.3 Consultant Service

This section determines and receives the additional equipment requirement for running their new project. If this department is refused any kind of bill then they will not be able to collect the bill from the finance section. This section cannot exceed any kind of bill without proper study and proper approval reference.

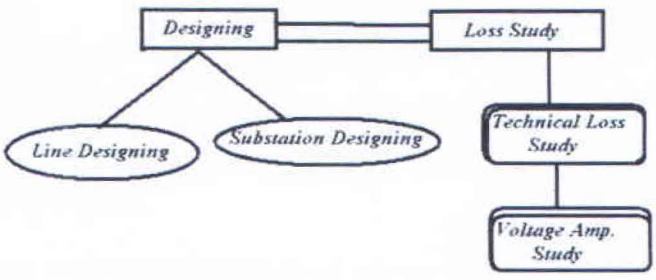


**Figure 5.4 :A tree diagram of Consultant section**

Future planning and field survey held under the consultant section. In those manners Consultant departments calculate the number of the member when a new line will be constructed to make sure that their main goal is achieved.

### 5.1.4 Engineering Section

In engineering section, we learn how they investigate the constructing line and also they supply the necessary equipment for the consumer to get connection. This section also records the system loss information and the information of the peak demand. They also recorded the total receiving power from the grid substation and also distributed power. Damaged transformers also repair from this section. Repairing transformer and supply the new transformer to the consumer or distribution substation is also the major responsibilities for the engineering section. Engineering section also works for any sudden accident happen and ensure the best solution as early as possible. Load dispose center also works under this section. Engineering department estimating the how long the line will be constructed for relevant year and they pass their estimate from their higher authority. The entire engineer and the staff will work together as their target. Polarity testing and the required number of the pole supply will the responsibilities of the engineering section. Here we show the figure 5.5 how they repair the transformer and fill up the oil in the transformer which we have seen in given in here:

**Figure 5.5 Repairing Transformer**

## 5.2. One Point Service of DPBS-1

One point service is the most essential and latest service system in our country. DPBS-1 is continuing this service with successfully. It is the center where the consumers get their necessary information by this service system. If a consumer idea that his billing system and

metering is occurred fault and then he comes the one point service and gets his available information. In this system the consumers are not moved door to door. It is the front face or mirror of DPBS-1. All types of consumer first come to the one point service center and then apply or collect their information as their demand. Main activities of one point service center are-

- Provide information to the consumer instantly.
- Receive all types of consumer complaint or information and register them in computer or paper.
- Give the proper guidance to the consumers.
- After service provide they contact with the consumer whether they satisfy or not.
- Possible all service or information are provide to the consumer instantly.
- All types of consumer complain/information entry in register.
- Give the proper guidance to the consumers.
- Communicate with the consumers for required further information.
- Consumer needs/solution handover to the consumer.
- Maintain consumer complain/information record.

### 5.3. Future Plan of DPBS-1

According to the 1991 survey, there are 86038 numbers of villages in Bangladesh. Seventy five thousand villages have been planned to be brought under REB program. The remaining villages and Chittagong Hill Tract covered by BPDB or DESA where REB program have not yet been considered for implementation. REB programmed was started in 1980. About 45% villages have already been brought under electrification by 2005 and the mid-term plan was to cover further 20% villages by 2005. The future plan is to cover remaining villages by 2020 under the long term plan. It is the final goal to get all the villages of Bangladesh under electrification by the year 2020.The number of PBS up to December, 2006 is 70 which cover more than 90% of effective area for rural electrification. This number is expected to rise up to 72 during the mid-term plan period and up to 75 during the long term plan period.

# 6. CONCLUSION

## 6.1 Introduction

In this chapter we will discuss about the difficulties that we have faced in DPBS-1 during the internship program. This brief discussion will bring up some recommendations which could be regarded as suggestions from our point of view. During our internship we have observe that the theory we have learnt in the university can be applied for real life implementation. The instructors at DPBS-1 demonstrate their working principle with their instruction manuals and also insist us to read about the reference books as well. One important feature of learning is the environment; sometime it seemed that if all the superiors were not so co-operative we would not be able to finish our internship properly.

