INTERNSHIP REPORT

ON

Power Grid Company of Bangladesh

By

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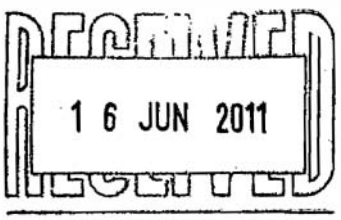

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Power Grid Company of Bangladesh Ltd.

(An Enterprise of Bangladesh Power Development Board)

ISO 9001:2000 CERTIFIED COMPANY

Certificate for Industrial Attachment Training Programme

This is to certify that ***Mr.Nur Mohammad*** *bearing student ID:* ***2006-3-86-003,*** *Department of Electrical and Electronic Engineering,* ***East West University,*** *Dhaka was a candidate for Industrial Attachment Training Programme at Maniknagar Grid Substation under Grid Maintenance Division,Dhaka South, PGCB, Dhaka from 2nd May to 15th May,2010. He successfully completed the Programme.*

Trainer

Company Secretary

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ACKNOWLEDGMENT

We wish to convey our heartfelt thanks and gratitude to almighty Allah for letting us complete the internship successfully.

We would like to thank Mr. Abdus Salam, Deputy General Manager of communication circle of Power Grid Company of Bangladesh for giving us the opportunity to do internship at Power Grid Company of Bangladesh.

We would like to thank and express our gratitude to Mr. Diponkor Das, Deputy Manager of Power Grid Company of Bangladesh. We worked under his generous supervision. Special thanks to all the respected officers and employees of Power Grid Company of Bangladesh for their continuous inspiration and support.

We would also like to thank Dr. Anisul Haque, Chairperson and Professor, Department of Electrical and Electronic Engineering (EEE) and Dr. Md. Ishfaqur Raza, former Associate Professor, Department of Electrical and Electronic Engineering (EEE) East West University for their generous guidance. Special thanks to Ms. Tahseen Kamal, Senior Lecturer, Department of Electrical and Electronic Engineering (EEE) and Mr. S.M. Shahriar Rashid, Research Lecturer, Department of Electrical and Electronic Engineering (EEE) of East West University for their kind supervision to complete our internship report. We are also very grateful to all of our teachers and fellow students for their encouragement and cooperation throughout our internship and academic life.

Finally, we are forever grateful to our parents for their patience and love.

EXECUTIVE SUMMARY

Power Grid Company of Bangladesh (PGCB) is created under the restructuring process of Power Sector in Bangladesh. This report is based on our internship work in Power Grid Company of Bangladesh at Manik Nagar branch. A power system has three basic segments, i.e. power generation, power transmission and power distribution. Basically Power Grid Company of Bangladesh deals with transmission part only. It primarily focuses on different processes of power transmission in power grid. We were introduced with various equipment of Power Grid, such as Relay, Circuit Breaker, Power transformer, Bus bars, Disconnector, Wave trap, Cable, DC battery.

We worked at PGCB as intern for 80 hours. Each day our activities were divided into three parts. Firstly our supervisor talked to us about the theory behind our day topic. Then we visited the grid with our supervisor to relate theory with practical implementation. Finally we visited the grid again to gather ourselves information about the equipment of that day.

Here we learned about power transmission and the behavior of various equipment used in grids. This report contains a detail description about some of these equipments. As we did not complete any major course related to power prior to doing the internship, we had to face hurdles. It would be beneficial and better for us if we had completed the courses Switchgear, Power Station and Power Electronics.

INTERNSHIP SCHEDULE

We worked in Power Grid Company of Bangladesh at Manik Nagar branch. We worked every day from 9.00 am to 5.00 pm except Friday for two weeks. Mr. Diponkor Das, Deputy Manager of PGCB was our supervisor for the internship.

Table 1: Internship Schedule

Date	Work done	Supervisor
02-05-10	Basic discussion on Power System. Transmission line of PGCB, type of Substation, Equipment of Substation.	Diponkor Das
03-05-10	Basic discussion on Single Line diagram and Manik Nagar substation single line diagram.	Diponkor Das
04-05-10	Transmission line, brief discussion about Substation equipment function, visited the Switchyard.	Diponkor Das
05-05-10	Basic discussion on Bus bar and Manik Nagar substation Bus bar, detail discussion about substation equipment.	Diponkor Das
06-05-10	Discussed about CT, PT, Wave Trap, Lighting arrester, PLC.	Diponkor Das
07-05-10	Discussed about control panel, Relay.	Diponkor Das
08-05-10	FRIDAY (CLOSED)	
09-05-10	Circuit Breaker discussion.	Diponkor Das

Date	Work done	Supervisor
10-05-10	Visited to the battery room, discussed about the battery they use.	Diponkor Das
11-05-10	Discussion on Underground Cable.	Diponkor Das
12-05-10	Discussion on Transformer.	Diponkor Das
13-05-10	Our advisors S.M. Shahriar Rashid and Ishfaqur Raza came to visit the substation and consulted with our supervisor.	
14-05-10	FRIDAY (CLOSED)	
15-05-10	Self Study	

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1. INTRODUCTION

1.1 Company Profile

Power Grid Company of Bangladesh (PGCB) was established to make progress of power sector in Bangladesh. PGCB was incorporated in November 1996 with an authorized capital of taka 10 billion. It was entrusted with the responsibility to own the national power grid and to operate and expand the same with efficiency. Then government decided to transfer of transmission assets to PGCB from Bangladesh Power Development Board (BPDB) and Dhaka Power Distribution Company (DPDC), former DESA, PGCB has completed taking over of all transmission assets on 30th December, 2002 and operating them.

PGCB is a public limited company. It has been incorporated through sponsorship of chairman, BPDB and its six members. BPDP owns 76.25% and general public owns 23.75% of PGCB. Its head office is situated at Institution of Engineers Bangladesh (IEB) Bhaban (3rd & 4th floor) Ramna, Dhaka-1000.

