STUDY ON

GENERATION AND OPERATION OF ASHUGANJ POWER STATION COMPANY LTD.

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

Submitted by

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Certification

This is to certify that this thesis entitled **"Study on Generation and Operation of Ashuganj Power Station Company Ltd."** is done by the following students under my direct supervision and this work has been carried out by them in Ashuganj Power Station Company Ltd. in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held.

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ASHUGANJ POWER STATION COMPANY LTD. (APSCL)

(An Enterprise of Bangladesh Power Development Board)

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For

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This is to certify that ***Md. Rakibul Islam, ID No: 141-33-1810,*** *a B.Sc. Eng. student of* ***Electrical & Electronic Engineering Department*** *from* ***Daffodil International University, Dhanmondi, Dhaka*** *has successfully completed* ***the Industrial Internship at a. Operation & Electrical Maintenance Sections of Gas Engine Power Plant & b. I&C, Generator & Sub-station Divisions of Electrical Maintenance Circle of Ashuganj Power Station Company Ltd.*** *The* ***Industrial Internship Program*** *was scheduled* ***from 25-01-2018 to 13-02-2018.*** *During the Internship Period, he paid due attention to the practical work.*

I wish him every success in life.

Executive Engineer (HRD)
Ashuganj Power Station Company Ltd.
Ashuganj, Brahmanbaria.

ASHUGANJ POWER STATION COMPANY LTD. (APSCL)

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Certificate

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This is to certify that ***Mohitul Islam, ID No: 133-33-1705,*** *a B.Sc. Eng. student of* ***Electrical & Electronic Engineering Department*** *from* ***Daffodil International University, Dhanmondi, Dhaka*** *has successfully completed* ***the Industrial Internship at a. Operation & Electrical Maintenance Sections of Gas Engine Power Plant & b. I&C, Generator & Sub-station Divisions of Electrical Maintenance Circle of Ashuganj Power Station Company Ltd.*** *The* ***Industrial Internship Program*** *was scheduled* ***from 25-01-2018 to 13-02-2018.*** *During the Internship Period, he paid due attention to the practical work.*

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Ashuganj, Brahmanbaria.

Dedicated to

Our Parents and Teachers

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List of Abbreviations

APSCL	Ashuganj Power Station Company Ltd.
BGTDCL	Bakhrabadh Gas Transmission Distribution Company Limited
GEPP	Gas Engine Power Plant
NLDC	National Load Dispatch Centre
TDC	Top Dead Centre
BDC	Bottom Dead Centre
HV	High Voltage
DCS	Distributed Control System
PLC	Programmable Logic Controller
FD	Forced Draft
MVR	Medium Voltage Room
RPM	Revolution Per Minute
CT	Current Transformer
PT	Potential Transformer
SF6	Sulphur Hexafluoride
LA	Lightening Arrester
PLCC	Power Line Carrier Communication
MoU	Memorandum of Understanding

ACKNOWLEDGEMENT

First of all, we give thanks to Allah. Then we would like to take this opportunity to express our appreciation and gratitude to our thesis supervisor **Professor Dr. M. ShamsulAlam**, **Dean** of the **Faculty of Engineering** for being dedicated in supporting, motivating and guiding us through this thesis. This Thesis can't be done without his useful advice and helps. Also thank you very much for giving us opportunity to choose this thesis.

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Apart from that, we would like to thanks to our teachers for sharing knowledge; information and helping us in making this Thesis a success.

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ABSTRACT

Bangladesh is a developing country. Where lifestyle is much more improving and the mills and factories are growing not accordingly but in a great number. We need electric energy like our daily food. Overwhelming increasing number of office, apartments, mills, factories, schools, colleges and universities needs more and more electric energy. Besides, electricity demands are uprising day by day. To meet up the increasing demand we need to generate huge amount of electricity and there is only way to face this challenge either we increase the number of Power Plant in our country or fully renovate the old Power Plant in operation. On the other hand, increasing the number of power plant will surely redeemed the scarcity of the electric energy but may be it would become the hardest thing for the common people. By calculating the efficiency and economic statement a tariff should be imposed which will may remove the hardness of common people. In the meantime APSCL is the biggest Power Plant in the country in the generation of electric energy according to the other generation company in Bangladesh so far. Its' installed capacity is 1875 MW which is fully functional and more capacity will be installed soon. In this theses we will know from Generation to Distribution and Instruments they uses. We can also know how it is transferred and where it is transferred. This will lead us to know better about power plant generation. And also know the economic and environmental aspects of APSCL production Process.

Training Schedule

Training Schedule of Md. Rakibul Islam and Mohitul Islam

Date	Division	Time	Training Hour	Mentor
30-01-2018	GEPP(Operation)	8am to 4pm	7 Hour	Engr. MazharulMonir
31-01-2018	GEPP(Operation)	8am to 4pm	7 Hour	Engr. Shamsuddin Ahmed
01-02-2018	GEPP(Electrical)	8am to 4pm	7 Hour	EngrAzizur Rahman
03-02-2018	GEPP(Electrical)	8am to 4pm	7 Hour	EngrAzizur Rahman
04-02-2018	GEPP(Electrical)	8am to 4pm	7 Hour	EngrAzizur Rahman
05-02-2018	I&C Auto Control Division(Block-A)	8am to 4pm	7 Hour	Engr. LabonnoBarua
05-02-2018	I&C Auto Control Division(Block-A)	8am to 1pm	5 Hour	Engr. LabonnoBarua
05-02-2018	I&C Auto Control Division(Block-B)	2pm to 4pm	2 Hour	Engr. A.K.M Kamal
06-02-2018	I&C Auto Control Division(Block-B)	8am to 4pm	7 Hour	Engr. A.K.M Kamal
08-02-2018	Generator Division	8am to 4pm	7 Hour	Engr. ObaidullaHaque
10-02-2018	Generator Division	8am to 4pm	7 Hour	Engr. ObaidullaHaque
11-02-2018	Sub-Station Division	8am to 4pm	7 Hour	Engr. Sohag Kumar Saha
12-02-2018	Sub-Station Division	8am to 4pm	7 Hour	Engr. Sohag Kumar Saha
13-02-2018	Sub-Station Division	8am to 4pm	7 Hour	Engr. Sohag Kumar Saha

Chapter 1

Introduction

1.1Introduction

Ashugonj power station is the largest power station company in Bangladesh. The present total power generation capacity of its 9 units is 1756MW. As a part of the power sector development and reform program of the government of Bangladesh, Ashugonj power station company ltd. has been incorporated under the companies' act 1994 on 28 June 2000. Electricity generated in this power station is supplied to the grid & distributed throughout the whole country. This power station generated more than 10% of the total demand of the country. In this power station natural gas from Bakhrabadh (Titas) gas transmission & Distribution Company Ltd. is used as fuel. Meghna River is used as the source of water for the steam in this plant. Huge water from the discharge channels are used for irrigation in dry section.

In this chapter, there will be a brief discussion on the history and specification of Ashugonj power station. Company profile will be discussed in the 1st part. We will discuss the objectives of this internship. And in the end there will be a discussion on Scope and Methodology.

1.2 Company Profile:

To know about Ashugonj power station we need to know about its past and its present status. In the beginning Ashugonj power station was not a company, it was 100% government. To improve its productivity government decided to make it a company. After it became a company its productivity increases. Company profile is given below for a clear idea.

Company Profile

Name of the Company: Ashuganj Power Station Company Ltd.

- Date of Incorporation: 28 June 2000.
- Registration No: C-40630 (2328)/2000 dt. 28.06.2000;
- Location: 90 km North-East of Dhaka on the left bank of the river Meghna.
- Land: 311.22 Acres
- Installed Capacity: 1756 MW
- Number of the installed Unit: 9

1.3 Installed Unit

Table: 1.2 Present Power generation in APSCL at a glance

Name of the Unit	Year of Commissioning	Installed Capacity (MW)	Present Net Capacity (MW)
Unit – 2	1970	6450	
Unit – 3	1986	150129	
Unit - 4	1987	150138	
Unit - 5	1988	150 128	
50 MW	2011	53 46	
225 MW	2015	223 222	
200 MW Modular (Co-Owner with United Ashuganj Energy Ltd.)	2015	195	195
450MW CCPP (South)	2016	382 359	
450MW CCPP (North)	2017	389 360	
9 Units	**Total =**	**1756 1627**	

1.4 Objective of the Internship

The primary objective of the internship was as follows:
"Monitoring, Evaluating and understanding of generation process, Instrumentation and control process and also overall transiting and maintenance process of a power plant, which is a part of completing our requirement for Electrical and electronic engineering program."
The secondary objectives were as follows:

- Understanding of generation & substation system in a power plant.
- To have a practical idea about what we learn in Electrical and Electronic Engineering program at the university.
- To have an idea on how a Power Plant should be operated.
- To have an idea, how power station can be controlled in different ways.
- To know properly about working environment of a power plant.

1.5Scope and Methodology

The goal of this Internship was to understand the practical operation of a power plant.
This report covered the following aspects:

- Power generation process
- Substation mechanism
- Protection skims in power station
- Instrumentation and control process

The information's that are used in this report is collected in different methods.

- The primary information was collected through direct interaction with APSCL engineers and employees. They also provide us some documents and diagrams from their offices.
- The secondary information's are collected from website of APSCL and using their annual report of 2016-2017. Different website also provides us information a lot which we have mentioned in the reference part.

Chapter 2

Operation & Electrical Section ofGEPP (GAS Engine Power Plant) 50MW

2.1Gas Engine Power Plant

To satisfy the high demand of electricity, recently APSCL has established one Gas Engine Power Plant.

- Unit # 9 (gas engine) – capacity 50MW of electricity and was established in 2011.

We have visited the Gas Engine Power Plant accordingly and properly. Also we have achieved a great knowledge about it.

