

INTERNSHIP REPORT

ON

BANGLADESH POWER DEVELOPMENT BOARD, RAJSHAHI

Submitted By

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Sl.No.-17/18 - 0763


বাংলাদেশ বিদ্যুৎ উন্নয়ন বোর্ড
Bangladesh Power Development Board

Rajshahi Training Center, PDB, Baganpara, Rajshahi

Certificate

In accordance with the statutes of BPDB

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Student ID 2013-2-80-089, Department of Electrical & Electronic Engineering, East West University, Dhaka having satisfactorily fulfilled the "Hand on Experience" training course organized by Rajshahi Training Center, BPDB, Rajshahi from 17 December, 2017 to 31 December, 2017 and having received the approval of the authority is hereby awarded this certificate.


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Bangladesh Power Development Board

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Course Co-Ordinator


Director

ACKNOWLEDGEMENT

First of all we would like to thank the Almighty Allah for giving us the opportunity to complete our internship and prepare the internship report.

We are very grateful to the management of Bangladesh Power Development Board for providing us the opportunity to accomplish our industrial training in Rajshahi Training Center (BPDB). We are very thankful to Engr. Hasina Dilruba, Director, and Engr. Md Hasibul Huda, Deputy Director of Rajshahi Training Center. We also thank all the engineers and members of Rajshahi Training Center for their guidance and suggestion during the internship. We would like to thank all engineers and members of Katakali Power Plant, Bheramara (HVDC) Substation, Barapukuria Coal Based Thermal Power Plant, and Baghabari Gas Turbine Power Plant.

We would also like to thank our supervisor, Sohana Tanzeem, Senior Lecturer, Department of Electrical and Electronic Engineering, East West University for providing us assistance and encouraging us to prepare the internship report.

We would like to mention the name of Dr. Muhammad Mojammel Al Hakim, respectable Professor and Chairperson of the Department of Electrical and Electronic Engineering, East West University.

Finally, we want to thank all of our honorable teachers, friends and family for their inspiration and co-operation throughout our whole academic life in East West University.

EXECUTIVE SUMMARY

In the modern world, we cannot think a day without electricity. Day by day the demand for electricity is increasing, but the generation of power is not increasing so much in Bangladesh. To fulfill a significant amount of demand of electric power in Bangladesh, Barapukuria Coal Based Thermal Power Plant (250MW), Baghabari Gas Turbine Power Plant (171MW), Recently Bangladesh is importing 500 MW electricity from India by Bheramara(HVDC) substation, all are playing a vital role in power generation in Bangladesh. Katakali power plant (50MW) is also used in emergency situation. A new unit of 275 MW is under construction in Barapukuria Coal Based Thermal Power Plant.

We have done our internship at BPDB, Rajshahi. We visited four different types of the power plant and two substations. Duration of our training was 100 hours for 15 days. In our internship, we visited those power plants and substation to achieve a clear idea of the power generation, control, and maintenance process. This report consists of a brief description of these processes. A lot of steps are needed to complete the supply of the power to the grid. All the steps are described in this report.

Thus internship training helped us with this opportunity to compare our theoretical knowledge with practical applications. Finally, we think, the knowledge we have gathered here really helped us to enhance our understanding of our academic knowledge.

Training Schedule

The table of our training schedule in BPDB, Rajshshi is given below:

Date	Division	Mentor	Time
17/12/2017 (Sunday)	HFO plants and impact of IPP in power sector	Engr. Shoayeeb Muhammad Shaikh	9 am to 6 pm
18/12/2017 (Monday)	Live startup and shutdown procedure of Katakali 50MW Peaking Power Plant	Engr. Mahmudul Islam	9 am to 6 pm
19/12/2017 (Tuesday)	Visit and discussion on protection system and auxiliary System, Generator, HFO engine of Katakali 50MW Peaking Power Plant	Engr. Md. Tareq Mosarraf	9 am to 6 pm
20/12/2017 (Wednesday)	Discussion on Power Grid system of Bangladesh at 132/33KV Grid substation	Engr. Md. Shakhawat Hossain	9 am to 6 pm
21/12/2017 (Thursday)	Discussion on Relay Relays, circuit breaker and other equipment of HVDC Grid substation	Engr. Md. Mostafizur Rahman	9 am to 6 pm
22/12/2017 (Friday)	Bheramara (HVDC) Grid Substation visit	Engr. Md. Shakhawat Hossain	9 am to 6 pm
23/12/2017 (Saturday)	Visit and demonstration on working principle Gas turbine power plant of Baghabari Gas Turbine Power Plant	Engr. Punab Chandra Kundu	9 am to 6 pm

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24/12/2017 (Sunday)	Demonstration of maintenance procedure of Baghabari Gas Turbine.	Engr. Md. Mamun-ar-Rashid	9 am to 6 pm
25/12/2017 (Monday)	Start and Shutdown procedure of Gas turbine power plant	Engr.Md. Bozlurur Rahman	9 am to 6 pm
26/12/2018 (Tuesday)	Discussion on metering system	Engr. Abdullah-Al-Mamun	9 am to 6 pm
27/12/2018 (Wednesday)	Discussion on working principle of thermal power plant	Engr.Muntasir Mamun	9 am to 6 pm
28/12/2018 (Thursday)	Visit and demonstration of maintenance procedure turbine equipment f Barapukuria Coal based thermal power plant	Engr.Md. Kamaruzzaman	9 am to 6 pm
29/12/2018 (Friday)	Different stage of turbine and maintenance procedure Of Barapukuria thermal power plant	Engr. Md. Hassan Mahmud	9 am to 6 pm
30/12/2017 (Saturday)	Demonstration of different types of equipment and their function at Barapukuria thermal power plant.	Engr. Md Mohsinul Firoz Mamun	9 am to 6 pm
31/12/2017	Evaluation and open discussion and closing ceremony	Engr. Md. Hasibul Huda	9 am to 6 pm

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Chapter 01: Introduction

1.1 The objective of the Internship:

The aim of our internship was to get introduced practically to the power generation and transmission process which involves getting a brief idea of all major machinery and systems that are engaged in the process. It enhances our understanding of academic knowledge regarding a power station and switchgear. We have also got introduced to the working environment of the professional engineers there. During this internship, we have visited different power station and substations. In this report, we briefly discuss the power station and substation.

1.2 Company Profiles:

In this report, we have discussed our visited power plant and substation the profile is given below.

1.3 Power Station:

We have visited four power stations that are Katakali Peaking Power plant in Rajshahi, Barapukuria Coal Based Thermal Power plant In Dinajpur, Baghabari power plant In Sirajganj and Bheramara Power Plant in Kustia.