Over the country, PGCB has several branches. We completed our internship at the Manik Nagar branch of PGCB. Manik Nagar grid station is a step down transmission substation, where generated high voltage from the generating substation reach through the transmission line, then the transformers step down the voltage and lastly, the distribution substation transmits the voltage. Here we were introduced with various types of equipment of substation, its protection system, and working principle of that grid equipment. [1]

1.2 Activity of PGCB

There are many activities which are done by PGCB. They mainly work on development of electricity transmission. So the following activities are mainly done by PGCB-

- Planning
- Operation and maintenance
- Load dispatching
- Design and evolution
- Protection
- Action for improvement

1.2.1 Planning

Under the supervision of the General Manager, planning jobs are headed by Deputy General Manager. That are-

- Load forecasting, this is used by Power Company to anticipate the amount of power needed to supply the demand.
- Short circuit analysis, it means, infinite resistance between two nodes, which may create a hazardous situation. So they plan such a way, that short circuit cannot make problem.
- System problem analysis, they analysis on the grid's various types of equipment.
- Study of new projects, in this planning, they plan to establish new grid station in a locality, where the scarcity of electricity is huge.

1.2.2 Operation and Maintenance

In Operation and maintenance, they mainly perform grid substation, transmission line and communication surrounded job.

- Regular checking of line and tower, so that nowhere any faulty line can create short circuit.
- Cutting of trees which are hampering the power flowing process, because if trees grow very near to the transmission lines, their branch might create the short circuit phenomenon.

- Checklist, this is used for creating a data on, which equipment are checked and which are not.
- Inspection of substation equipment.
- Operation and maintenance of Power Line Carrier Communication, for their communication.
- Battery and battery charger's operation and maintenance, cause DC battery is the main part of the substation. During power failure, without DC supply a substation will stop working.

1.2.3 Load Dispatching

This type of job is mainly performed by deputy General Manager.

- Generation planning and schedule preparation, here they have to plan that how much electricity they will generate and in what time they will distribute to the customer.
- System control.
- Record collection of operation which is done.
- Monthly operation report, what they have to submit in the head office.
- Annual report of load dispatching or load distribution on the locality.

1.2.4 Design and Evolution

In this field the following jobs are-

- Drawing approvals for the grid station.
- Preparation of technical specification of substation equipments, tower conductors etc.

1.2.5 Protection

Under the supervision of the General Manager, substation protection and co-ordination is headed by deputy general manager and foreman are performing the following jobs-

- Substation equipment checking, otherwise faulty equipment could be harmful for the substation.
- Relay testing, for the full protection of the equipment of the substation. Because when a fault occurred in the line, relay will give a signal. If relay itself doesn't work, then substation may catch fire.
- Weekly, monthly and annual maintenance of relay.

1.2.6 Action for Improvements

Under the supervision of the General Manager, Deputy Manager does the following improvement job.

- Design of every stage of a substation, they have to plan.
- Construction is needed when they want to expand their area or if they want to make the substation in a new way.
- Erection of substation.
- Regular checking of progress.
- Project compilation report.

1.3 Substation Category of PGCB

GIS means Gas Insulated sub-station. Where circuit breaker, isolator, earth switch, current transformer, voltage transformer are surrounded with SF6 gas in an enclosed case. AIS mean Air Insulated Substation. PGCB has following types of substations.

- **230KV substations**
  Total AIS number: 10
  Total number of GIS: 0
- **132/33KV substations**
  Total AIS number: 74

Total number of GIS: 2

- **400/230/132 HV substations**

  Total AIS number: 0

  Total number of GIS: 0

1.4 Motivation for Internship

This internship is done to fulfill the requirement of bachelor's degree in EEE (Electrical and Electronic Engineering) at East West University. At East West University, department of Electrical and Electronic Engineering mainly emphasize on developing the theoretical knowledge with practical basic. This internship has given such opportunity to connect with our theoretical knowledge with practical concern of the power transmission system, how a substation works, bus bar, current transformer, voltage transformer and other equipment in the power sector. And building this report has given us the opportunity to write down the whole process of our internship work.

1.5 Scope and Methodology

1.5.1 Scope

This report provides an overview of power transmission system. This contains description of some equipment being used in PGCB.

1.5.2 Methodology

This report has been written on the basis of information collected from primary sources as well as secondary sources. The primary information has been collected from mentor's lecture, our visitation at the work place, personal observation, discussion with employees and technicians. The secondary information has been taken from the company's website and other websites.

2 DETAIL OF INTERNSHIP WORK

At PGCB, Manik Nagar substation, we were introduced with various equipment of substation during our internship. Our supervisor Mr. Diponkor Das helped us to learn about them. At Manik Nagar substation, we have come across with the following equipment. We visited the grid station from, 2nd May, 2010 to 15th May, 2010. Now in the following sections, we will discuss about the following equipment elaborately.

- Circuit Breaker
- Current Transformer
- Potential Transformer
- Relay
- Battery and Battery charger room
- Wave trap
- Lightning Arrester
- Power Line Carrier Communication (PLCC)
- SCADA (Supervisory Control and Data Acquisition)
- Transmission Line
- Transformer
- Bus bar

2.1 Circuit Breaker

Mr. Diponkor Das, the Deputy Manager of the PGCB of Manik Nagar branch, at first took us to visit the switchyard. There he introduced us with various types of switchyard equipment. The

most important part of the switchyard is Circuit Breaker (CB). He told us about circuit breaker that, it is a protective device which protects electric load devices and electric power cables from a large fault current caused by an electrical shortage and a ground fault that can be generated on an electrical circuit. It also performs the breaking operation automatically when such fault current is generated. When the fault current occurs, then electric circuits detect the leakage current and give a trip signal. Circuit breaker may include an electronic trip unit that senses the over rated current. If it sense that the over current is flowing through the circuit, then in response of trip signal, it will separate breaker contacts. Circuit breaker can be of many types. It is mainly divided on the basis of voltage level, construction type, interruption type and their structures. They are Low Voltage Circuit Breaker, High Voltage Circuit Breaker, Magnetic Circuit Breaker, and Thermal Circuit Breaker. In Manik Nagar grid station, we have seen three types of Circuit Breaker. A typical circuit breaker is shown in Figure 1.