2.2 Engine Configuration

1. Engine capacity/rating-3350KW (4497HP) per engine
2. Total engine 16
3. Rpm of prime mover-1500
4. Stroke -4
5. Cylinder -20
6. Main effective pressure-22bar
7. Used fuel- gas+air mixture
8. Compression ratio-11 epsilon

2.3Cooling System

- Engine cooling by jacket water(Temp60-65 C).
- Engine bearing cooling by lube water.
- Generator outside cooling by Natural air.

2.3.1 Cooling Requirement

- 330 liter water is required for 3 MW GEPP of simple drinking water
- PH level:7.5.
- 670 liter lube oil is required of grade SAE40(Society of Automotive Ingenious)

2.4Volume on Engine Cylinder

I. Clearance volume : gap on the cylinder when piston is in upper position

II. Sweat Volume: Top to bottom volume on cylinder

III. Total volume= Sweat volume + Clearance volume.

2.5Configuration -FAG Bearing Germany

a. Cylindrical roller bearing

NU1036-MI-120AA-C3

b. Cylindrical roller Bearing

NU1036-MI-C3

c. Deep Groove ball bearing

16036-C3

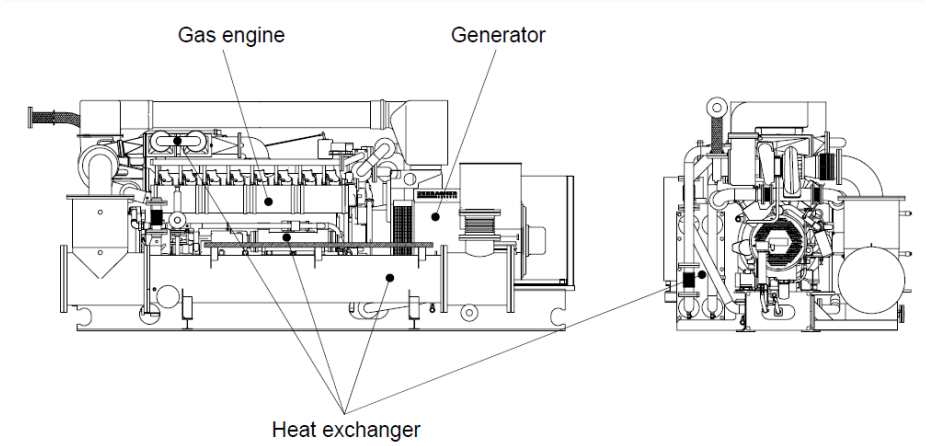


Figure 2.5: Cross sectional view Of GEPP

2.6Working Flow Chart

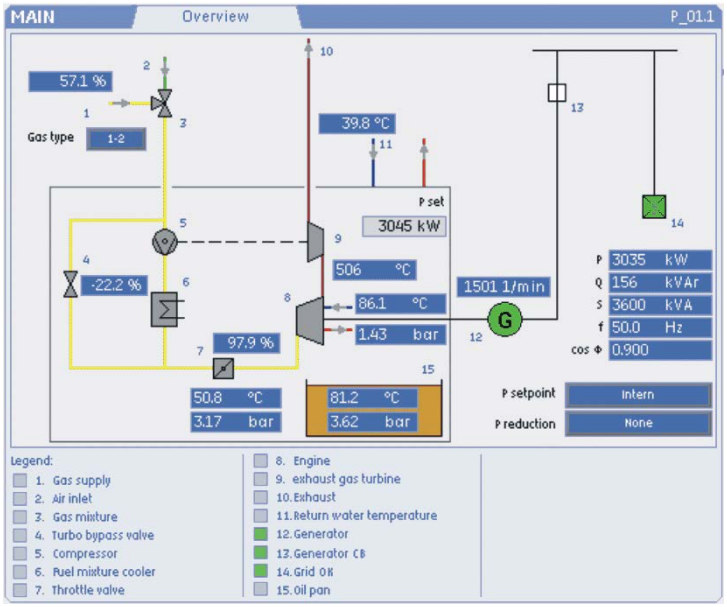


Figure 2.6.1: Working Flow Chart of GEPP (Controller View)

In figure 2.6.1 we showed simple flow diagram of gas engine of APSCL. Here, in a gas engine power plant, air and natural gas mixture is used. The point number 3 shows the valve which controls the air gas mixture as 1:8. The point number 8 and 9 shows the turbo charger which compresses the air fuel mixture and then transferred to the combustion chamber and burns at high temperature (1010°C).

The combustion of the air and gas mixture works as the 4 stroke engine. Shaft is coupled with the generator part.

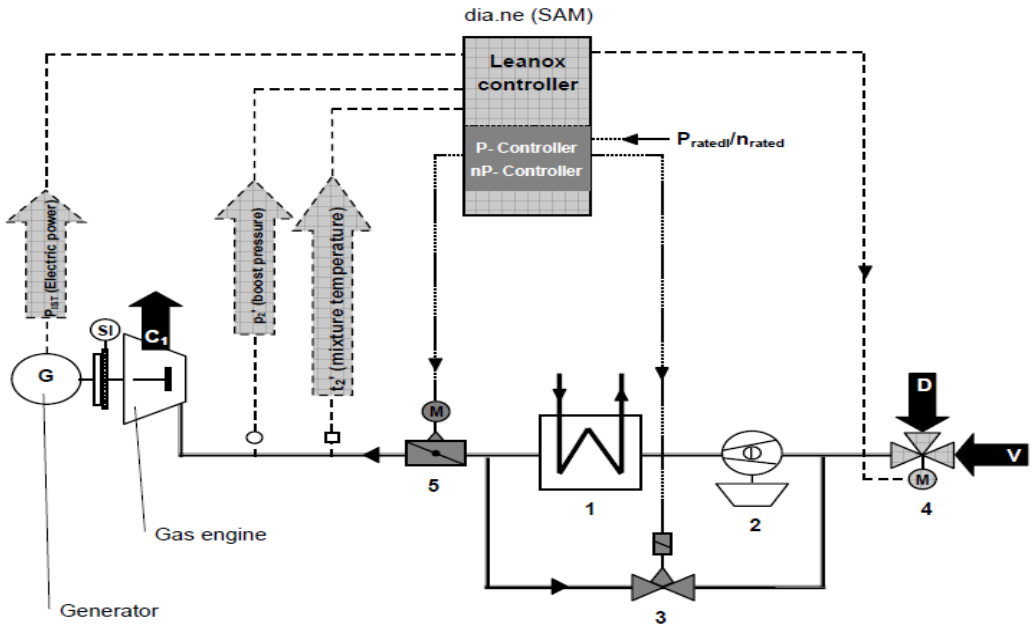


Figure 2.6.2: Simple flow diagram of gas Engine of APSCL

2.7 Working Component of APSCL Gas Engine Power Plant

The simple flow gas turbine power plant is shown in Figure 2.6.2. The main components of the Plants are:

- ❖ Generator
- ❖ Compressor
- ❖ Combustion Chamber
- ❖ Controlling unit

2.8Power Calculation:

$P=\sqrt{3}$ V x I Cosφ

$=\sqrt{3} * 11 * 10^3 v * 219A * 0.8$

=3.349MW

Here, P= Power

Voltage,V=11kv

Current, I=219.7A

Power Factor, Cosφ=0.8

Per Engine Produces 3.349 MW Power

Total Engine 16

Total generation in GEPP= (16x3.349) MW

=53.584 MW

Transferable Power = 52MW

2.9 Single line Diagram of GEPP in APSCL

Bellow figure shows that the simple single line diagram of GEPP in APSCL. Here it shows that 2 unit having 8 engine each generate the power and through the common bus bar the energy goes to the Substation and then step it up by a step up transformer and then send it to the grid eventually. Here NLDC (National Load Dispatch Center) control how much should be generated.

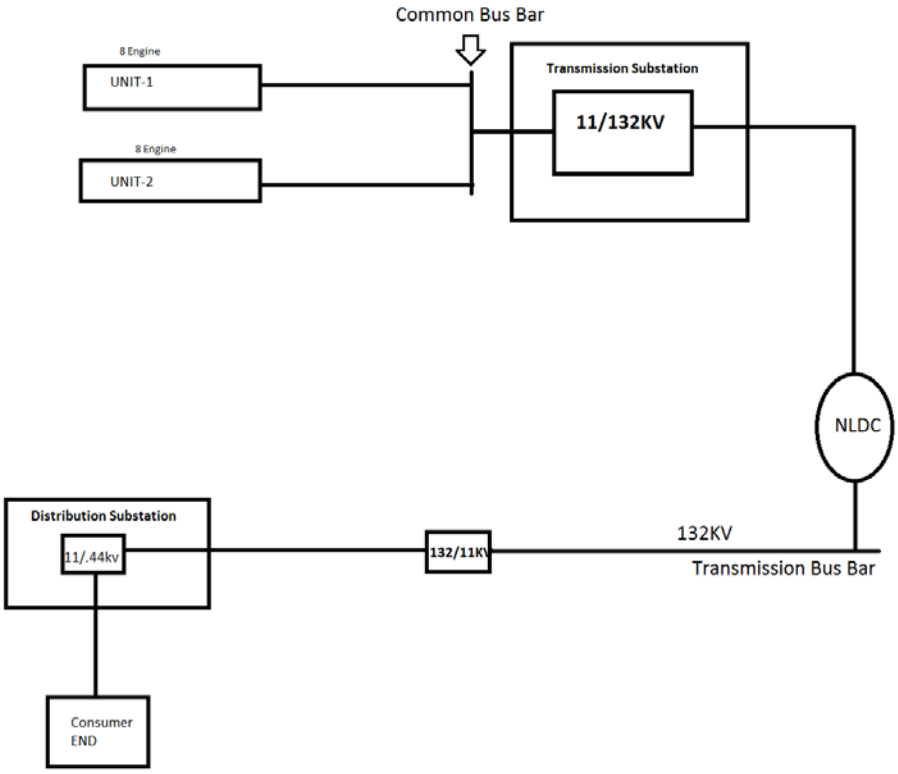


Figure 2.9: Single line diagram of GEPP

2.10 Operation of 4 Stroke Engine

2.10.1 Four Stroke Cycle Engines

A four-stroke cycle engine is an internal combustion engine that utilizes four distinct piston strokes (intake, compression, power, and exhaust) to complete one operating cycle. The piston make two complete passes in the cylinder to complete one operating cycle. An operating cycle requires two revolutions (720°) of the crankshaft. The four-stroke cycle engine is the most common type of engine. A four-stroke cycle engine completes five Strokes in one operating cycle, including intake, compression, ignition, power, and exhaust Strokes.