## 6.2 Problem and Finding

Some problems that we had to face during the internship are given below -

- Sometimes it was very difficult to understand the matters as they were unable to show the internal configurations properly.
- In the power station all the equipment's are running system, so we did not learn practically about all kinds of faults although the instructor there helped us a lot to make us understand about different types of faults of the equipment's in UPGD and SPL.
- During the internship they asked us to provide a detailed working list outlining what we were expecting to complete during the internship, but we were unable to provide it to the mentor as we did not prepare it before.

## 6.3 Recomendation

From our point of view the internship program is very effective to learn something practically applying the theoretical knowledge. To get the best from the internship program, some necessary steps could be followed by the interns. The recommendations can be summarized as below-

- We suggest all the notes from the instructor about what s/he is instructing.

- Taking some suggestions before the internship program from relevant teacher would be very effective to learn the matters.
- Devising a total outline of what to learn during the internship program discussing with the relevent instructor can be a helpful practises.
- Before going for an internship in a power station, completion of the power related courses can help the interns.

### 6.4 Conclusion

It is evident that Bangladesh is one of those countries which faces severe power crisis. REB is trying to solve this scarcity of supply by implementing small power plants as in PBS-1. However, although we have huge lack of electricity in Bangladesh but all of generation, Grid supply, sub-station, consultancy, local member service of REB is more efficient and taking important role to cover lack of electricity. Dhaka Polli Bidyut Samity-1 (DPBS-1) has given us the opportunity to achieve the experience through power generation to distribution by a long and disciplined process.We were lucky enough to work with a group of enthuiastic and communicative people in United Power Generation and Distribution Limited, Summit Power Limited and Dhaka Polli Bidyut Samity-1.

# Appendix

## Acronyms

| | |
|---|---|
| REB | Rural Electrification Board |
| KWh | Kilo-Watt-Hour |
| KV | Kilo-Volt |
| MW | Mega Watt |
| PBS | Polli Biddut Samity |
| DPBS-1 | Dhaka Polli Bidyut Samity-1 |
| PDB | Power Development Board |
| PGCB | Power Grid Company Bangladesh |
| UPGD | United Power Generation and Distribution Company Limited |
| SPL | Summit Power Limited |
| PT | Potential Transformer |
| CT | Current Transformer |
| LD | Load Division |
| LA | Lighting Arrestor |
| EPZ | Export Processing Zones |

## Reference

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4. http://www.pbs-1.bd/
5. http://www.artsci.pdf.com
6. Author: Sunil S. Rao 1973."Switchgear Protection and Power System". (KHANNA PUBLISHERS)

**Table 1: Training Schedule**

| Day | Topic | Mentor | Time Duration | Training Hour |
|---|---|---|---|---|
| 20.08.2011 | Power Generation in Summit Power Limited | Engr. Md. Habib Plant Manager | 8:30 am – 1:30 pm | 5 |
| | | | 2:30 pm – 5:30 pm | 3 |
| 21.08.2011 | United Power Generation and Distribution Company Limited | Engr. Md. A.S.M. Ahsan Habib Plant Manager | 8:30 am – 1:30 pm | 5 |
| | | | 2:30 pm – 5:30 pm | 3 |
| 23.08.2011 | Grid Substation Bismail, Nobinogor, Savar | Engr. Md. Saiful Islam Senior Staff | 8:30 am – 1:30 pm | 5 |
| | | | 2:30 pm – 5:30 pm | 3 |
| 24.08.2011 | Distribution Substation Nobinogor, Savar | Engr. Md. Saiful Islam Senior Staff | 8:30 am – 1:30 pm | 5 |
| | | | 2:30 pm – 5:30 pm | 3 |
| 25.08.2011 | Introduction to substation, Transformer, Bus bar Connection, Transmission Line Protection | Engr. Md. Saiful Islam Senior Staff | 8 :30 am – 1:30 pm | 5 |
| 27.08.2011 | Engineering service | Engr. Shushanto Engineer COM | 8:30 am – 1:30 pm | 5 |
| | | | 2:30 pm – 5:30 pm | 3 |
| 29.08.2011 | Construction, Operation and Maintenance | Engr. Shushanto Engineer COM | 8:30 am – 1:30 pm | 5 |
| | | | 2 :30 pm – 5:30 pm | 3 |