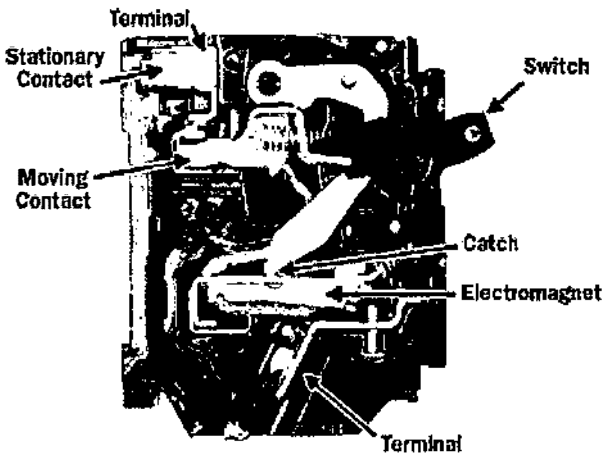


Figure 1: Inside of a typical Circuit Breaker [5]

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

- Oil circuit breaker
- SF6 circuit breaker
- Air blast circuit breaker

Now the description of these types of circuit breaker is given below, what Mr. Diponkor Das had shown us.

2.1.1 Oil Circuit Breaker

In Manik Nagar power grid station, they use Low Oil Circuit Breaker. There are two chambers in a low oil circuit breaker and each chamber is separated from each other. Upper chamber is called the circuit breaker chamber and lower chamber is called the supporting chamber. Circuit breaking chamber consists of moving contact and fixed contact. Moving contact is connected with a piston. The whole device is covered using Bakelite paper and porcelain for protection. In Figure 2, we have shown a Minimum Oil Circuit Breaker.

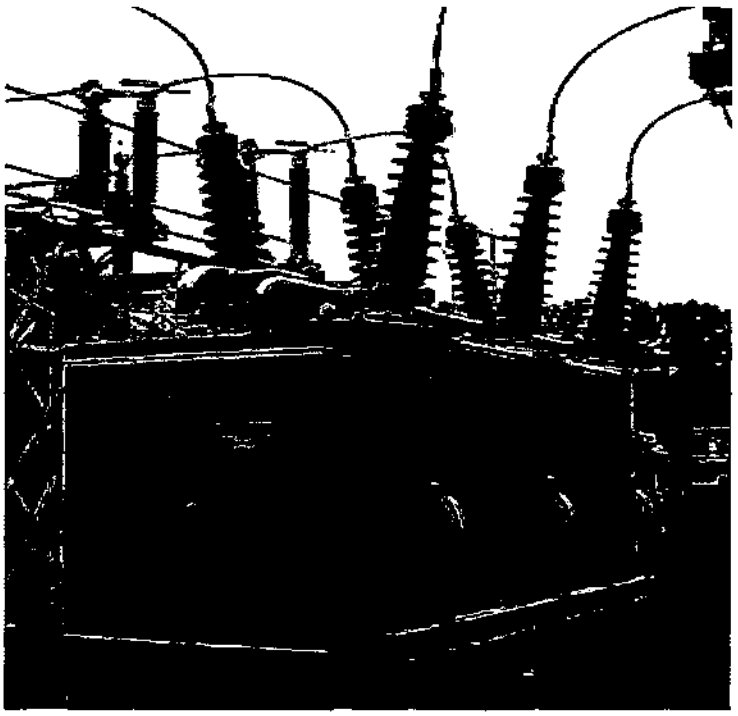


Figure 2: Minimum oil Circuit Breaker [6]

2.1.2 SF6 Circuit Breaker

Sulfur Hexafluoride (SF6) is an excellent gaseous dielectric for high voltage power applications. This gas is an electro negative gas and has a strong ability to absorb the free electrons. The contacts of the breaker are opened in a high pressure flow of SF6 gas and an arc is struck between them. The conducting free electrons in the arc are rapidly captured by the gas. This

forms negative ions. This loss of conducting ion build up the insulation strength and extinct the arc. In Figure 3, we have shown a SF6 circuit breaker. The gas SF6 has following characteristics.

- SF6 has very good arc quenching property, so it extinct the arc in a very short time.
- Its dielectric strength is much greater than air so it can break a large current.
- Noise free operation.
- SF6 is an inflammable gas.
- No carbon deposition.

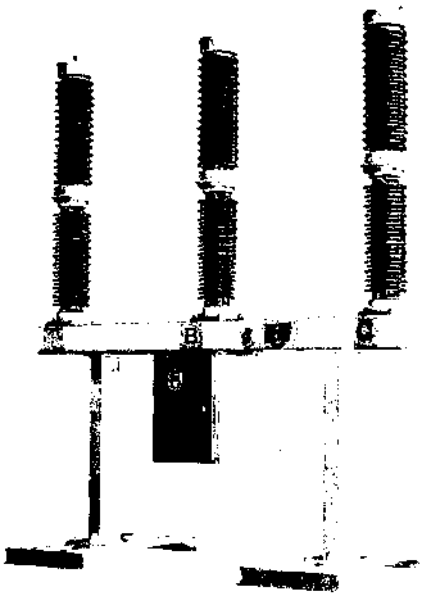


Figure 3: SF6 Circuit Breaker [6]

2.1.3 Air Blast Circuit Breaker

These circuit breakers employ a high pressure air-blast as an arc quenching medium. When the arc struck, the contacts are opened in a flow of air-blast established by the opening of the blast valve. The air-blast cools the arc and sweeps away the arcing products of the atmosphere. Consequently, the arc is extinguished and flow of current is interrupted. Whenever current at high voltages needs to be interrupted, more breaking units are used, in series. Dry and clean air

supply is one of the most essential requirements for the operation of the Air Blast Circuit Breakers. In addition, other gases such as Nitrogen, Carbon dioxide, and Hydrogen can also be used. But air is preferred because of the fact that the Carbon dioxide tends to freeze, and the hydrogen gas is very expensive. This type of circuit breaker is used for high voltage applications, where faster breaker operation is required. Air Blast Circuit Breaker is shown in Figure 4.