Intake Stroke

The intake event is when the air-fuel mixture is introduced to fill the combustion chamber. The intake event occurs when the piston moves from TDC to BDC and the intake valve is open. The movement of the piston toward BDC creates a low pressure in the cylinder. Ambient atmospheric pressure forces the air-fuel mixture through the open intake valve into the cylinder to fill the low pressure area created by the piston movement. The cylinder continues to fill slightly past BDC as the air-fuel mixture continues to flow by its own inertia while the piston begins to change direction. The intake valve remains open a few degrees of crankshaft rotation after BDC. Depending on engine design. The intake valve then closes and the air-fuel mixture is sealed inside the cylinder.

Compression Stroke

The compression stroke is when the trapped air-fuel mixture is compressed inside the cylinder. The combustion chamber is sealed to form the charge. The *charge* is the volume of compressed air-fuel mixture trapped inside the combustion chamber ready for ignition. Compressing the air-fuel mixture allows more energy to be released when the charge is ignited. Intake and exhaust valves must be closed to ensure that the cylinder is sealed to provide compression. Compression is the process of reducing or squeezing a charge from a large volume to a smaller volume in the combustion chamber. The flywheel helps to maintain the momentum necessary to compress the charge.

When the piston of an engine compresses the charge, an increase in compressive force supplied by work being done by the piston causes heat to be generated. The compression and heating of the air-fuel vapor in the charge results in an increase in charge temperature and an increase in fuel vaporization. The increase in charge temperature occurs uniformly throughout the combustion chamber to produce faster combustion (fuel oxidation) after ignition.

The increase in fuel vaporization occurs as small droplets of fuel become vaporized more completely from the heat generated. The increased droplet surface area exposed to the ignition flame allows more complete burning of the charge in the combustion chamber. Only gasoline

vapor ignites. An increase in droplet surface area allows gasoline to release more vapor rather than remaining a liquid.

The more the charge vapor molecules are compressed, the more energy obtained from the combustion process. The energy needed to compress the charge is substantially less than the gain in force produced during the combustion process. For example, in a typical small engine, energy required to compress the charge is only one-fourth the amount of energy produced during combustion. The compression ratio of an engine is a comparison of the volume of the combustion chamber with the piston at BDC to the volume of the combustion chamber with the piston at TDC. This area, combined with the design and style of combustion chamber, determines the compression ratio. Gasoline engines commonly have a compression ratio ranging from 6:1 - 10:1. The higher the compression ratio, the more fuel-efficient the engine. A higher compression ratio normally provides a substantial gain in combustion pressure or force on the piston. However, higher compression ratios increase operator effort required to start the engine. Some small engines feature a system to relieve pressure during the compression stroke to reduce operator effort required when starting the engine.

Figure 2.10.1: Jenbacher Gas Engine in APSCL

Ignition Event

The ignition (combustion) *event* occurs when the charge is ignited and rapidly oxidized through a chemical reaction to release heat energy. Combustion is the rapid, oxidizing chemical reaction in which a fuel chemically combines with oxygen in the atmosphere and releases energy in the form of heat. Proper combustion involves a short but finite time to spread a flame throughout the combustion chamber. The spark at the spark plug initiates combustion at approximately 20° of crankshaft rotation before TDC (BTDC). The atmospheric oxygen and fuel vapor are consumed by a progressing flame front. A flame front is the boundary wall that separates the charge from the combustion by-products. The flame front progresses across the combustion chamber until the entire charge has burned.

Power Stroke

The power stroke is an engine operation Stroke in which hot expanding gases force the piston head away from the cylinder head. Piston force and subsequent motion are transferred through the connecting rod to apply torque to the crankshaft. The torque applied initiates crankshaft rotation. The amount of torque produced is determined by the pressure on the piston, the size of the piston, and the throw of the engine. During the power Stroke, both valves are closed.

Exhaust Stroke

The exhaust stroke occurs when spent gases are expelled from the combustion chamber and released to the atmosphere. The exhaust stroke is the final stroke and occurs when the exhaust valve is open and the intake valve is closed. Piston movement evacuates exhaust gases to the atmosphere.

As the piston reaches BDC during the power stroke combustion is complete and the cylinder is filled with exhaust gases. The exhaust valve opens, and inertia of the flywheel and other moving parts push the piston back to TDC, forcing the exhaust gases out through the open exhaust valve. At the end of the exhaust stroke, the pist2on is at TDC and one operating cycle has been completed.

2.11 Engine Auxiliaries

2.11.1 Starting Equipment

Starter batteries:

- lead/acid
- 24 V, 400 Ah per module.

Charger:

- 24V, 80A
- With integrated control system power supply 24V =, 18 Ah. Used for module controller.

2.11.2 Engine Jacket Water Circulating Pump

Jacket Water Circulating Pump 3x 400 V, 50 Hz, 7,5kW:

Pump operates during module operation and for 20 minutes cool down run of the turbocharger after module stop. In case of loss of the supply voltage during the cool down run the jacket water circulating pump will be switched over to a battery supplied converter to ensure the cooling. As soon as the supply voltage is back again the engine jacket water circulating pump will run for other 20 minutes.

2.11.3 Jacket Water Circulating Pump

231 V, 50 Hz, 245W:

Pump operates generally during engine shutdown for jacket water preheating.

In case of loss of the supply voltage the jacket water circulating pump will be automatically switched over to a battery supplied converter to ensure the cooling of the turbo charger for 30 minutes.

The proper function is monitored by a differential pressure switch. A malfunction will be displayed with the alarm “PREHEATING PUMP FAILURE”. A further module start will be blocked.
When service selector switch is "OFF", the circulating Pump is switched off 30 min. after module stop.

2.11.4 Intercooling Water Pump

3x 400 V, 50 Hz, 4.0 kW:
Pump operates during module operation and during 5 minutes cool down run.

2.11.5 Pre-Lube and Cool Down Oil Pumps

1x 3 phase 400 V, 50 Hz, 1,5kW, 1x 24 VDC, 1.5 kW:
Controlled by module PLC.
Function: Both pumps operate for normal start. Only DC pump operates for black start.
Operating time of pumps greater than 1 minute before engine start. Once engine speed exceeds 800 rpm, pumps are switched off.

2.12Gas Engine Safety Loop

For each engine, a current loop safety circuit for the following is provided.

1. Emergency stop
2. Over speed
3. Ignition monitoring
4. Control of switchgear under voltage trip device for,
5. Alternator reverse power

6. Shutdown fault

7. Missing power signal

8. Power signal overload

Tripping of the safety loop shuts down only the appropriate engine.

2.13 Generator switchgear

- 1 earthing breaker for MV/HV generators
- 3 x current transformer for protection 300/5A; 10P10; 20VA for MV/HV generators
- 1 x cable transformer (for earth fault port) 50/5A; 5P10; 20VA for MV/HV generators
- 3 x fuses (and potential transformer 11kV/1,73 : 110V/1,73 Class 0,5; 50VA) for measurement /synchronization
- 3 x fuses (and potential transformer 11kV/1,73 : 110V/1,73 Class 6P; 50VA) homo polar voltage (open delta)
- 3 x fuses (and potential transformer 11kV/1,73 : 110V/1,73 Class 0,5; 200VA) for measurement
- synchronization at the bus bar side (1* per bus bar)
- Generator protection operate directly on the opening coil of the circuit

2.14 Shut down in Manual Operation

Before manual shut down load should be decreased after that the engine will be ready to manually shut down. On the other hand there is an emergency stop button for emergency shutdown. Bellow figure show the emergency stop button.

Figure 2.14: Emergency Stop Button

2.15Communication System of GEPP

50 MW GEPP runs on DCS (Distributed control system). We have discussed about DCS in chapter number 3. In every distributed control system there must have the communication process or link. All the signal comes in or goes out from the PLC. From the PLC board the connection goes to the Ethernet switch. After that the connection goes to the several places such as server, service computer and control room pc.