Now we will discuss the power station shortly.

1.3.1 Katakali Power Station:

Katakali is a peaking power plant situated in Rajshahi. It generates 50MW electricity. It is a diesel based power plant. Here they used furnace oil and diesel as fuel.

1.3.2 Barapukuria Power Station:

Barapukuria is situated at Phulbari, Dinajpur district, Rajshahi, Bangladesh. It is a coal-based thermal power plant. There are two units. Each unit generates 125MW of electricity. Coal type fuel is used here. It is operated by Bangladesh power development board.

1.3.3 Baghabari Power Station:

Baghabari Power Plant is situated at Baghabari, Shirajganj. It is a gas turbine power plant. Here natural gas and fuel oil are used to generate power. Its capacity is 171MW (1×71MW, 1×100MW).

1.4 Bheramara (HVDC) Grid Substation:

Bangladesh-India current transmission center is located in Bheramara, Khustia. Understanding the increase in demand for electricity for the social development of Bangladesh, the present government has taken the initiative of importing electricity from India.

1.5 Metering System:

Electricity metering is the process of measuring the instantaneous voltage and current to calculate the consumed electric energy which is typically calibrated into billing units such as kilowatt-hour (kWh). Electricity metering is a broad term which includes both AC and DC metering.

1.6 Company Mission:

Every power plant has a common mission. It is to generate electricity with a reasonable price and make some planning for future demand.

1.7 Future Plan:

- i. Katakali is a 50MW peaking power plant in our country. Its generation cost is very high. Generation of electricity occurs here when the electricity demand is high.
- ii. Barapukuria Coal Based Power Plant has a mission to construct a third unit, which is almost done.
- iii. Baghabari Power Plant is taking a mission to do a combined cycle generation soon.

1.8 Scope and Methodology:

The report is prepared based on the daily practical activities in power development company Bangladesh. In this report, we have covered the total process of generation of electricity, power transmission, and power distribution system. This report contains the description of the equipment and machines used for power generation, transmission, and distribution.

Chapter 02: Barapukuria Power Station

2.1 Introduction

Barapukuria is one of the largest coal-based power plant which is owned by the BPDB. It is situated at Phulbari, Dinajpur district. The area of the plant is 290 acres. It has two 125 MW units and one 275 MW units. It generates 13.8 KV. The annual coal consumption is 0.72 million metric ton. The annual gas generation is 0.08 million metric ton. This is a power plant which has solved the under voltage problem in the northern zone.

2.2 Working Principle of a Steam Turbine Power Plant

Barapukuria Coal Based Thermal Power Plant is a steam turbine power plant. Electrical energy generated by three steps. At first, extracting thermal energy from the fuel. By burning fuel, heat is produced. The heat is used to create steam from water. Then the thermal energy of the steam is converted into kinetic energy. And the kinetic energy rotates the turbine which coupled with a rotor. And at last mechanical energy of turbine converted into electrical energy by using a generator.

2.3 Production Capacity

The installed capacity of Barapukuria power plant is 525MW. It has three units, the capacity of two units is 125MW, and other one's capacity is 275MW which is recently constructed. All units are steam turbine based.

2.4 Coal Treatment

Coal treatment plays an important role in coal-based thermal power plant. The coal is carried from Barapukuria Coal Mine by conveyer belts to the power plant. At first, coal passes through a magnetic separator which separates metals from the coal. Then it sends to the coal crusher which crushes the coal. After it send to the pulverizer which turns the coal into coal powders and hot air is mixed with the coal powder. And at last, the coal is sent to the boiler for burning. The quality of the coal used in the power plant is very high.

2.4.1 Belt Type Coal Conveyer

In figure 2.1 a belt-type conveyer is shown. In Barapukuria belt-type conveyer is used for carrying the coal to the power station from a coal mine. The advantages of belt type coal conveyer are low speed, uniform operation and noise free.



Figure 2.1: Conveyer belts for coal transport at Barapukuria

2.5 Boiler

The steam boiler is an important part of the thermal power plant. It burns the coal and transfers the heat to the water. By the boiler, we can control steam heat and pressure. Water is stored in the boiler. By burning, hot fuel gasses are produced. Heat is transferred to the water and steam is produced. Then this high-pressure steam is sent to the turbine which coupled with a generator.

There are two types of boiler

1. Fire tube boiler
2. Water tube boiler

2.5.1 Water tube boiler

In Barapukuria thermal power plant water tube boilers are used. In the water tube boiler, water flows through the tubes and the hot gases flow over the tubes. There are some advantages to use water tube boiler over fire tube boiler. It requires less space and provides high working pressure due to the small drum.

2.6 Furnace

The furnace is a part of the boiler which is installed where coal is burned, and heat is produced.

2.7 Circulating water pump

Circulating water pump used to circulate the water in the boiler to support the operation of boiler. Barapukuria power station has both, close and open water flow system. They pump out water from the deep level of the surface.

2.8 Feed Water Pump

The feed water pump is used to increase the pressure of the feed water which is necessary to enter the boiler. It improves the overall efficiency. For boiler safety, the water is de-mineralized by removing dissolved particle.

2.9 Super heater 4.7.4

Super heater converts the saturated steam into super-heated steam. The temperature of the super-heated is 538°C .

2.10 Economizer

In economizer, the waste heat of the fuel gas is used to increase the temperature of feed water which increase the boiler efficiency. The heat is recovered from flu gas.

2.11 Steam turbine

The steam turbine is the device which converts thermal energy into mechanical energy. In a power plant, the steam turbine is attached to a generator to produce electrical power. The turbine works as the major mechanical side of the system which provides rotary motion to the generator. The turbine of Barapukuria 125 MW unit is shown in figure 2.2.



Figure2.2: Turbine of Barapukuria 125 MW unit

Turbine Specification of 125MW at Barapukuria

- Model - N-125-14/535/535
- Type- High pressure, reheating combined HP&MP cylinders with the double flow, single shaft
- Speed- 3000 (rpm)
- Rated Capacity- 125000KW
- Rotation- Clock wise

2.12 Generator

A generator converts mechanical energy into electrical energy in the form of altering current. For simplicity, most of the alternators use magnetic field as rotor and armature as a stator. In power stations generators are driven by turbine or engines. In Barapukuria the generators are driven by the steam turbine. In figure 2.3, a picture of 125 MW unit's generator is attached.