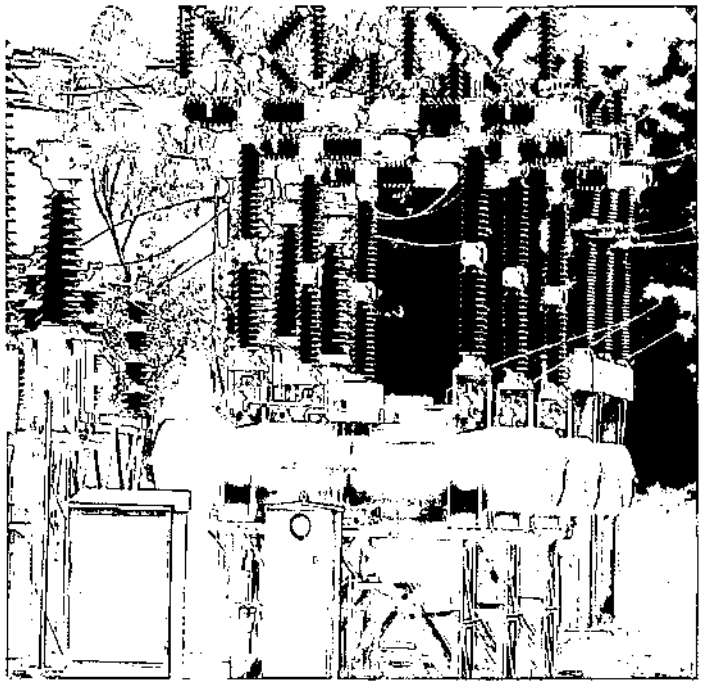


Figure 4: Air blast Circuit Breaker [7]

2.2 Current Transformer (CT)

At Manik Nagar PGCB, we have seen various types of Current Transformers. The engineers of substation informed us about the usage of current transformer in series with equipment for the protection. Current transformer or CT is used for measuring the current of electric equipment. It is a step down transformer. When high current is applied to any measuring circuit and then it can be damaged. Current transformer then produces reduced current which is proportional to the applied current. Only then, this reduced current is safe for measuring circuits and measuring instruments. For that current transformer is often termed as Instrument Transformer. When we were doing internship at the power grid station, we were told that current transformer is excessively used in protective relays and measuring circuits. It is usually connected to the bus bar protection system and circuit breakers trip unit. For the safety of the system, current transformer's secondary winding should be checked regularly, because if it gets unloaded or open, then it can create arc, which is harmful. Sometimes current transformers step up the current in the transmission line that reduces the cost of transmission with less power loss. Without current transformer, the transmission of electricity would not be cost effective and our house hold equipment, which works on AC, would not be safe. So in the metering, monitoring, relaying and protection functions, current transformer is playing a vital role. A typical current transformer is shown in Figure 5.

Figure 5: Current Transformer [8]

2.3 Potential Transformer (PT)

Mr. Diponkor Das has shown us the Potential Transformer on 6th May. He told us that, potential transformer can be also considered as Voltage Transformer. Potential transformer is a step down type transformer. This is mainly used for protective relaying purpose and operation of other instruments such as ammeter, voltmeter and watt meter etc. In Figure 6, a typical potential transformer is shown. This transformer works for single and three phase system both. While doing internship, we learnt that if a potential transformer is not used then KV (Kilovolts) voltage cannot be measured because it is too high to damage any meter. This transformer's primary winding is connected to the transmission line and secondary winding is connected to the point that will be measured. Potential transformer keeps the instrument voltage at a safe level and isolates from the power system. So there is no direct connection between power lines and measuring instrument. Potential transformer is designed to provide as accurate a voltage step down ratio as possible. We have seen the Coupling Capacitor Voltage Transformer (CCVT) in PGCB.

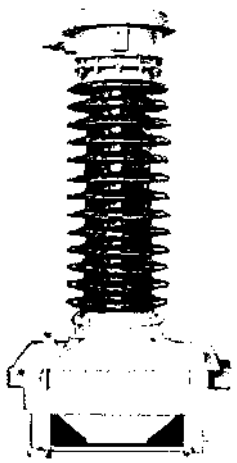


Figure 6: Potential Transformer [9]

2.4 Relay

At PGCB protection is main concern. A relay is an electrical switch which is used where several electrical circuits are controlled by one signal. Relays are used at the both side of the circuit breaker. There are three types of relays. One is primary relay and another two are back up relay for each protection part. Our supervisor gave us a handout about relay to study, because we did not have enough theoretical idea about relay. After studying we learnt following things about relay. We observed relay panel and how to operate it. Relay panel operates by DC power supply. There are three different sources of DC power supply which are connected in parallel with relay panel. The DC power sources are Grid, DC battery and generator, when one is unable then another one is active automatically. Because safety reasons, we could not test and operate relay. Relay or protective relay is necessary with almost every electrical plant so that no part of the power system is left unprotected. This protection depends on various matters such as type and rating of the protected equipment, location, abnormal condition, cost etc. A relay is an electrical switch which is used where several electrical circuits are controlled by one signal. The relays distinguish between normal and abnormal condition. Whenever the abnormal condition appears, relay close its contacts and energize the trip coil of the circuit breaker. Then the faulty parts get disconnected by the opening of circuit breaker. Removal of this faulty part from the system is automatic. [2]

2.4.1 Function of the protective relay

A relay's principal function is to protect service from interruption or to prevent or limit damage to apparatus of the grid station. Following functions are operated by a protective relay [4]-

- Close the trip circuit for opening the circuit breaker during the abnormal condition such as unbalanced load, reverse power, over current flow, short circuit etc.
- Make sound or give alarm for opening the circuit breaker during the abnormal condition.
- To disconnect the faulty part as soon as possible to minimize the damage.
- To improve the system stability, service continuity and system performance, relay disconnects the faulty part quickly.