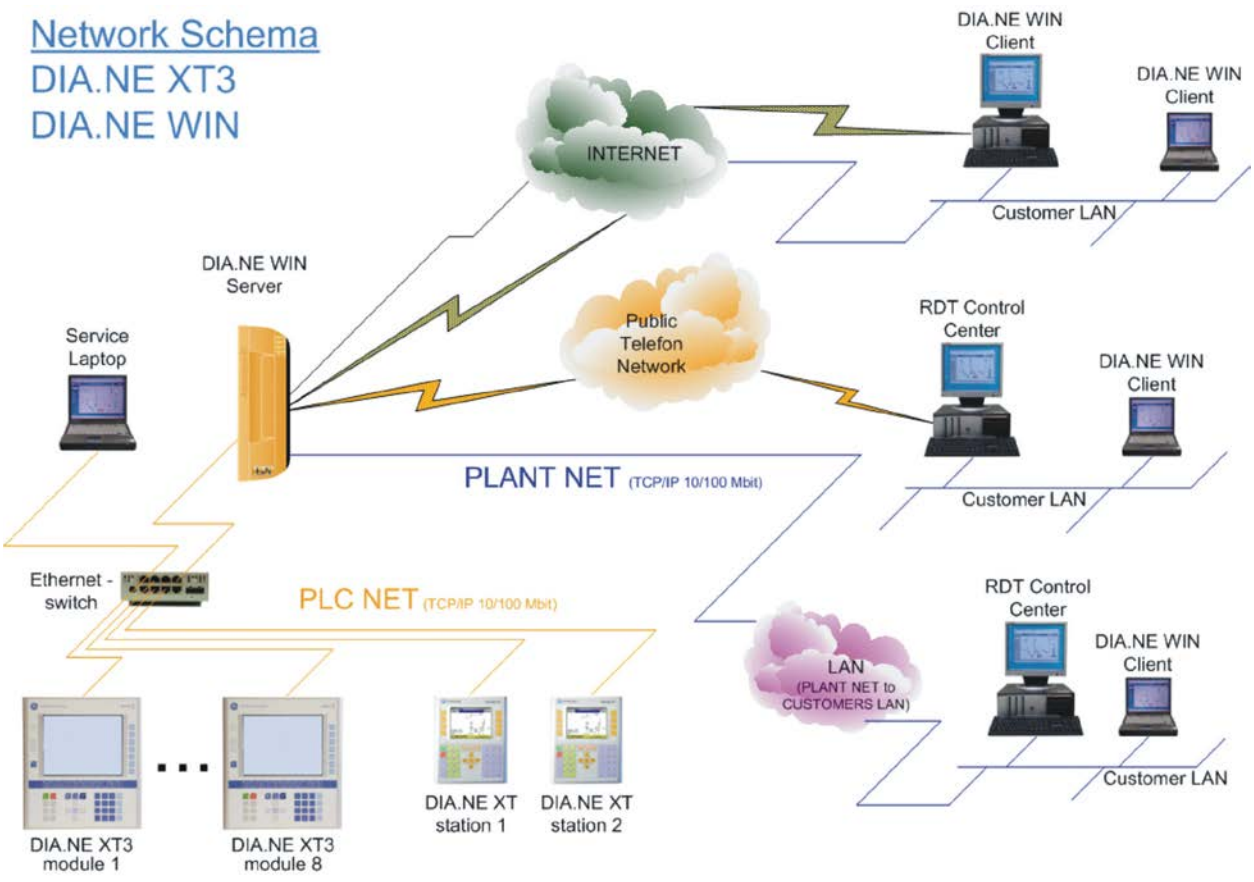


Figure 2.15: Communication System of GEPP Control Unit

2.16 Gas Engine Operational Part

2.16.1 Engine principle

GE Jenbacher gas engines use the LEANOX method, which is a further development of the lean-mix engine principle.

Here the engine is supplied with a mixture of gas and a surplus of air to minimize emissions already at the

Combustion stage in the engine.

2.16.2 Crankcase

The crankcase is a special casting and features side crankcase covers that provide easy access during assembly/disassembly.

The flywheel-sided gear train is sealed off by the gearbox, and the vibration damper-sided gear train by the crankcase cover.

2.16.3 Oil pan

The oil pan is made out of welded steel plate and closes off the bottom of the crankcase.

2.16.4 Cylinder Liners

The cylinder liners are wet and can be exchanged individually. They are spun cast and are inserted into the cylinder block from above.

As they heat up they are free to expand downwards.

The water room and the crankcase are separated by O-rings on the outside of the cylinder liners.

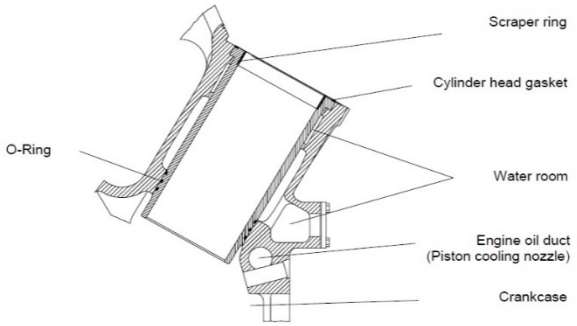


Figure 2.16.4: Cylinder Liners

2.16.5 Cylinder Heads

The water-cooled cylinder heads can be exchanged separately and are equipped with two intake and two exhaust valves, a pre-combustion chamber with a pre-combustion chamber gas valve and one spark plug on each cylinder.

The intake and exhaust valves feature a valve rotation device (Roto-caps). The pressed valve seat rings can be renewed.

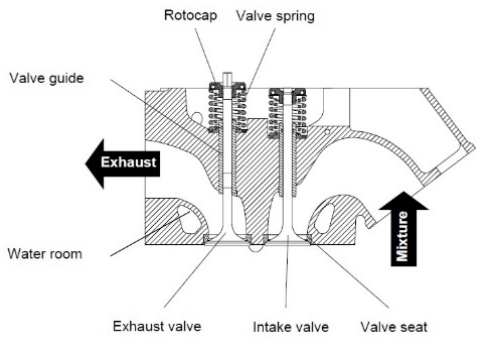


Figure2.16.5: Cylinder Heads

2.16.6 Crankshaft

The drop-forged crankshaft runs on eleven bearings, is statically and dynamically balanced and has bolted-on counterweights. All bearing journals have been surface hardened and fine polished. One of the main bearings is designed as a guide bearing and takes the axial forces exerted by the crankshaft.

The crankshaft main bearings are lubricated via oil ducts in the crankcase.
A balanced flywheel with starter pinion is mounted on one end of the crankshaft, and at the other end a vibration damper is fitted.

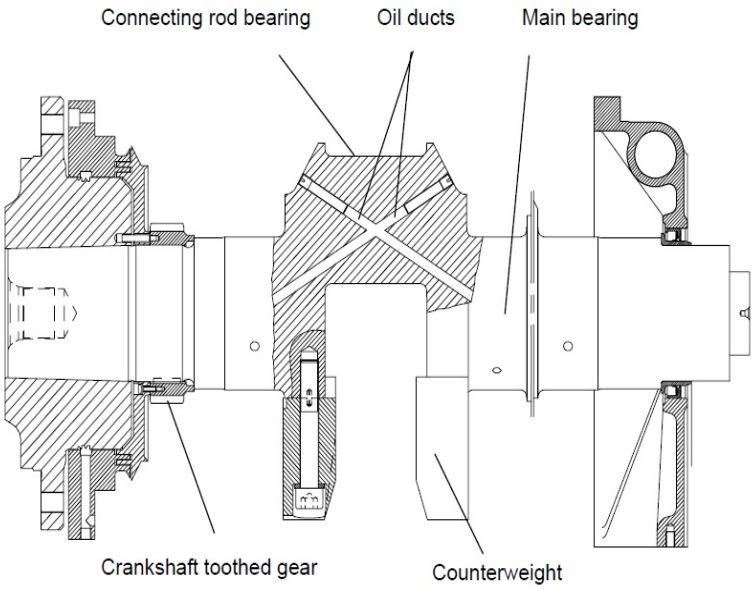


Figure2.16.6: Crankshaft

2.16.7Connecting Rod

The connecting rods are drop-forged and quenched and tempered. They are separated diagonally across the big-end and have serrated joins. The cross-section is designed as an I-profile to provide maximum stability of the connecting rods.

The big-end bearing shells are replaceable plain bearings. The small end bushings are pressed in. The big-end bearings are lubricated via oil ducts in the crankshaft.

The gudgeon pins are supplied with oil from the piston cooling nozzles.

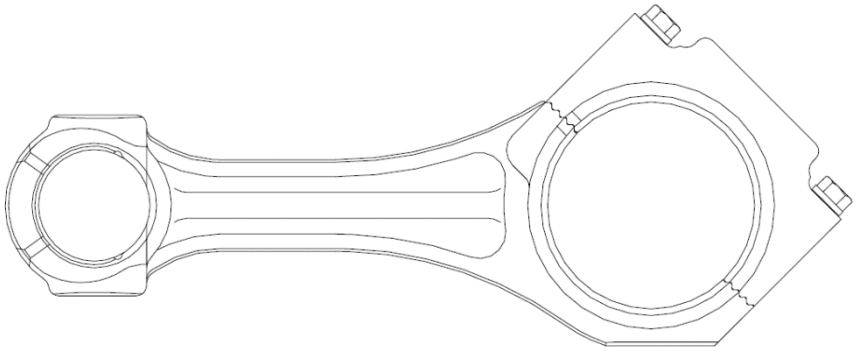


Figure2.16.7: Connecting Rod

2.16.8 Vibration Damper

A viscous damper is used to reduce rotational vibrations on the crankshaft. This viscous damper consists of a completely sealed housing into which a flywheel is mounted. The cavities between housing and flywheel are filled with silicone oil.

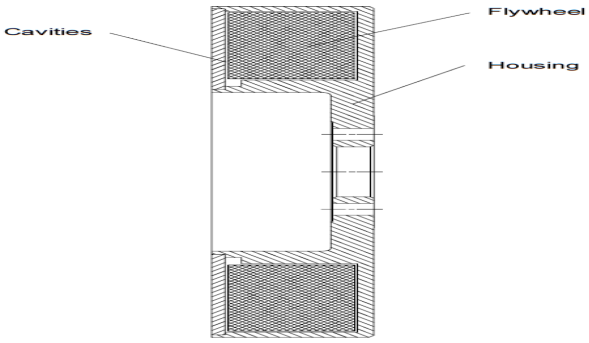


Figure 2.16.8: Vibration Damper

2.16.9Pistons

The light metal alloy pistons feature a cooling duct and are equipped with a plain compression ring, taper face compression ring and oil-control ring with expander.
Cooling oil is supplied via fixed spray nozzles mounted in the crankcase.

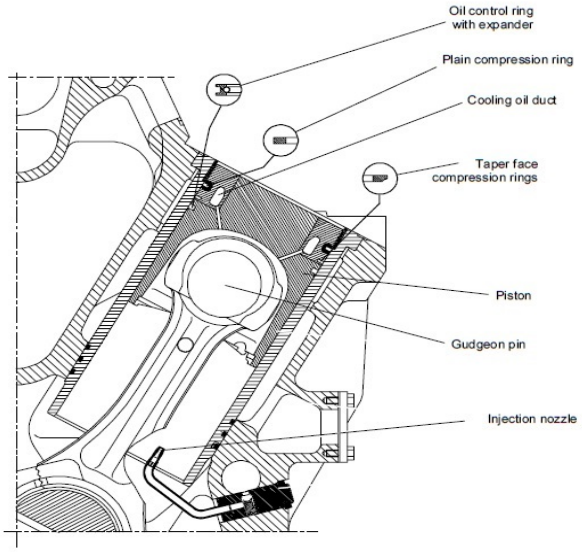


Figure2.16.9: Pistons

2.16.10Gear Train

The gear train at the flywheel side provides drive for the camshaft and the engine oil pump. The crankshaft toothed gear, the intermediate gears and the camshaft timing gear all have timing marks to ensure that the timing is correctly adjusted.