Figure2.3: Generator of Barapukuria 125 MW unit

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Turbine Specification of 125 MW at Barapukuria

- Type- QFS-125-2
- Rated Capacity- 156250KVR
- Active Power- 125000KW
- Stator Voltage -13.8KV
- Stator Current- 6537A
- Rotor Voltage- 275V
- Rotor Current- 1750A
- Speed-3000rpm
- Frequency- 50Hz
- Phase- Y

2.13 Power transformer

In Barapukuria step-up transformer is being used to step up the generated voltage from 13.8KV to 230KV. In figure 2.4 a transformer of Barapukuria power plant is shown. The cooling system of the transformer is oil filled cooling system. MVA rating is 156.25 MVA. This is a three-phase transformer. The cooling system is ONAF.



Figure 2.4 Power transformer of Barapukuria

2.14 Cooling system

In Barapukuria power plant the water type cooling system is installed. They have 14 deep tube wells and cooling towers for the cooling purpose. From figure 2.5 picture we can see the cooling towers. In cooling, process water extract heat from the equipment's and release it in the air. Water is circulated inside the system through water jacket, and hot water is sent to the heat exchanger then water cooled in the cooling tower and recirculates.



Figure2.5: Water cooling towers of Barapukuria 125 MW unit

2.15 Waste Management 3.2 AC networks

Waste management is very important in Barapukuria power plant because it is a coal-based power plant and it produces ash. The power plant produces 0.08 million metric ton ash per year. So there fly ash, and bottom ash collector device is installed to manage the ash. There are two ash ponds. All ash are stored in the ash pond. From figure 2.6 we can see an ash collector of Barapukuria power plant.



Figure 2.6: Ash collector at Barapukuria Power Plant

Chapter 03: Katakali Power Plant

3.1 Introduction:

Katakali is a peaking power plant situated in Kathakali, Rajshahi. It generates 50MW electricity. It is a diesel based power plant. Two types of oil are used in here. One is light fuel oil (LFO) and the other is heavy fuel oil (HFO). HFO is cost effective, and it goes down the rate of the electricity production per unit.

3.2 Working Principle:

In Kathakali power plant at first, they start demineralized water pump. Then they start heat recovery steam system power supply. After that, they start up the boiler supply and the compressor. Then they open the compressor air valve after the air pressure raised 25 bars. When steam pressure raise at 4 bars then they open the steam valve in HFO booster unit. After that, they start the LFO pump from the control room. Then they start booster and viscosity pump. When these steps are all complete, then they run the engine and produce electricity. After 30% load supplied HFO separator turn off LFO supply and start HFO pump.

3.3 Production Capacity:

The Production capacity of Kathakali power plant is 50 MW. It has six units; each unit has a capacity of 8.7 MW.

3.4 Fuel Processing:

In engine based power plant Fuel processing system is a very important process. At Katakali power plant there are two types of fuel is used. One is HFO (heavy fuel oil) furnace oil and another one is LFO (low fuel oil) diesel oil. Although Katakali power plant is a diesel engine power plant, it uses furnace oil as fuel to reduce the production cost. Diesel is only used when the power plant is starting power generation and also when it is stopping. Here fuel processing is needed for the furnace oil because the viscosity of the furnace oil is not enough to go through the engine for production. For power generation, the temperature of furnace oil should be $110^{\circ}\text{C}\pm 5^{\circ}\text{C}$. This process is done under some criteria. At first, the furnace oil comes to the storage tank where the temperature must be 40°C - 45°C . For this, the furnace oil pipe coupled with hot water pipe to rise the temperature of the furnace oil before storing in the tank. Then it goes to the buffer tank. In the buffer tank, the temperature of the oil should be maximum 85°C . After this the oil goes to the day tank through two pumps. When the oil comes into the day tank in between there is a separator to separate the dust (hard particle and water) from the oil. This dust store in the slash tank and the purified HFO oil store in the day tank. Then the oil goes to the booster unit where the temperature is controlled at 110 - 115°C . This pure oil then goes to the engine through change over the unit. Now the pure oil is ready to use. Diesel is again filtered before injecting it into the engine by the

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fuel injection pump. The fuel is supplied to the engine according to the load of the plant. Figure 3.1 shows HFO tanks where HFO oil is stored.



Figure 3.1: HFO tank at Katakali power station.

3.5 Diesel Engine:

Katakali power plant is an engine based power plant. The engine model is GSD 18 V 32/40 MAN. These engines are manufactured by German MAN companies. It has 18 V-shaped cylinder that is why it is called 18 V MAN. The generator is coupled to the diesel engine. The speed of rotation is 3000 rpm with two poles. Figure 3.2 shows MAN18V32/40 Diesel engine of Katakali power plant.



Figure 3.2: MAN18V32/40 Diesel engine at katakhali power plant.

3.6 Generator:

At katakhali, AC generators are used. An AC generator produces alternating power. When a conductor moves in a magnetic field, it cuts magnetic lines of forces, due to which an emf (Electromagnetic Field) is induced in the conductor. The magnitude of this induced emf depends upon the rate of change of flux linkage with the conductor. This emf will cost a current to flow if the conductor circuit is closed. There are two types of generator, one is AC generator, and other is DC generator. Whatever may be the types of generator, it always converts mechanical power to electrical power. Figure 3.3 shows generator of katakhali.