2.4.2 Desirable quality of protective relay

Protective relay should have certain qualities. Without these qualities we cannot say a protective relay is a really good relay. So those qualities are [4]-

- **Selectivity:** Selectivity is a quality being selective, selective in protecting equipment. The protective relay should select the faulty part from the system and should isolate as soon as possible.
- **Speed and time:** As soon as possible relay will select the faulty part, damage would be that much minor.
- **Stability:** Stability is defined as the quality of protective system by the virtue of which the protective system remains inoperative and stable under specified condition such as system disturbance, faults etc.
- **Reliability:** Reliability means trustworthiness. It should not fail to operate during the fault in the protected zone.

2.4.3 Types of relay at PGCB

There are various types of protective relays. At Manik Nagar power grid station, they use following types of relay.

- **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 Manik Nagar 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.

- **Induction type relay**

This type of relay is basically used for inductive load and over current protection. It has Inverse Definite Minimum Time (IDMT) characteristic. Here angular force is used for time adjustment. This type of relay is made by the help of energy meter's principal. It is sensitive to

direction. There is a Time Setting Multiplier (TSM) and Plug Setting Multiplier (PSM) at the upper part of the relay for controlling the characteristic curve of the relay. This type of relay is basically used for providing protection of Generator, Motor and feeder.

- **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. To provide protection of power transformer at Manik Nagar substation, this type of relay is basically used.

- **Impedance type distance relay**

This is a voltage restrain over current relay. Transmission line protection is really a complex task due to its long distance. If abnormal condition is occurred in transmission line, relay should trip the coil quickly and identify the point of fault part of the transmission line for repairing. Impedance type distance relay is used for providing protection for transmission line. This type of relay is the most costly.

- **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. At PGCB of Manik Nagar branch, they use microwave type pilot relay and power line carrier type pilot relay for protecting the transmission line.

2.4.4 Measurement in relay

Relay could measure the voltage, current, frequency, temperature, impedance, power, pressure, velocity, difference between two currents, magnitude etc.

2.5 DC Battery and Battery charger room

Battery is the most important source in the grid station. It is the heart of the station because most the equipment is run on DC power. Battery is the only back up source of DC supply. Without DC power supply, the grid is unprotected, because security lighting, fire alarm circuit, breaker control circuit, heating equipment and relay get energized by the DC supply. In the Manik Nagar power grid station, they have a battery charger room and there were 84 nickel cadmium battery cell and another 24 battery cell for SCADA operation. The battery is manufactured by Rahimafrooz Batteries Ltd.

2.6 Wave Trap

Wave trap is also known as line trap. It is an electronic filtering device. Wave trap is a parallel tuned inductor- capacitor circuit made to be resonant at the desired communication frequencies. Its main purpose of the use is for communication between two substation and also use the same transmission line between those substations. Through coupling capacitor and Line Matching Unit (LMU), this device traps the high frequency signal which is sent from the remote substation and diverts that signals to telecom panel in the substation control room. These signals are mainly teleprotetion signals and also there are voice and data communication signals. In wave trap, there is high impedance, thus this communication frequency cannot flow through the substation bus bar and transformer. If there is no high impedance in the wave trap, then data could get lost and then communication between those substations would be ineffective or may be impossible. [3]

2.7 Lightning Arrester

Lightning is a huge spark and takes place when clouds are charged to such a high potential with respect to ground or earth. A lightning arrester is a device used on electrical power system to protect the insulation system and other equipment from the damaging effect of lightning.

Lightning arrester is also known as surge arrester. It has a high voltage terminal and a ground terminal. One end of the arrester is connected to the terminal of equipment to be protected and the other end is grounded. It has also a non linear resistance with spark gap. Under the normal condition lightning arrester does not work but when the high voltage or thunder strike occur then air insulation of the gap breaks and arc is formed for providing a low resistance path for surge the ground. In this way the excess charge on the line because of the surge harmlessly conducted through the arrester instead of being sent back in the line, because when the surge is over the resistance offers high resistance to make the gap non-conducting.

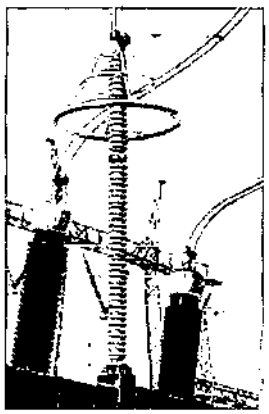


Figure 7: Lightning Arrester [10]

2.7.1 Types of Lightning Arrester at PGCB

A protective device designed primarily for connection between a conductor of an electrical system and ground to limit the magnitude of transient over voltages on equipment. It is also known as lightning arrester. Basically lightning arrester could be various types. At Manik Nagar power grid station, we saw several types of lightning arresters. They are-

- **Rod gap arrester**

It is very simple type of lightning arrester which consists of two rods and is bent at right angle with a very short gap. One rod is connected to the line and other is connected to the ground.

- **Horn gap arrester**

Horn gap arrester is also another types of arrester which consists of a two horn shaped metal rods separated by a small gap. One end of the horn is connected with line circuit and other end is connected with the ground. The gap between of the horn is so adjusted that normal supply voltage is not enough to cause an arc across the gap.

- **Multi-gap arrester**

Multi gap arrester consists of a series of metallic cylinders insulated from one another and separated by small intervals of air gaps. The first cylinder is connected to the line circuit and others are connected to the ground though a series resistance.

- **Overhead ground wires**

The most effective method of protection to transmission line against lightning strokes is use of over head ground wires. Over head ground wires are mainly seen at the top of the transmission tower and also are grounded through a low resistance. Below it, there are conductors. For such positions of the over head ground wire, all the lightning strokes are intercepted by them, and ground wire will take up all the strokes instead of allowing them in the conductors.