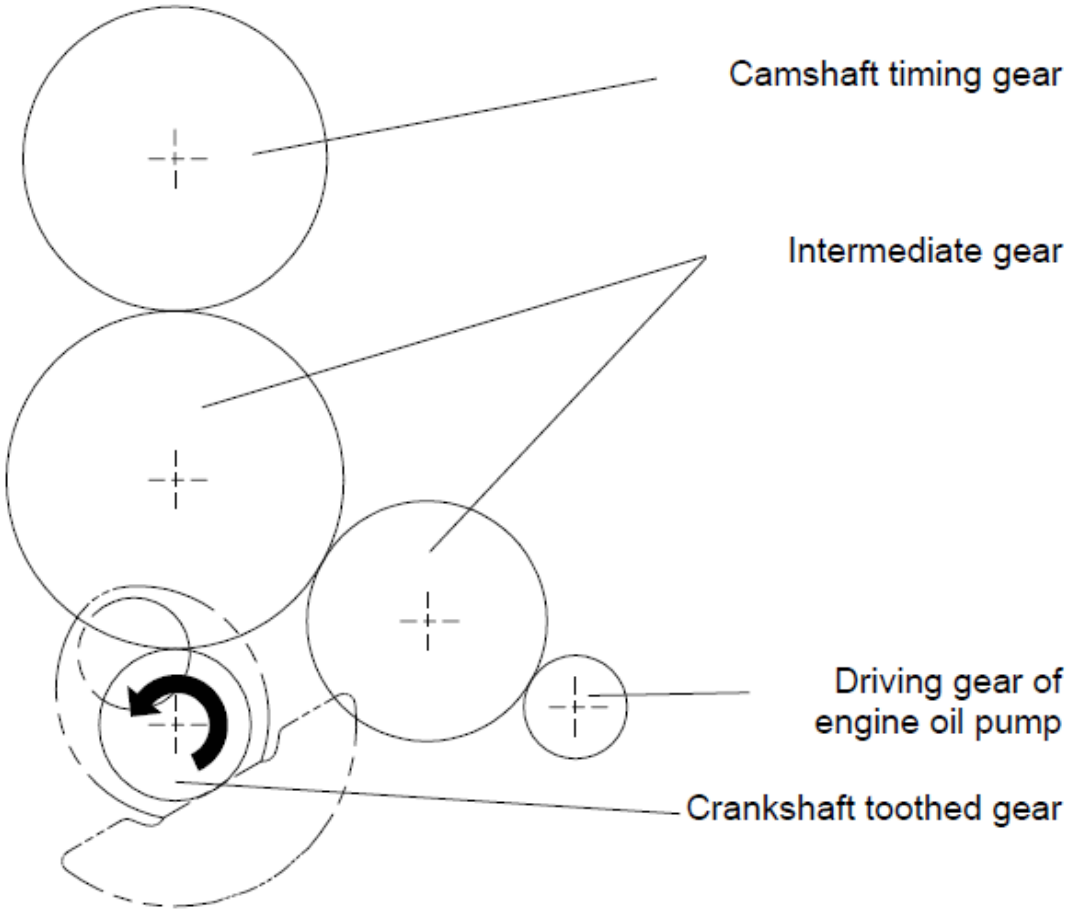


Figure 2.16.10: Gear Train

2.16.11 Timing Gear

The camshaft runs on eleven bearings in replaceable bushings, and is driven by the crankshaft via intermediate gears. The rocker arms on the intake and exhaust valves are operated by the camshaft by means of tappets and push rods. An adjustment bolt on each rocker arm is used for accurate adjustment of the tappet clearance. Pressurized oil is used to lubricate the tappets and the rocker arm mountings, whereby the oil is supplied to each rocker arm through a bore in the push rod. The other moving parts in the cylinder head are lubricated by the spray oil emerging at the rocker arm mountings

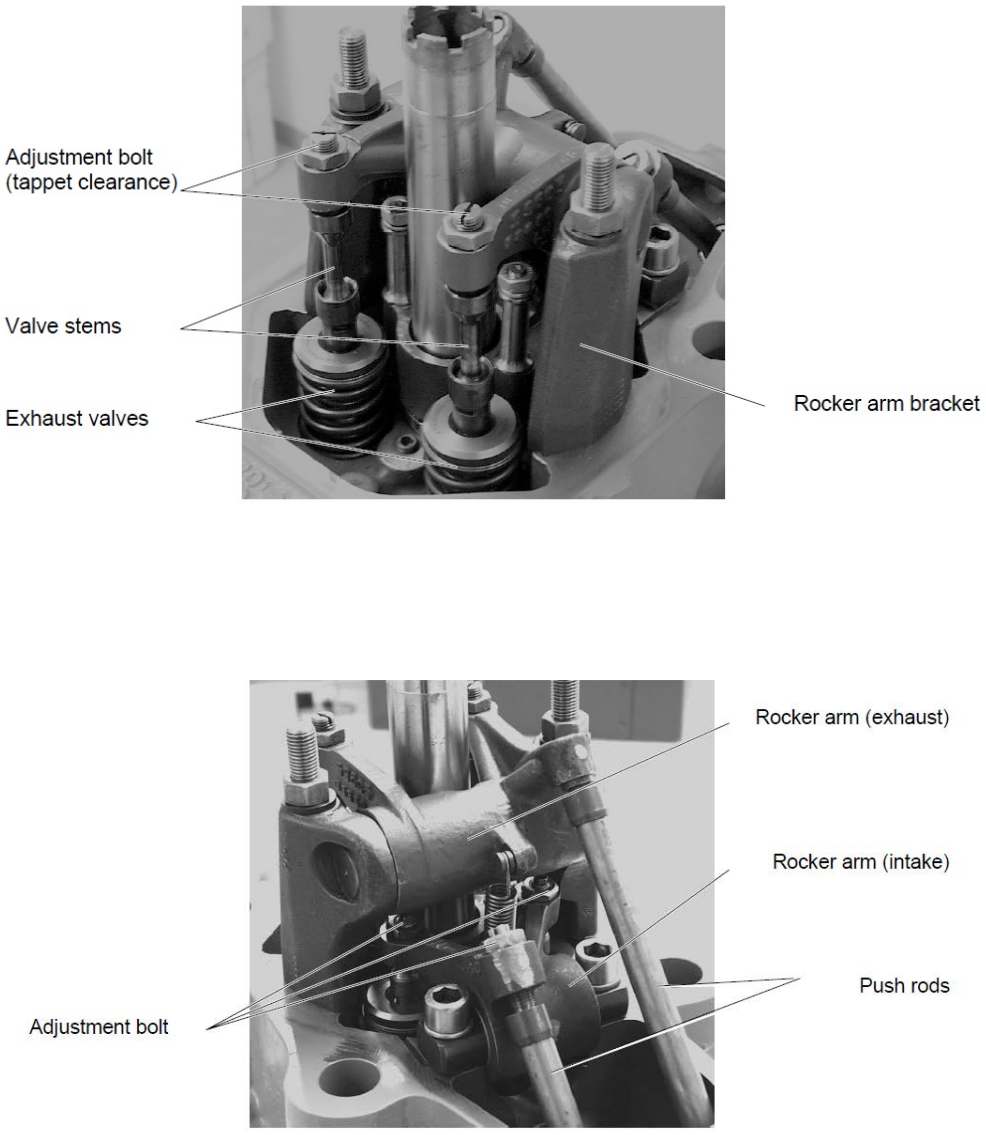


Figure 2.16.11: Front and Rear view of Timing Gear

2.16.12 Exhaust Gas Turbocharger

The exhaust gases entering the turbine housing drive the turbine wheel, and therefore also the compressor impeller which sits on the same shaft as the turbine wheel. The compressor impeller sucks air-gas mixture from the air-gas mixer and passes it on under pressure via the mixture cooler (mixture/water heat exchanger) and the throttle valve to the intake chamber of the engine. The exhaust gas turbocharger is lubricated by the engine lubricating system.

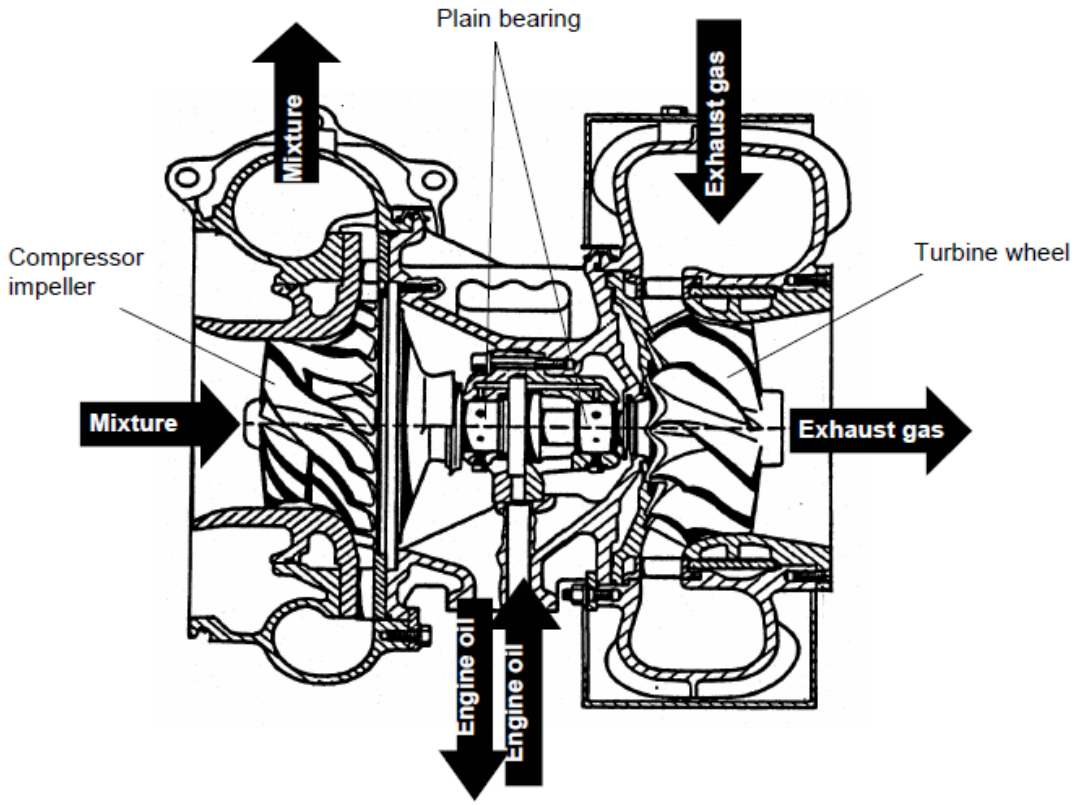


Figure2.16.12: Exhaust Gas Turbocharger

2.16.13Engine oil pump

GE Jenbacher engines are equipped with a forced feed lubrication system. A mechanical gear pump is used as the engine oil pump.