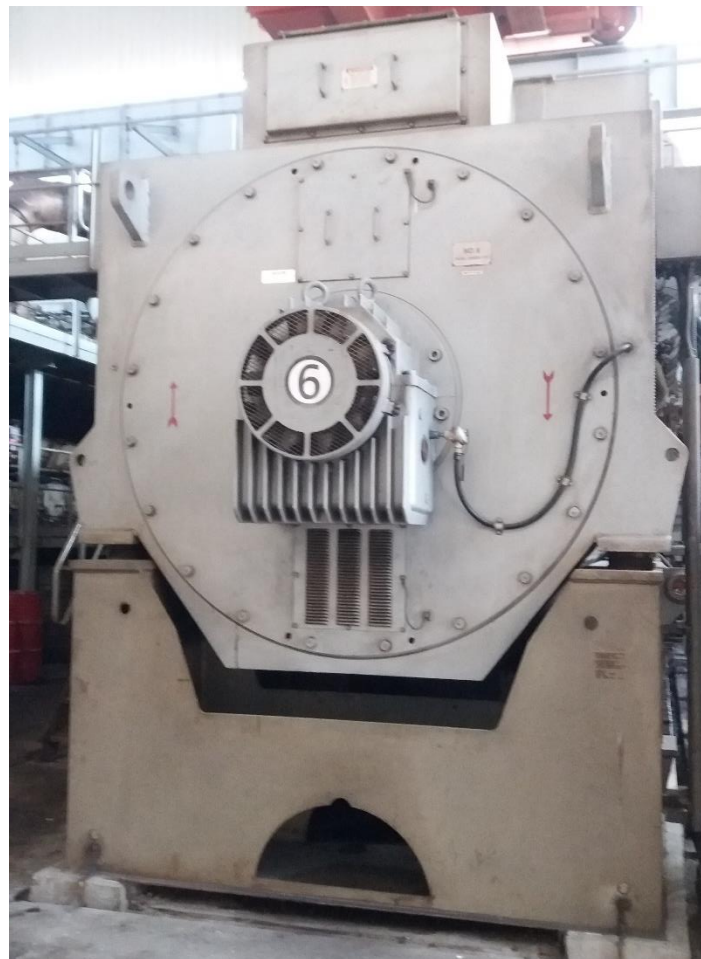


Figure 3.3: Generator at katakhali power plant.

3.7Generated Voltage and Supply Voltage:

At Katakali power plant we observed the generated voltage is 11 KV. Each of the generators generates 8.7 MW power and delivers 11 KV to the bus bar. From the bus bar, 11 kV line goes to three single phase step-up transformer and make a 3 phase connection. This step-up transformer is used to raise the voltage 11KV to 132 KV. Then this 132KV line goes to the SF6 circuit breaker after that to the isolator then to the PT then to the lighting arrester and then to the PGCB sub-station. This 132 KV is then sent to the national grid. From figure 2.6 we can see the transformers of katakhali power plant.



Figure 3.4: 11/132KV transformer at Katakali Power Plant

3.8 Auxiliary Systems:

At Katakali power plant there are seven steam generators. Six of the steam generators are attached with six engines, and another one is kept as a backup. The steam generators produce steam and steam are used to raise the temperature of the HFO. The temperature of the HFO needs to be 110oC for use as diesel. Here steam header pressure is 0.5MPa-0.6MPa. There are different kinds of pumps are used in katakali power plant. Fuel pumps, water circulation pumps, etc. There is some compressor are used to compress the air. Compressed air is used on the piston to start the rotation of the engine. The pressure of the compressed air is around 25bar-30bar. There is an emergency diesel generator in katakali for emergency purpose. To run the full auxiliary systems of Katakali power plant, it requires electricity of around 700KW. Which is come from the national grid.

3.9Cooling System:

There are water cooling, heat exchanger and lube oil cooling system. Demi water is used for water cooling system. Water cooling system is used for the external cooling of the generator, and also heat exchanger is used for that. Finally, lube oil used for internal cooling and protection of the engine and the generator.

3.10 Protection System:

There is mainly water is used for external protection system. There are two types of pump one is electrical pump another pump is the engine based pump. These pumps are used for water pumping. Moreover, there are foam generator and fire extinguisher for fire protection. Auxiliary generator is used to supply electricity at the time of the blackout. SF6 circuit barkers are used here for electrical protection use.

3.10.1 SF₆ Circuit Breaker:

It is a type of circuit breaker which uses SF₆ gas as an insulating medium. The gas has good dielectric and arc extinguishing properties. The dielectric strength of SF₆ is around three times than the dielectric strength of air. What SF₆ circuit breaker is, at the time of arc the SF₆ gas is blown axially at zero current to build up the insulating property for neutralizing the arc between the contacts. Figure 3.5 shows the SF₆ circuit breaker.



Figure 3.5: SF₆ Circuit Breaker

3.10.2 Lightning Arrester:

A lightning arrester is a device used on electrical power systems to protect the insulation and conductors of the system from the damaging effects of lightning. The typical lightning arrester has a high-voltage terminal and a ground terminal. When a lightning surge (or switching surge, which is very similar) travels along the power line to the arrester, the current from the surge is diverted through the arrester, in most cases to earth.

3.10.3 Isolator:

The Isolator is a mechanical switch which isolates a part of the circuit from the system as when required. **Electrical isolators** separate a part of the system from rest for safe maintenance works. Isolators are used to open a circuit with no load.

3.10.4 Current Transformer:

In electrical engineering, a current transformer (CT) is used for measurement of electric currents. When the 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

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can be conveniently connected to measuring and recording instruments. It is also used for protection system. Current transformer gives information to relay to operate circuit breaker.

3.10.5 Potential Transformer:

The potential transformer is used to measure or monitor the voltage on transmission lines and to isolate the metering equipment from the lines. It is also known as a voltage transformer (VT). Potential Transformers are designed to have a precise voltage ratio to accurately step down high voltages so that metering and protective relay equipment can be operated at a lower potential

3.11 Control Room:

In every power station, there is a control room. All components and machinery are controlled from the control room. Generally, in every control room PLC is used to control overall the system. Figure 3.2 shows the Control room of Katakali Power Plant.



Figure 3.6: Control room of Katakali Power Plant

Chapter 04: Baghabari Power Plant

4.1 Introduction:

Baghabari Power Plant is situated at Baghabari, Shirajgonj. It is a gas turbine power plant. Here natural gas and fuel oil are used to generate power. It has two units. One unit produces 71MW, and another unit produces 100MW. The first unit was commissioned in 1991 and the last in 2001. It is operated by Bangladesh Power Development Board (BPDB).

4.2 Working Principle:

The main component of the gas turbine power plant is:

1. Compressor
2. Combustion chamber
3. Turbine

4.2.1 Compressor:

The compressor of the plant is rotary type. The air at atmospheric pressure is drawn by the compressor through the filter which removes the dust from the air. The rotary 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.

4.2.2 Combustion Chamber:

The air at high pressure from the compressor is led to the combustion chamber through the regenerator. In the combustion chamber, heat is added to the air by burning oil. The oil is injected through the burner into the chamber at high pressure to ensure atomization of oil and its thorough mixing with air. The result is that the chamber attains a very high temperature (about 3000°C). The combustion gases are suitably cooled to 1300°C to 1500°C and then delivered to the gas turbine.

4.2.3 Turbine:

The products of combustion consisting of a mixture of gases at high temperature and pressure are passed to the gas turbine. These gases in passing over the turbine blades expand and thus do the mechanical work. The turbine rotates with 3000rpm with two poles. The temperature of the exhaust gases from the turbine is about 575°C. Other components are regenerator, alternator and starting the motor.

4.3 Regenerator:

A regenerator is a device which recovers heat from the exhaust gases of the turbine. The exhaust is passed through the regenerator before wasting to the atmosphere. A regenerator consists of a

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nest of tubes contained in a shell. The compressed air from the compressor passes through the tubes on its way to the combustion chamber. In this way, compressed air is heated by the hot exhaust gases.