2.8 Power line carrier communication (PLCC)

PLCC means Power Line Carrier Communication. It is mainly used for Telecommunication, Tele-protection and Tele-monitoring between electrical substations through the power lines at high voltage. Through the power line, the PLCC system is established. PLCC integrates the transmission of communication signal and 60 Hz power signal through the same power cable. So it is a real benefit that two important application, power transmission and telecommunication are occurring in a single system. Here, in this system, audio frequency carried by carrier frequency and the modulation system is amplitude modulation. Carrier frequency range is set according to the distance of sub stations. This carrier frequency is distributed to include the audio signal,

protection and pilot frequency. We got to know from the Manik Nagar power grid station that they use this PLCC for their substation to substation communication.

We have seen following contents of PLCC-

- **Wave trap:** Wave trap is also known as Line trap. It is connected with the power line and blocks the high carrier frequency and let 60 Hz power waves to pass through.
- **Coupling capacitor:** Coupling capacitor provides low impedance path for carrier frequency and provides high impedance for power frequency, so that it cannot pass through.

2.9 SCADA

SCADA means Supervisory Control and Data Acquisition. SCADA mainly refers to a system that collects data from various sensors at power plant or power station or in other remote locations and then sends this data to a central computer which then manages and controls that data. At Manik Nagar power grid station they also had SCADA system. But they couldn't tell us about SCADA more because they do not operate it; it is mainly operated by head office.

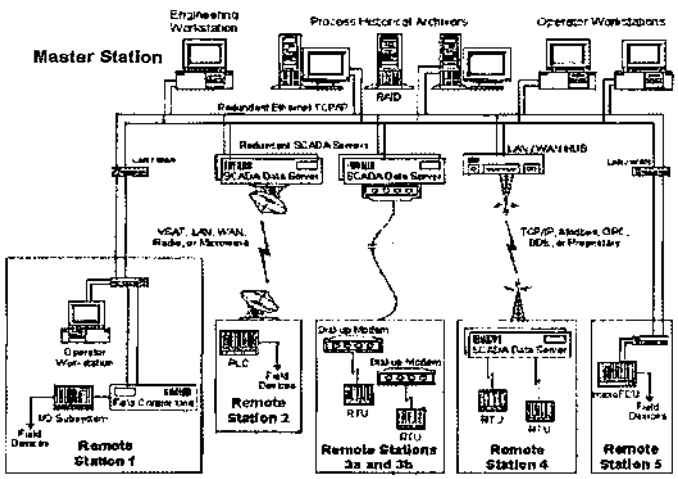


Figure 8: SCADA hierarchy [11]

2.10 Transmission 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. During Internship we saw there some incoming and outgoing transmission lines. They had also underground transmission lines.

- **Incoming feeder**

  There were three incoming feeders, which transmit 230 KV.
  Haripur 1, Haripur 2, and Matuail. They used steel as conductor
  Haripur 1 and 2 is double feeder, Matuail is single feeder.
  all incoming feeder to reduce thunder storm effect on system.

  Total input power to the feeders is 130 MW. There are three incoming feeders, each of supply 230 KV.

  - Haripur 1
  - Haripur 2
  - Matuail

- **Outgoing feeder**

  There are five outgoing feeders, the outgoing feeders are

  - Narinda 1
  - Narinda 2
  - Bangabhaban 1
  - Bangabhaban 2
  - Kazla 1

  Narinda 1 and Narinda 2 are double outgoing feeders, these feeders transmit 33 KV and almost 40 MW power. Steel is used as conductor.
  are double outgoing feeders. These feeders transmit 132 KV and almost 70 MW power.

Kazla 1 is single outgoing feeder and transmits 33 KV and almost 20 MW power. So the total outgoing power is 130 MW.

2.10.1 Cable

At Manik Nagar substation, following types of cable they are using as transmission line. The cables are-

- **Twisted Pair:** The Twisted Pair transmission line consists of insulated wires twisted together to form a flexible line without the use of spacers.
- **Shielded Pair:** The Shielded Pair consists of parallel conductors separated from each other and surrounded by a solid dielectric. The conductors are contained within braided copper tubing that acts as an electrical shield. The assembly is covered with a rubber or flexible composition coating that protects the line from moisture and mechanical damage.
- **Coaxial cable:** It is an electrical cable with an inner conductor surrounded by a flexible, tubular insulating layer, surrounded by a tubular conducting shield.
- **Underground cable:** An underground cable essentially consists of one or more conductors covered with suitable insulation and surrounded by a protecting cover.

Cable should have the following properties:

- Cable should have steel, Copper or aluminum conductor for good conductivity.
- The maintenance cost should be reasonable for cable.
- It should have good insulation properties for protecting undesirable situation.
- It must have good mechanical strength.

2.10.1a Construction of cable

Cable must have following conductor and insulation for the best performance.

- **Conductor in cable**

  A good conductor can provide efficient service for power transmission. Depending upon the service category, conductor's core may be one or multiple. Aluminum conductor is

being used as a cable conductor at Manik Nagar substation for minimizes the cost and efficient service. They mainly use following types of conductor.

- Copper conductor
- Steel conductor
- Aluminum conductor

2.10.1b Insulation in cable

The suitable insulation is given for each core of conductor depends upon of the voltage transmission.

Insulating material for cable should have the following properties:

- To avoid leakage current, it's should have high resistivity.
- To prevent the electrical breakdown of cable, insulation should have high dielectric strength.
- It should have high mechanical strength.
- It has to be non inflammable.
- The insulation material has to be incapable to make any kind of chemical reaction.

2.10.1c Insulating material

Following materials are used as insulation materials at Manik Nagar substation.

- **Rubber**

Rubber has following characteristics:

- Rubber relative permittivity is varried between 2 and 3.
- It has almost 3KV/mm dielectric strength.
- It absorbs moisture.
- It's safe temperature is low, almost 38~39 degree Celsius.

2.10.1d Polyvinyl chloride (PVC)

PVC has following characteristics:

- It has high insulation resistance.
- It has good dielectric strength.
- It has no good mechanical properties.
- It is used as an insulation material for low voltage transmission.