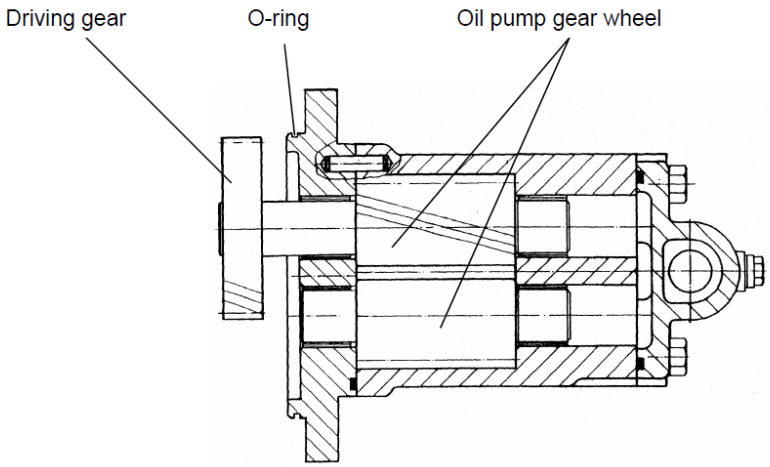


Figure 2.16.13.1: Engine Oil Pump

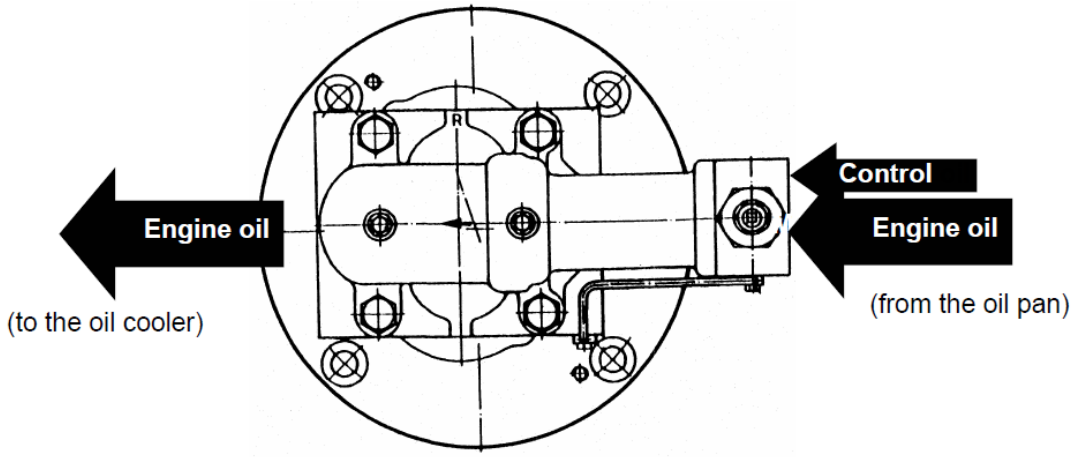


Figure 2.16.13.2: Engine Oil Pump Oil direction

2.16.14 Gas Quantity Controller

The gas volume controller is an active gas dosing valve and is part of the LEANOX system. To change the air ratio, the required gas amount is entered via the CAN bus.

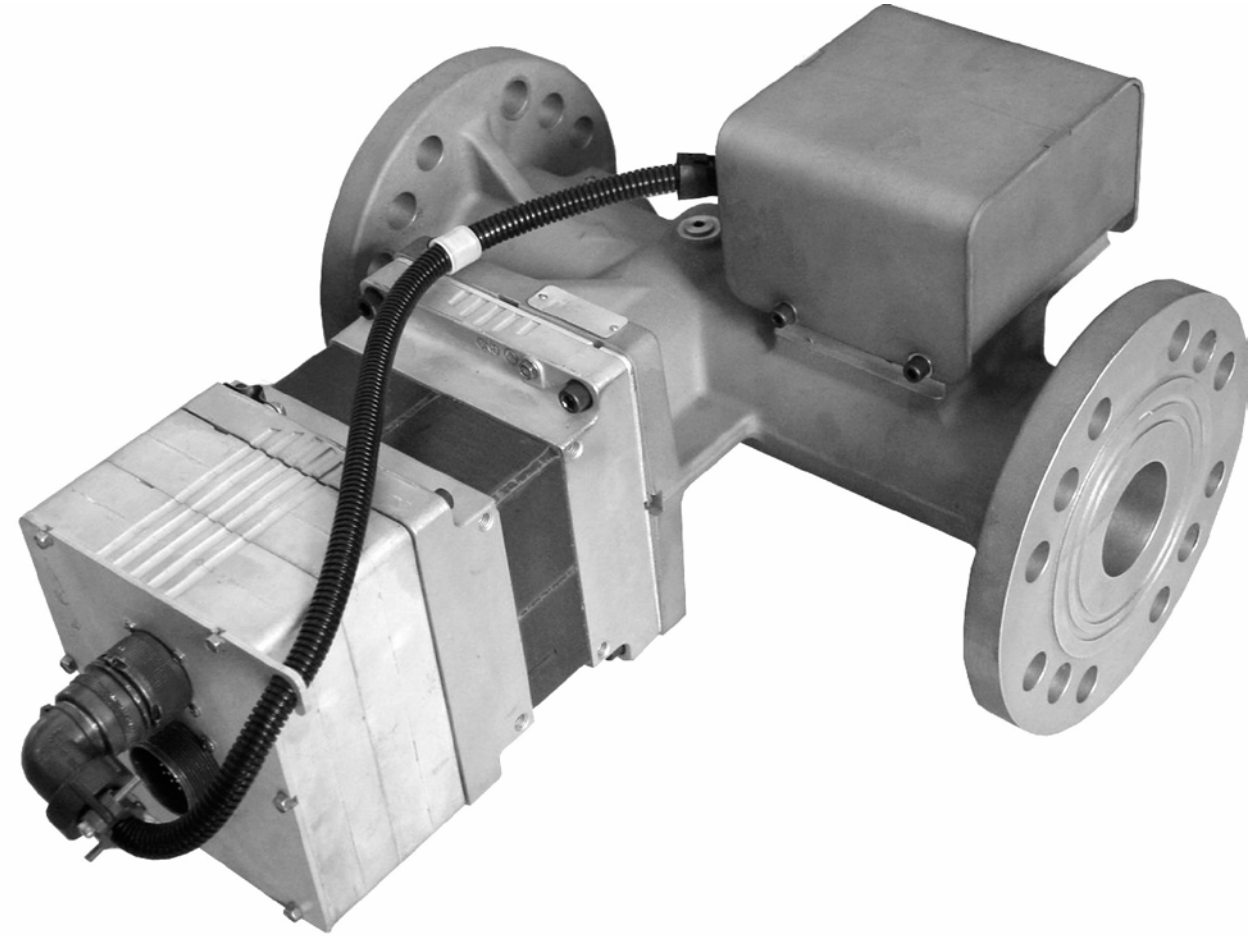


Figure 2.16.14: Gas Quantity Controller

2.17 Efficiency calculation and Other Required quantity of GEPP

Table 2.17.1: Power and Degree of efficiency

Power and degree of efficiency:

Qzu/Qm	Energy supplied/mechanical	kWh/kWh	2,25
pme	Effective mean pressure	Bar	22,00
Pm	Mechanical output	kW	3431
	Blocked ISO standard power ICFN according to ISO		
	3046		
Pel	Electric power output at cos phi = 1	kW	3356
ηel	Electrical efficiency	%	43,5
ηtherm	Therm. efficiency		
ηges	Total efficiency	%	43,5

Table 2.17.2: Exhaust Gas system

Exhaust gas system:

Maf	Exhaust gas volume moist	kg/h	18796
LP	Residual sound pressure level when operating a	dB (A) at 10m	75
	Module	distance	
NOx	Nitrogen oxide	mg/Nm3	500
CO	Carbon monoxide	mg/Nm3	1050

Table 2.17.3: Fuel gas system:

Mz	Methane number		80
Hμ	Calorific value	kWh/Nm3	9,5
Vgas	Fuel gas volume	Nm3/h	811

Table 2.17.3: Water circulation:

$\mathbf{V_{ww}}$	Cooling water	Liter/h	54,1
$\mathbf{V_{gk}}$	Mixture cooling water	Liter/h	40,0

CHAPTER 3

I & C / AUTO CONTROL DIVISION

3.1 INTRODUCTION

Industrial process is to be truly controlled, it is essential that certain system variables have been monitored. That is, conditions within the system must be constantly measured a converted to other forms of signal. So integral parts of any industrial process control system e those elements or subsystems that are capable of sensing the system conditions. These elements can be classified into two parts; input transducers and sensors. Process For measurement point consists of measuring element or primary element. Primary also called transducer or sensing element.