4.4 Alternator:

The gas turbine is coupled to the alternator. The alternator converts mechanical energy of the turbine into electrical energy. The output from the alternator is given to the bus-bars through the transformer, circuit breakers, and isolators.

4.5 Starting Motor:

Before starting the turbine, the compressor has to be started. For this purpose, an electric motor is mounted on the same shaft as that of the turbine. The motor is energized by the batteries. Once the unit starts, a part of the mechanical power of the turbine drives the compressor and then there is no need for the motor.

4.6 Air Intake Filter:

Air intake filter is used to filter the atmospheric air from the dust and all kinds of impurities of the environment. The main function of these filters is to supply air to the compressor and then to cool the generator and turbine. Figure 4.1 shows the Air Intake Filter.



Figure 4.1: Air Intake Filter

4.7 Auxiliary System:

Auxiliary transformers supply power to the auxiliary equipment of power station. It takes power from the grid. It is a step-down transformer 11/0.4 KV.

4.8 Protection System:

The purpose of the gas turbine controls is to meet specific control requirements of users and safe operation of the turbine. There are two types of controls. They are shown in bellow

- (A) Prime control
- (B) Protection control

4.8.1 Prime Control:

The objective of the prime control is to ensure the proper application of the turbine power to the load. The users of the gas turbine have specific control requirements according to the users of the gas turbine. The requirements might be to below:

- a. The frequency of an ac generator
- b. The capacity or head of a pump or compressor.

On gas turbine, ac generator set the prime objective of the control is to maintain the constant electrical frequency irrespective of the load. This is achieved by selecting the primary controller as a speed governor, which maintains the constant electrical loads. On the gas turbine is driven pipeline compressor, the prime objective of the control is to maintain a constant pipeline pressure downstream of the driven compressor. In this case, the pipeline is sensed, and turbine power is varied to maintain a constant pipeline pressure for varying the flow conditions. There is a relatively constant relationship between turbine power and fuel power. So in the prime control, the position of fuel valve is controlled.

4.8.2 Protection Control:

The objective of protection control is to ensure adequate protection for the turbine in preventing its operation under average conditions. Whenever unsafe operating conditions are approached, the prime control is overtaken by the protective control to protect the turbine or driven equipment.

protection control is two types:

- a. Shutdown control
- b. Modulating control

4.9 Shutdown Control:

The shutdown type control detects a condition which can cause a serious malfunction and actuate the shut-off valve to stop the turbine following the various types of shutdown control.

- a. Turbine over temperature,
- b. Turbine over speed,
- c. Low lube oil pressure,
- d. High lube oil temperature,
- e. Excess vibration.

4.9.1 Turbine over Temperature:

Turbine over temperature maybe well sensed at the turbine inlet but the sensing device put at turbine inlet goes wrong, and therefore it is sensed at the turbine exhaust, which is also an

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indication of turbine inlet temperature. The temperature sensor may be a thermocouple, bimetal or mercury vapor. As soon as the turbine inlet/ exhaust temperature increases a predetermined value, the relay system acts upon the shut-off valve and shut down the turbine by stopping the supply the fuel completely to the combustion chamber.

4.9.2 Turbine over-speed:

The turbine over speed control is similar to the prime speed control. In this case, the reference speed is the maximum allowable speed instead of rated speed. The speed sensor could help centrifugal governor, a tachometer generator or magnetic pickup. If the speed increases a certain fixed value, the speed acts upon the relay system to shut down the fuel valve.

4.9.3 Low Lube Oil Pressure:

It is essential to protect the turbine from low lube oil pressure to ensure proper lubrication and cooling of the turbine bearing. This is accomplished by the use of a pressure switch in the lube oil supply line. The switch operates an alarm signal or shut down fuel valve if the oil pressure drops a safe valve.

4.9.4 High Lube Oil Temperature:

High lube oil temperature in the lubrication system is a dangerous signal as it is an indication of low lube oil supply or failure in bearings, gears, etc. This protection is accomplished through the use of a temperature-sensing device immersed in the lube oil. The sensing device is may be a thermal switch, which triggers an alarm or shut down the turbine.

4.9.5 Excess Vibration:

A slight increase in vibration in a cause of warning protection against vibration is by stalling one or moves vibration pick-ups. The output signal is fed to a monitoring device, which may shut down the turbine if the vibration increases a certain valve.

4.10 Control Room:

In control room, the whole system is controlled by using PLC. Figure 4.2 & 4.3 shows The Control Room of Baghabari Power Station, where operators can control & monitor all of the components of the plant. From figure 4.2 and 4.3 we can see the control room computer monitor of 71 MW and 100 MW unit.

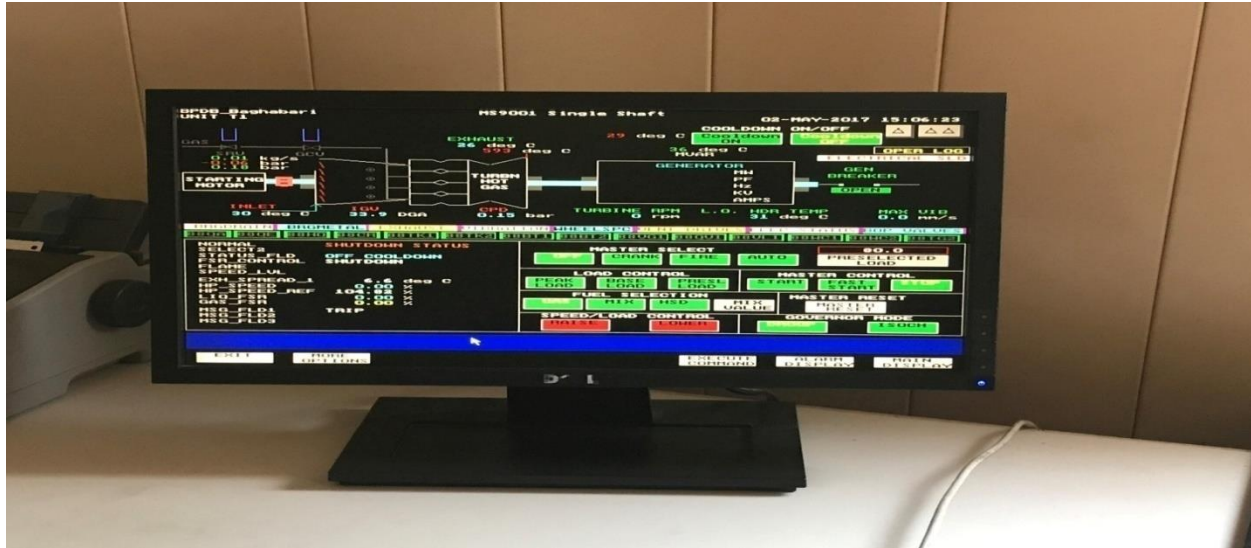


Figure 4.2: Control room of 71MW unit.