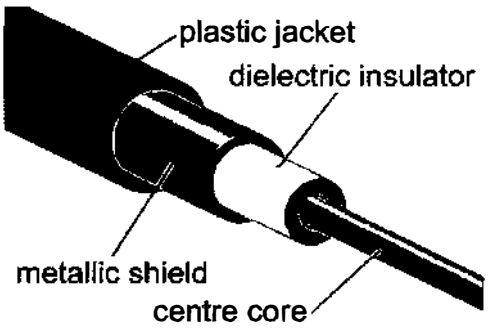


Figure 9: Co-axial cable [12]

2.10.2 Insulator

An insulator, also called a dielectric, is a material that resists the flow of electric charge. In insulating materials valence electrons are tightly bonded to their atoms. These materials are used in electrical equipment as insulators or insulation. Their function is to support or separate electrical conductors without allowing current through themselves. The term also refers to insulating supports that attach electric power transmission wires to utility poles. There were several types of insulators at PGCB. Such as-

- **Pin type Insulator:** This type of insulator only used for above 33 KV transmission line. Otherwise electricity transmission cost will rise,
- **Shackle type Insulator:** At the beginning shackle insulators were used as strain insulator but later they are used in low voltage distribution line. This type of insulator can be used for both horizontal and vertical position and also directly fixed with a bolt.
- **Suspension type Insulator:** This type of insulator is cheaper than pin type insulator beyond 33 KV voltages. The desired number of disc can be connected in series for

suspension type insulator. The series disc arrangement provides more flexibility to the transmission line. The insulators string is free to swing in any direction. If the demand of supply voltage is being increased; we can manage this demand by using series disc.

2.10.2a Cause of Insulator failure

Causes of insulator failure at Manik Nagar substation are given below.

- The insulators have to withstand both mechanical and electrical stress.
- Due to flash over voltage.
- Due to undesired line voltage.
- Insulator may fail due to spark.
- Due to air gap.

2.10.3 Tower

Tower is a tall structure, usually a steel lattice tower, used to support overhead electricity conductors for electric power transmission. There are various types of tower at PGCB, Manik Nagar substation. At the substation, there are following types of tower.

2.10.3a Line Tower

This type of tower is used for supporting the overhead line conductors. It has following properties.

- It has high mechanical strength to withstand the weight of conductors.
- It has long stability.
- Easy accessibility of conductors for maintaining.
- It is low costly for maintaining.

2.10.3b Wooden pole

Wooden pole is made by seasoning wood. It is suitable for lines of moderate cross-sectional area and of relatively shorter spans. It has following properties.

- It has high availability.
- Providing insulating properties.
- It is very cheap for operating.

2.10.3c Reinforced Concrete pole

This is most popular and used as line supporters in recent year. It has following properties.

- It has greater mechanical strength compare to steel pole.
- It has good insulation properties.
- It has less weight.

2.10.3d Steel tower

This type of Tower is suitable for high power transformation with long distance. It is used most of the cases at Manik Nagar substation due to following properties.

- Steel tower has more mechanical strength.
- It has longer life compare to other types of tower.
- It permits the use of longer span.
- This type of tower can minimize the lighting travel as each tower acts as a lightning conductor.
- It is suitable for bad climate condition.

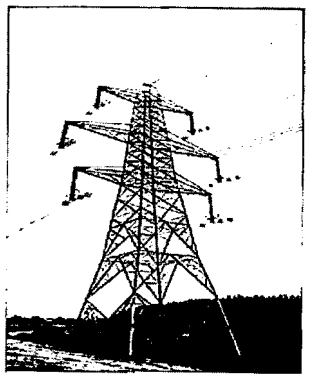


Figure 10: Transmission line & Tower [13]

2.11 Bus bar

In electrical power distribution, bus bar is a thick strip of copper or aluminum that conducts electricity within a switch board, distribution board and other electrical elements. Bus bar is used to carry a very large current or to distribute current to multiple devices within switchgear or equipment. The size of bus bar is important in determining the maximum amount of current that can be safely carried.

There are several types of bus bar such as-

- Single bus bar
- Double bus bar
- Double bus bar with reserved bus bar
- Ring bus bar etc.

But during our internship, we got to know that Manik Nagar grid station uses double bus bar arrangement. So we only discuss here about the double bus bar arrangement. They don't use single bus bar because it cannot carry large load.

2.11.1 Double Bus bar arrangement

Bus bar arrangement is very important issue in substation. But this arrangement depends on several issues like flexibility, technical consideration, economic consideration, safety, extension etc.

Advantages

Double bus bar has several advantages. It has following advantages-

- Cost of equipment is less.
- Easy to use.
- Requires less space.
- Cost of installation is less.
- Cost of maintenance and spares holding is less.

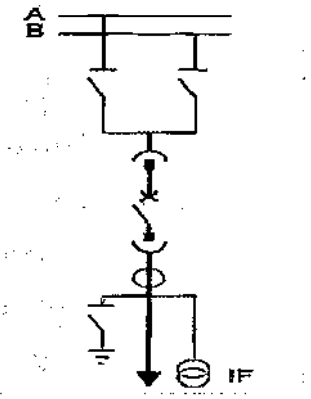
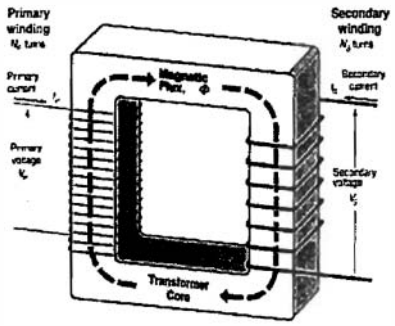


Figure 11: Double Bus bar arrangement system [14]

2.12 Transformer

At Manik Nagar power grid station they mainly use step down transformer. A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductors, the transformer's coils. A varying current in the first or primary winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic field through the

secondary winding. This varying magnetic field induces a varying electromotive force (EMF) or "voltage" in the secondary winding. This effect is called mutual induction. If a load is connected to the secondary, an electric current will flow in the secondary winding and electrical energy will be transferred from the primary circuit through the transformer to the load. In an ideal transformer, the induced voltage in the secondary winding (Vs) is in proportion to the primary voltage (Vp), and is given by the ratio of the number of turns in the secondary (Ns) to the number of turns in the primary (Np) as follows: Vs / Vp = Ns / Np



By appropriate selection of the ratio of turns, a transformer thus allows an alternating current (AC) voltage to be "stepped up" by making Ns greater than Np, or "stepped down" by making Ns less than Np. In the vast majority of transformers, the windings are coils wound around a ferromagnetic core, air-core transformers being a notable exception. Transformers range in size from a thumbnail-sized coupling transformer hidden inside a stage microphone to huge units weighing hundreds of tons used to interconnect portions of power grids. All operate with the same basic principles, although the range of design is wide. Transformers are essential for high voltage power transmission, which makes long distance transmission economically practical.