On the other hand controller is an instrument that receives input signal from the transducer or transmitter as measured value (MV), compares this measured value with the desired value (SV) and produces an output signal for the correcting element/control value.

This part is supervised by Assistant Engr. A.K.M Kamal.

So basically the control system should consist of,

- Measuring or sensing equipment: They measure the actual output of the process. Different kinds of sensors such as LVDT, tachometer, temperature sensors, liquid level sensor, and pressure sensor are used at APSCL. The outputs of the sensors or measuring equipment are termed as the Process Value (PV). PV is the actual output of the process or plant.
- Comparator or error checker: The elements that differentiate between the desired value or set value and the actual value of a process are termed as error checking elements. Generally, Set Point (SP) is used to indicate the desired value at which a process variable is to be maintained.

$$\text{Error} = |\text{Set Point (SP)} - \text{Process Value (PV)}|$$

- Actuators such as different types of motors, valves etc. to carry over the control action.

3.2 Classification Of instruments use in APSCL:

- Measuring instruments.
  - I. -measuring instruments with indicating system
  - II. -measuring instruments with recording system
  - III. -measuring instruments with counting system
- Controlling instrument.
- Safety and interlock instruments.

3.3Different Kinds Controller at APSCL

Controller can be classified into many different ways.

On the basis of auxiliary power:

A) Pneumatic controller

B) Electric Controller

On the basis of working Principle

I. On-off controller
II. Proportional controller
III. Proportional plus integral controller
IV. Proportional plus derivation controller
V. Proportional plus derivation controller plus integral

3.4Elements of control Loop:

- Process: a variable of which has to be controlled
- Measuring System: measures the physical variable
- Transmitter: transmits measured signal to the controller
- Controller: Which generates the control command according to the desired value
- Final Control Elements: Which carried out the control command
- Connecting tubes and pipes: Which passes the signals.

3.5Types of control:

- Feedback control (Close-loop control)
- Feedforward Control (Open-loop Control)

3.6Different Kinds Actuators at APSCL:

An actuator is a type of motor for moving or controlling a mechanism or a system. It is operated by a source of energy, usually in the form of an electric current, hydraulic fluid pressure or pneumatic pressure, and converts that energy into some kind of mechanical motion. There are 3 types of actuators. They are:

• Electric Actuator: operates the valve using electrical signal.

• Pneumatic Actuator: operates the valve using compressed air.

• Hydraulic Actuator: operates the valve using oil pressure.

At APSCL all these 3 types of actuators are used. But electrically actuated systems are widely used in control system because they are easier to interface with the control systems.

3.7Different Kinds of Sensors at APSCL:

Different kinds of sensors are used to measure and detect the analog signals such as voltage, current, pressure, speed etc. Some of the major sensors used at APSCL are tachometer, linear variable differential transformer (LVDT), selection output controlled sensor etc. These sensors are briefly described in the following sections.

3.7.1 Tachometer

Tachometer measures rotational speed and converts the speed into the proportional voltage. The speed is measured as revolution per minute (RPM). In the plant, the tachometer is directly coupled with the turbine shaft, which allows the tachometer to rotate at the turbine speed. As a result, a voltage, proportional to the turbine speed is produced. Thus, low or high turbine speed situation can be detected at the control room.

3.7.2 Linear Variable Differential Transformer (LVDT)

Linear Variable Differential Transformer (LVDT) is one kind of sensing element that is broadly used in controlling the opening of the valves. An LVDT comprises of 3 coils; a primary and two secondary coils. The primary winding is excited with an AC supply. The transfer of current between the primary and the secondary coils of the LVDT is controlled by the position of a magnetic core, the two secondary coils are connected in opposition. When the magnetic core is at the center, the induced voltage at two secondary coils are equal, but out of phase, resulting in zero output from the sensor. As the core moves away from the center, the result is an increase in the induced voltage in one of the secondary coil and a decrease in the other, which results variable output voltage. On the other hand, phase of the output voltage also changes. Thus depending on the output voltage the linear displacement is determined.

The core is externally connected to the valve. Thus, the motion of valve's opening or closing makes a linear displacement of the core. This linear displacement of core, creates a proportional electrical output. LVDT is used to measure displacement ranging from fraction millimeter to centimeter. LVDT can be used as a device to measure force, weight and pressure etc.

3.7.3 Selection Output (S/O) Controlled Sensor

Selection output controlled sensor is used to measure or sense the opening or closing of the valve. The sensor is attached with the valve. There is a lid on the valve. S/O controlled sensor is placed beside this lid. When the valve opens, then the lid opens and the magnetic field area inside the valve spreads outside and when the valve closes, the lid closes and the magnetic field area

inside the valve cannot spread outside or magnetic field area decays. This spreading of magnetic field area allows the sensor to measure the opening or closing of the valve.

Figure: 3.8.3 Selection Output (S/O) Controlled Sensor

3.8Different Kinds of Valves at APSCL:

Valve is a mechanical device usually used to stop completely or regulate fluid flow through the pipeline or equipment.

In APSCL there are a number of different designs for valves depending on how they are being used. The basic valve types can be divided into two general groups: stop valves and check valves.

Many special valves, which cannot really be classified as either stop valves or check valves, are found in the engineering spaces. Many of these valves serve to control the pressure of fluids and are known as pressure-control valves. Other valves are identified by names that indicate their general function.

3.8.1 Gas Pressure Reducing Valve

Gas is the major component of Ashuganj Power Station. Gas turbines and burners of all units are totally dependent on the gas. The pressure of the gas should control. In the gas station there has a valve called solenoid valve. At first, the pressure of the gas may be higher than 30 bar. The solenoid valve controls the gas pressure of 4.5 bars. If the gas pressure increases then this valve has a meter, which shut off the valve.

Figure 3.8.1.1: Gas pressure reducing valve.

3.8.2 Gas filter Inlet Shut of valve

This valve is used for filtering the gas. The gas which is used for the combustion in the combustion chamber should be moisture free. This valve protects gas from moisture and passes the pure gas.

Figure 3.8.1.2: Gas filter inlet shut off valve.

3.8.3FD Fan Air Flow Control Valve

In the combustion chamber of the burner one of the most important elements is air. This air istaken using force draft fan. Flows of the air are controlled by the control valve. It is an analogcontrol valve. This valve can be operate automatically by a motor also, where it has a manual operation system

Figure 3.9.3: FD fan air flow control valve.

3.8.4Non Return Valve

The non-return valves are used in units 3, 4, and 5. This valve is also called check valve or one way valve. The size of the valve is 200 mm, rated pressure is 27 bar and rated temperature is 80°C.

This valve is two-port valve, which means it has two openings in its body, one for the fluid to enter and the other for the fluid to leave. This valve is used in water pipelines and used to control the flow of water in one direction only.

Figure 3.8.4: Non Return Valve

3.8.5Globe Valve

The globe valves are the type of valve which is used in units 3, 4 and 5 for regulating the flow of the water in the pipelines.

Figure 3.8.4: Globe Valve

It consists of a movable disk-type element and a stationary ring seat in a general spherical body. The movable disk inside the globe valve allows the water flow from high pressure to low pressure region. Figure 3.9.4 shows the globe valve.

3.8.6Pneumatic Valve

Pneumatic valves are extensively used in power station because these valves can be operated by the compressed air pressure or compressed inert gases with the help of pneumatic actuator. The force of compressed air against a diaphragm is opposed by the force of a spring to control the area of the opening for a fluid stream. From APSCL control room electrical signal within the range of 4-20mA is sent to the field where the input converter converts these electrical signals into pneumatic signals. Actuators control the valve opening depending on the amount of pneumatic signals.

Figure 3.8.5: shows a pneumatic valve.

3.8.7Temperature Controlled Valve

Temperature controlled valve is a special type of valve which is controlled by temperature.

Figure 3.8.6 Temperature Controlled Valve

These valves are mostly used in waste water basin. It is used to reduce the temperature of hot waste water by opening the valve of cooling water pipelines. When heat of the water is too high, the valve receives a signal from the heat sensor and opens the cooling water spray lines automatically. When water heat becomes normal it closes automatically. The purpose of the cooling of water is to prevent unexpected environmental effect. Figure 2.6 shows the temperature controlled valve.

3.8.8Super Heater Safety Valve

Supper heater is used for make steam from the water. The temperature of the supper heater may be 300 CEL to 500 CEL. But this temperature can be increased abnormally, if the pressure of steam becomes unbalance. The abnormal heat may cause a big damage of the supper heater. The maximum steam pressure of supper heater is 93 BAR. So, when the pressure of steam passes the limit then extra heats are exhaust using supper heater safety valve.

Figure 3.8.7: Super heater safety valve.

3.8.9Pressure Relief Valve

The pressure relief valve is a type of valve which is used to control or limit the pressure of gas.

This valve is normally in closed position. When gas pressure is too high, the valve gets opened up by the pressure of the gas. Then the gas passes through the bypass pipeline and thus the maximum pressure of the gas is controlled. The pressure relief valve has a spring inside it which mainly helps the valve to open and close. This kind of valves is used in the gas pipelines at the boiler of the thermal power plant.

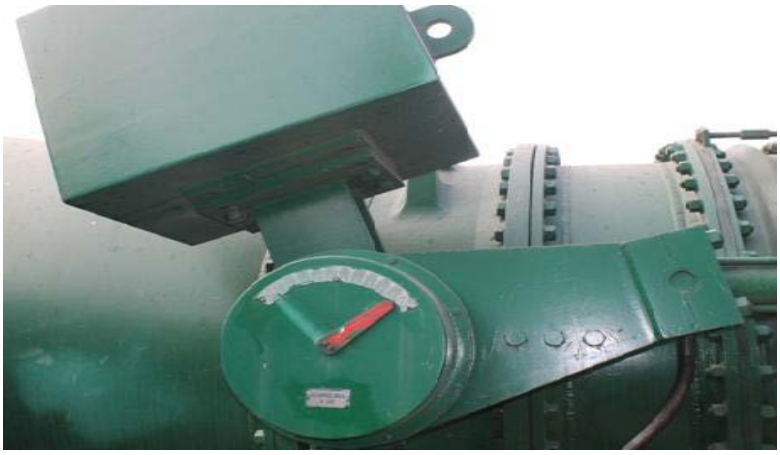


Figure 3.8.8: pressure relief valve

3.9 Auto Control Division

Auto Control is related to PLC controlled system. Also related to the Distributed control system in short DCS which is using in Unit 5 and 50 MW GEPP and 450MW CCPP NORTH

Also there is manual control in the APSCL unit number 1, 2, 3 and 4.