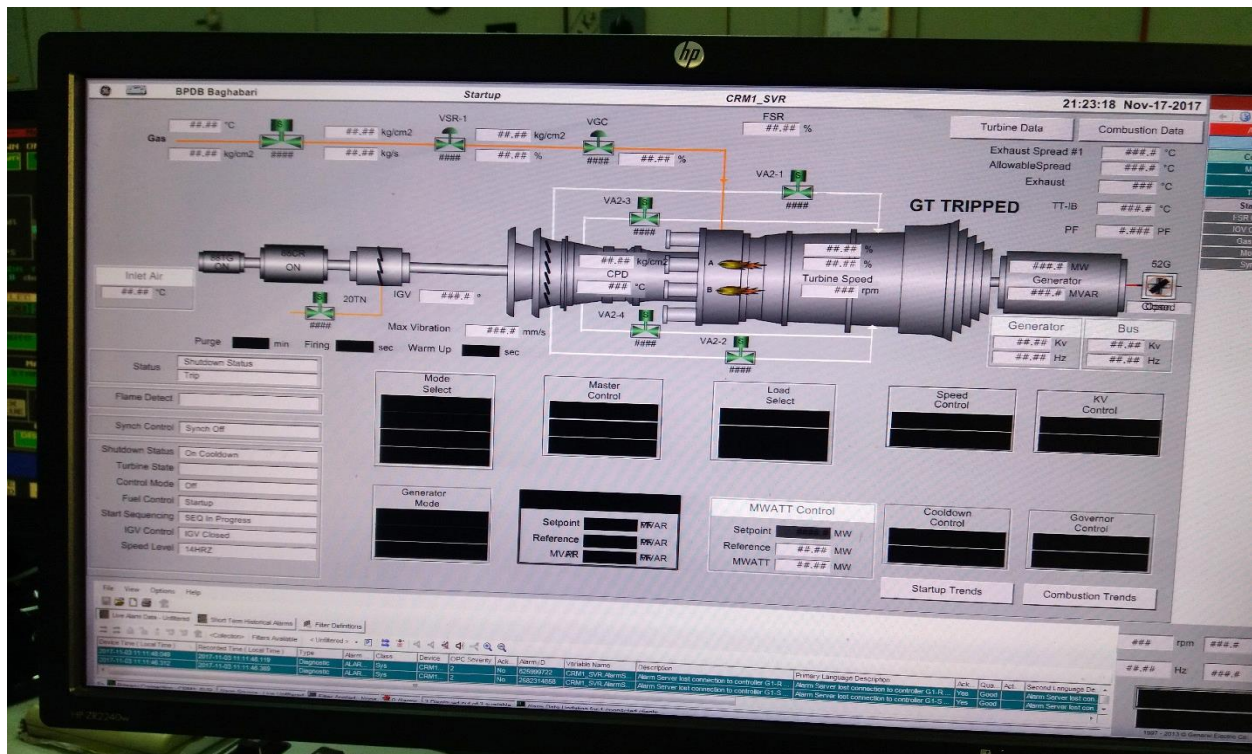


Figure 4.3: Control room of 100MW unit.

Chapter 05: Bheramara (HVDC) Grid Substation

5.1 Introduction:

Bangladesh-India current transmission center is located in Bheramara, Khustia. Understanding the increase in demand for electricity for the social development of Bangladesh, the present government has taken the initiative of importing electricity from India.

5.2 Main Data:

AC system frequency 50Hz for both Bangladesh and India but the system voltage is the difference. AC system voltage of Bangladesh is 230 KV, and for India it is 400KV. The rated power is 500MW. Direct voltage and current is 158.1 KV and 3189 A. Overload 1.1 up for 2 Hours and 1.33 up for 5 sec. There is three single phase 3 winding converter Transformer on both sides.

5.3 AC-DC-AC Back To Back Processing:

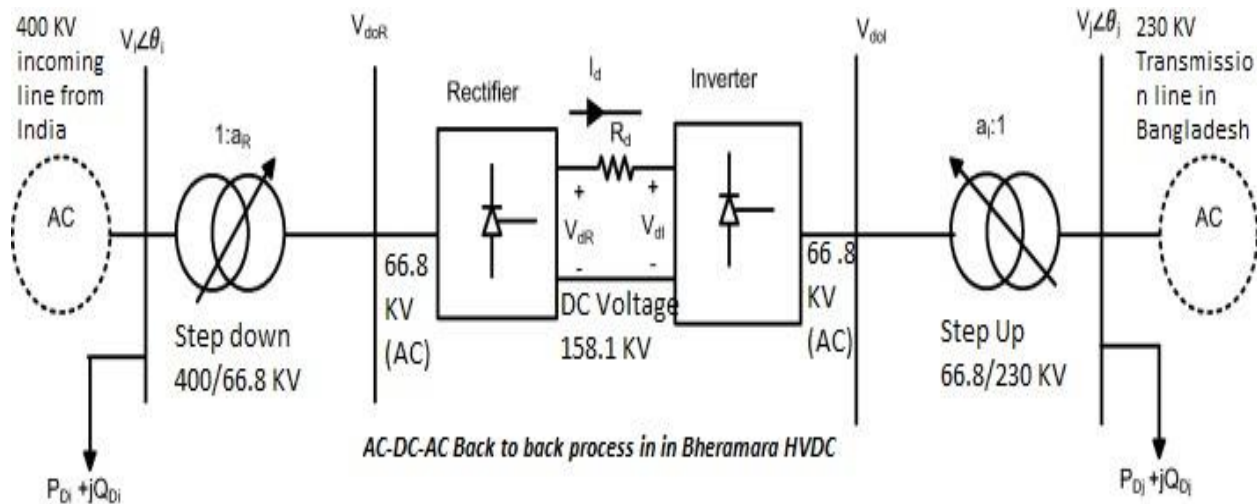


Figure : 5.1 AC-DC-AC back to back processing in Bheramara HVDC

India supply 500MW at 400 KV through the 100km transition line. Bheramara substation receive the power and step down the voltage from 400 to 66.8 KV then it send to the rectifier. A rectifier is an electrical device which converts alternating current to direct current and it flows in only one direction. The rectifier output current is 3189 A at 158.1 KV at DC. This current pass through the inverter after frequency stabilization. Inverter convert the DC current into AC current at 66.8 KV and then it step-up to 230 KV for transition in Bangladesh.