There is a step down DY11 Power transformer present at Manik Nagar substation. There are high tension (HT) side and low tension (LT) side at Power Transformer; we observed that high tension side is Y connection to the three phases of incoming transmission line and low tension side is Delta connection to the three distribution line. The cores of Potential transformer are marched into oil for transferring the induce heat from cores to outside of the transformer. Two cooling system for potential transformer are presented there; one is Natural cooling (ONAN) and another one is Force cooling (ONAF). The Potential transformer is cooled automatically by the help of nature in Natural cooling system (ONAN), but at Force cooling system, transformer is

cooled by the help of Fans which is providing force. The performance of the Potential transformer is increased almost 10% to 14% percent, if use force cooling system; but ONAF system consuming more power for operating fans. We observed nameplate data of Power transformer during our internship; we got interesting information from data that is the capacity of transformer was given 75 KVA, but the unit should be in watt, because power unit is watt. Our supervisor answered us that transformer loss depend on voltage (V) and current (I) but not on power factor, so the unit is given in KVA range. We also observed that Power transformer is protected by using a percentage differential type relay. [3]

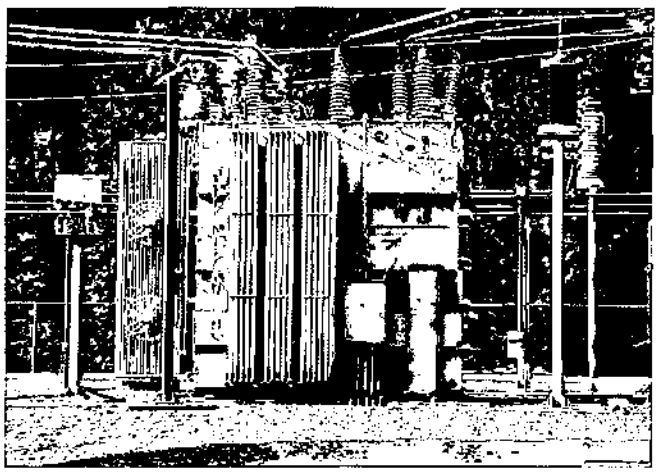


Figure 12: Step down Transformer [15]

2.14 Maintenance of a Substation

Maintenance of a substation is very important work. Without it, a substation becomes unprotected. So for the protection and maintenance, they use various types of systems. Here we give a brief discussion on the Manik Nagar Power Grid maintenance system.

2.14.1 Protection System

In control room and switchyard, in both places they have to protect their equipment from various faults. So they protect their equipment from fault by using-

- Current Transformer

- Potential Transformer
- Surge Arrester
- Relay
- Rubber shoes, helmet, sun glasses are also used for the protection of workers of substation.

2.14.2 Lighting System

For the maintenance and protection, at the substation and switchyard, they have sufficient lighting or illumination system.

2.14.3 Fire fighting system

As they are dealing with high voltage and high current, fire related accident is very common at any substation. At Manik Nagar substation, a good fire fighting system is always presented. People who maintains and operate switchyard, they are always alert for any kind of fire type accident. So they have following protection systems-

- Sensor and detection system
- Alarm system
- Fire extinguisher
- Water sprinkler system etc.

2.14.4 Cooling system

Cooling system is must at any substation. As the equipment of substation is working with high voltage and high current, so they always generate high temperature. If there is no good cooling system, then there are chances of fire and damage of the equipment. So for the cooling system, PGCB of Manik Nagar branch uses-

- Fan
- Various type of oil
- Water tank

- Air conditioner

2.14.5 Standby Power system

If power failure occurs suddenly, the system gets power from the continuous power supply in control room.

- Generators
- DC battery
- Transmission line etc

2.14.6 Communication System

Communication system is very important system in a substation. At Manik Nagar power grid station, they have-

- Telephone
- PLCC

3 PROBLEMS AND RECOMMENDATION

3.1 Problem

While doing our internship we have encountered a certain number of problems. As we did not complete our relevant course(s) before doing the internship, understanding some of the topics were troublesome. Besides, because of confidentiality we could not visit and see all the equipment (internal circuit of relay operation). Last but not the least switching on and off of power supply is not possible in substation and without permission of authority, we could not visit the switchyard. So we could not test and operate the equipment.

3.2 Recommendation

Because of the above mentioned problems our supervisor and also our teachers recommended any intern to complete relevant courses before doing the internship. That will help us to understand the internship and as well as make the report. And if anyone wants to complete internship at PGCB, we will recommend those students to try to operate the equipment with the help of PGCB's engineers. It will help to gather practical knowledge besides the theoretical knowledge.

4 CONCLUSION

In this report our main objective is to appraise the practical knowledge, information and understandings that we have acquired from working at Power Grid Company of Bangladesh. Working environment at PGCB is very friendly. Everyone in PGCB is very helpful and cooperative. We have really enjoyed every moment at PGCB. The only one problem was that we did not complete our internship related courses, so we faced some troubles. So our supervisors and teachers recommended us and even we also recommend to complete relevant topics before attend internship program. During this internship we have learned about the equipment of Switchgear and some operating systems of equipment. We wish to carry this knowledge forward and be able to use it in our career.

REFFERENCE

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