5.4 AC Networks:

Bangladesh Side:

Rated	AC Side	Valve Side, Y	Valve Side, D
1 Phase MVA	201	100.5	100.5
Voltage KV	$\frac{230}{\sqrt{3}}$	$\frac{66.8}{\sqrt{3}}$	$\frac{66.8}{\sqrt{3}}$
Tapping Range	-7% to +11% (Step 1%)	N/A	N/A

Table 5.1: Bangladesh Side

India Side:

Rated	AC Side	Valve Side, Y	Valve Side, D
1 Phase MVA	201	100.5	100.5
Voltage KV	$\frac{400}{\sqrt{3}}$	$\frac{66.8}{\sqrt{3}}$	$\frac{66.8}{\sqrt{3}}$
Tapping Range	-7% to +11% (Step 1%)	N/A	N/A

Table 5.2: India Side

5.5 AC Filter:

At India side, 4×91 MVAR, 12/24th Harmonic Filter and two shunt reactors of 63 MVAR are installed on 400kv buses. At Bangladesh side, 2×91 MVAR, 12/24th and 2×91 MVAR, 3/24th Harmonic Filter and 1×91 MVAR C-Shunt are installed. Two Shunt reactors of 35 MVAR are also installed on 2 KV buses.

5.6 Bus Bar:

Bus bar is used to connect all the equipment in a substation. So when some lines operate at the same voltage and both connected electrically, then it is known as a bus bar. In a substation, incoming and outgoing lines are also connected to the bus bar.

5.7 HVDC Valves:

In quadruple structure, each valve consists of 26 No. 8 KV (5'' LTT) thyristors connected in series. Its structure suspended form top. High voltage bus on the lower side and the neutral bus are on higher side.

5.8 Valve cooling system (VCS):

Deionized water circulated in a close loop system and the valves are cooled by the system. The conductivity of cooling water $0.5 \mu\text{S}/\text{cm}$. The alarm system will be active if the conductivity rise than $0.5 \mu\text{S}/\text{cm}$. And the system will trip if the value is larger than $0.7 \mu\text{S}/\text{cm}$ for 2 minutes. Here figure 5.1 shows the cooling system of HVDC.

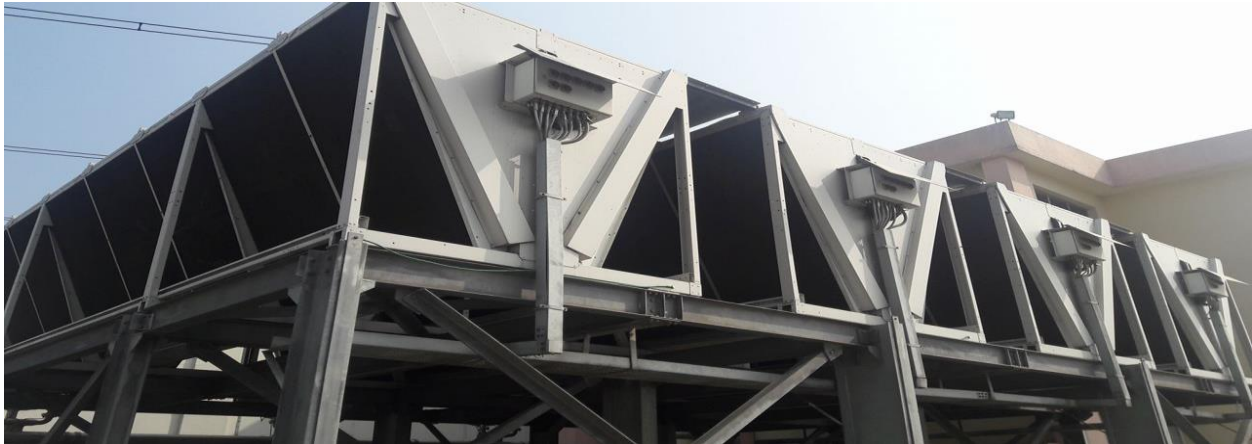


Figure 5.2: Cooling System

5.9 Lightning Arrester:

A lightning arrester is a device used in electrical power systems and telecommunications systems to protect the insulation and conductors of the system from the damaging effects of lightning. The typical lightning arrester has a high-voltage terminal and a ground terminal. Here figure 5.2 shows lightning arrester of HVDC.



Figure 5.3: Lightning Arrester of (HVDC) Grid Substation

5.10 Control room:

In Bheramara (HVDC) Grid Substation there is a control room for controlling the whole station. The control room is made by Germany-based Company Siemens. Which is very much well equipped and they maintain heavy security for the control room. Figure 5.3 shows the water treatment system which is monitoring in control room by the operator.

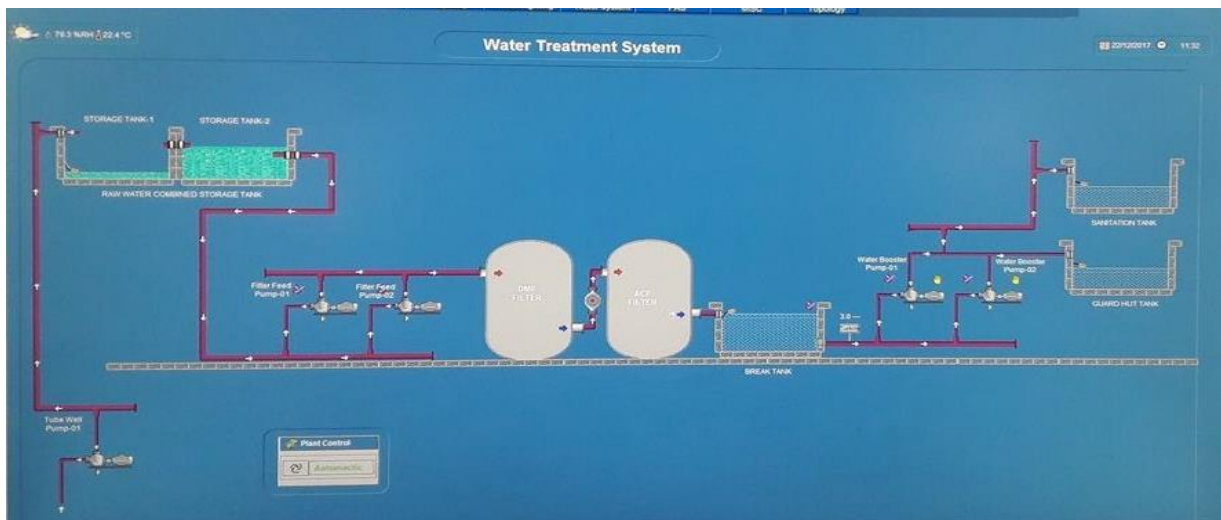


Figure 5.4: Water treatment system monitoring in control room

Chapter 6: Metering System

6.1 Introduction:

Electricity metering is the process of measuring the instantaneous voltage and current to calculate the consumed electric energy which is typically calibrated into billing units such as kilowatt-hour (kWh). Electricity metering is a broad term which includes both AC and DC metering. The metering system is one of the important parts of power generation.

6.2 Types of Electric Meters:

1. Single phase meter.
2. Three phase meter.

6.2.1 Single Phase Meter:

Single phase electricity is connected at 230 or 240 volts via two wires, active and neutral, and is found in most domestic settings. There are both of analog, and digital meter are used in single phase meter. The type of single meter is CELL-4. In a residential area, single phase meter is used. Figure 6.1 shows The Single Phase Meter.



Figure 6.1: Single-Phase Meter

6.2.2 Three Phase Meter:

Three-phase electricity is connected at 400 or 415 volts, by three active wires or phases and one neutral. This is mostly used in industrial and large commercial settings where powerful appliances are powered. There are two types three-phase meter. These are,

1. High tension meter.
2. Low tension meter.

6.2.2.1 High Tension Meter:

High tension meter is used when the supply ranges between 22kv and 66kv. Here the High tension meter type is “Landis+Gyr-E650. Figure 6.2 shows High Tension Meter.



Figure 6.2: High Tension Meter

6.2.2.2 Low Tension Meter:

Low tension meter stands for the meter which is used for domestic and industries purpose which is in the range of 220-400v. Figure 6.3 shows The Low Tension Meter.

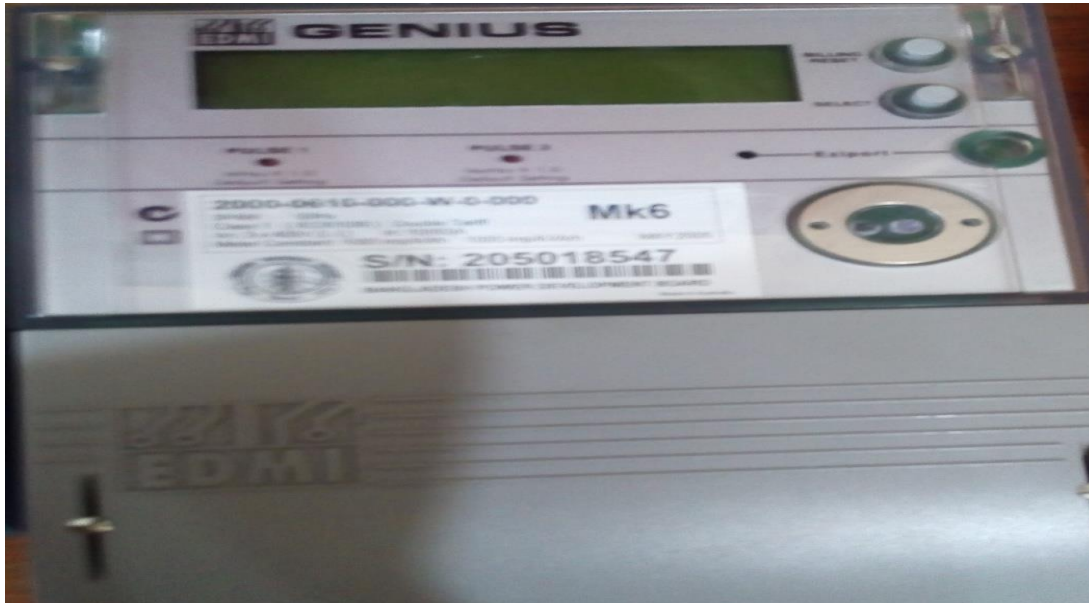


Figure 6.3: Low Tension Meter

6.3 Metering Test:

The metering test is very important because some people are cheating with the distribution company. They damage the meter for that reason meter cannot read properly. As a result it this is a huge loss of distributing company. Two types of test such as time test or power test and revolution test are mainly used for the metering test.

6.3.1 Time Test:

Formula is given bellow

$$T(\text{calculate}) = \frac{360 \times T(\text{no. of revolution})}{pF \times \text{voltage} \times \text{current} \times \text{meter constant}}$$

Where, T= number of revolution

6.4 Calculation of Error:

$$\text{Error} = \frac{T_{\text{calculate}} - T_{\text{measured}}}{T_{\text{measured}}} \times 100 \%$$

Chapter 7: Conclusion

7.1 Discussion:

We have gathered experience and practical knowledge of generation and distribution of power from our internship. Before this internship program we had only theoretical knowledge, but now we can relate our academic knowledge with the practical field. The engineers of power sector are very helpful. Their helpful behavior helped us and encouraged us to learn better and gather as much as possible in these fifteen days of internship. It was a great opportunity for us to have an experience of power generation process and see the practical work. During our internship, we have observed four power stations and two substations. This experience will provide us confidence to face interview and build our future career in the power sector.

7.2 Problems:

We have faced some problems here:

1. Our internship time was only for 15 days in BPDB, Rajshahi, which was not sufficient for gaining proper practical knowledge.
2. We cannot participate in any practical work. We have just observed the system and working procedure.
3. Due to privacy of administration, we could not collect some data or information.

7.3 Recommendation:

1. Before going to intern, students must complete the power station courses. They should have to know the knowledge of boiler, turbine, generator, and substation
2. The duration of the internship should be increased.
3. Everyone should know the safety procedure of the power station.

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Appendix (i)

Abbreviations

BPDB: Bangladesh Power Development Board

ESP: Electrostatic Precipitator

CT: Current Transformer

PT: Potential Transformer

CB: Circuit Breaker

SF₆: Sulfur Hexafluoride Gas

ONAN: Oil Natural Air Natural

ONAF: Oil Natural Air Forced

OFAF: Oil Forced Air Forced

OFWF: Oil Forced Water Forced

LFO: Light Fuel Oil

HFO: Heavy Fuel Oil

EMF: Electromagnetic Field