3.10Control Room

In the Ashuganj Power Station Company limited there are two operating systems used for most machine or devices. These are given below:

- Analog Control System
- Digital Control System (Distributed Control System).

Figure 3.10: Shows the control Room of APSCL

3.11About Analog Control System

Analog control system is decorated by many indicators all over the control room. Also the controlling instrumentations are also in analog form. Various buttons having various colored light attached with them has various meaning and working principle.

It is necessary to know that all the indicators those are set up in various sectors in the plant send their indications or transmitted through the Decontic room. The analog control unit uses the +24v,-24v or 240v DC current. The Diod Room supports these unit data. When the whole grid

falls the DC source remain operational by the help of Battery Room. So it shall reduce the effort to figure out the faulty part.

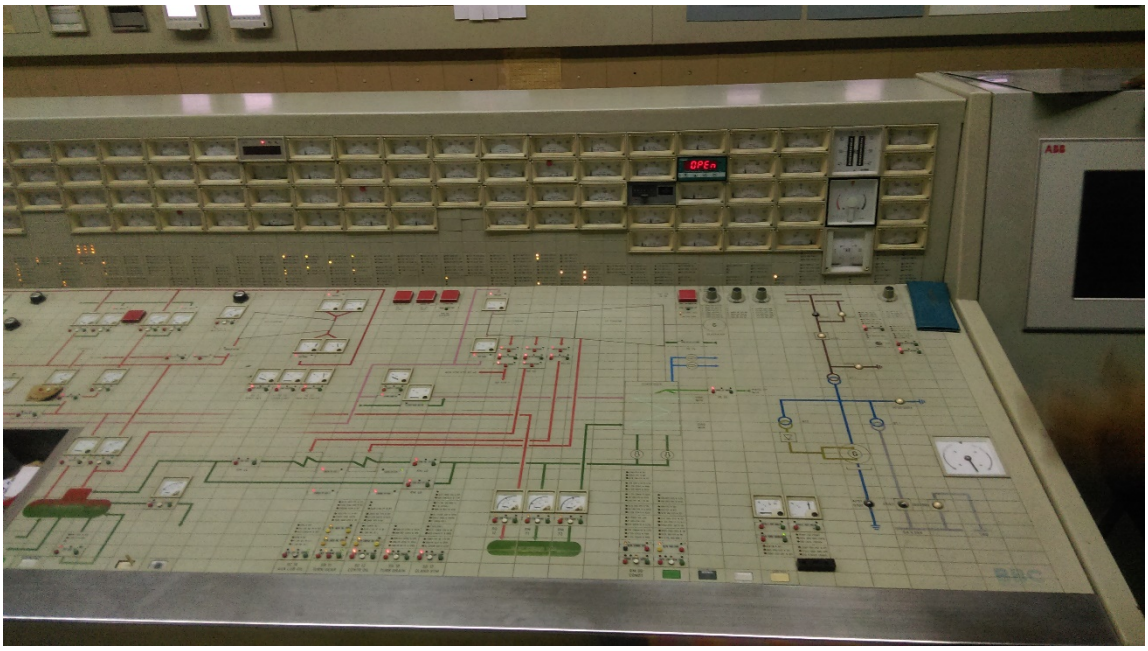


Figure 3.11 Shows the Analog control Room

3.12About Distributed Control system

Distributed Control system is one kind of Computer control system, in which the control is distributed to computer module containing one or more microprocessors based controller & each controller have capabilities to control several instrument loops.

DCS makes the way of controlling too simple to operate. It also an automatic control system. When the power factor goes under the reference value it automatically take action to increase it. It reduces the hardness of controlling in comparison with the analog control system. Also reduces the space allocated for the control room.

Figure 3.12: Software based control system in 150MW & 11 KV unit 5.

3.13Decontic Room

It is a room where all the signals from various measuring instruments, actuators, and controlling components gathers hare and then goes to MVR (Medium Voltage Room) and then goes to the Control room. It is hard to describe but easy to observe. Signals gathers in a card, like microchip card. Trouble shooting can be also be possible by checking those cards from the decontic room. Any failure to the measuring, controlling and other auxiliaries can be checked in this room by the help of a group of technicians.

The foreman and the technician with the help of Engineer take immediate action to resolve any problem to take bake the plant on its previous position if any problem occurs. A print out copy and a pdf version of diagram of the cards on a dicontic room remains available all the time to their nearest position.

The room is fully air conditioned and the moisture proof. Moisture can harm the microchip.

Figure 3.13 Shows the Decontic Chip on decontic room

3.14Battery Room

Control room has various indication monitors, recording component and controlling signals switch which operates in DC.

If power generation falls it will be hard to find out the faulty part. So the control room components should be alive for easily finding out the problem and to take immediate action. To ensure the continuity of control room there is a battery room for each and every unit.

It is only a room for emergency help with batteries in it. It can support +24v,-24v,+240v DC by connecting the +2 volt cell of the Industrial batteries.

Room Configuration is bit different from the others. Because battery is sensitive thing. In any problem it may it may explode or may get fire in it. On the other hand led acid battery emits hydrogen gas through ban plug. Hydrogen gas is explosive and cause danger. So room should be properly decorated to avoid such circumstances. Special modified light is used in here, Proper ventilation system is present and right temperature is maintained.

Figure 3.14: Battery Room in Apscl unit-1

3.15Diod Room

Batteries are for emergency DC supply but in the normal situation control room draws DC current from the diod room. From the electricity produced a part of generating current is connected to the diod room and then the current is converted to DC after that it uses the Conrol room and other DC operated Components.

3.16Summary

The main mechanism of generator is to convert the mechanical energy into electrical energy. The term is simple to look at. But this is related to many more terms. Without the instrumentation and control of the generator it is impossible to run any kind of power plant.

Chapter 4

Generator

4.1 Introduction

Generation of maximum power in minimum cost is the main concern of a power generation plant. In nature, energy cannot be created or destroyed, but its form can change. In generating electricity, no new energy is created. Actually one form of energy is converted to another form. Depending on environment and fuel there is different type of power generating plant.
Whole generator part of Ashugonj Power Station Company Ltd. will be discussed in this chapter. Discussion on different types of plant in APSCL will be emphasized. Steam turbine, gas turbine and CCPP will be discussed separately. Most of the discussion will be on the generating equipment, HVR, MVR, DeconticRoom,Boiler, fuel, procedure etc. Different control system used in APSCL in the generation part will also be discussed.
These sections are described by Engr. ObaidullaHaque, Engr. NirmalDatta, Engr.Md. Kamruzzaman in 8th and 10th February 2018 7 hours each day. In total we have completed 14 hours in those2 days.

4.2 Power Generation Process in APSCL

Ashugonj power station com. Ltd is the largest power producing company. Power generation started in Ashugonj power station in 1970. In the beginning the generation capability was total 128MW using two Unit s 1 & 2. Then gradually the plant improved its generating capability by installing more unites. Now the total generating capability or installed capacity of Ashugonj power station is 1756 MW. In APSCL for generation of electricity engineers are using five types of generating units.

- Steam turbine unit
- Gas turbine unit
- Diesel generator unit.
- Combined Cycle Power Plant Unit
- Modular.

The generator of gas turbine unit and steam turbine unit are same. So we will know about the generator first.

4.3 Generator of Gas Turbine and Steam Turbine Unit

In our house and in different industry AC current is used. So the power generating plants mostly use AC generator to produce AC current. That's why Ashuganj power plant have only AC generator to produce AC current. In Gas turbine and steam turbine units of APSCL same type of AC generator is used. These generators are different in production capability. Most of the steam turbine generators in APSCL are very high in production capability. There are 150 MW Steam power generator used in unit number 1,2,3,4 and 5 in APSCL. Generating voltage of the steam generator is 15.7kv.

Figure4.3: 150 MW AC generator of unit 3

4.4 Description of AC Generator in APSCL

The turning of a coil in a magnetic field produces motion emf in both sides of the coil which add. If the velocity perpendicular to the magnetic field changes sinusoidally with the rotation, the generated voltage is sinusoidal or AC. And this generator used in AC current generation is

known as AC generator which is used in APSCL. The main generating method of APSCL is based on this procedure.

AC generator based on this method has different parts. By visiting and instructions of APSCL instructors, structure of generators and parts used in it is clear to us.

4.5 Excitation Process of Generator

Generator needs excitation on its stator part to generate. It means that stator part need current to be magnetized. According to the faradays law the rate of change of flux is the main reason of producing the electric current. There are two types of generator based on the excitation. Such as:

1) Self-excitation.
2) External excitation.

4.5.1 Self-excitation

In these generator there is no need to give the excitation from the external sources. Its mechanism is much different from the others. When the turbine rotates by the flows of steam the generator rotor part starts to rotate as the rotor part is coupled with the turbine shaft. There is a small permanent magnet generator which is called Pilot Generator. So there is no need to give external excitation on it. When the rotor rotates the permanent magnet generator generates the current. This current is transmitted to the diode room and being amplified the current it returns to the stator of the 2^{nd} part of the generator. This generator achieve the sufficient amount of the excitation to generate the current. Then this current again sent to the diode room to amplify and returns it to the stator part of the main 150MW generator. Then the generator generates and the generating current transmitted to the substation through the bus bar.

All these three parts of the generator are in a one generator form. Unit number 1, 2, 3 are the example of self-excitation generator

Figure 4.5.1: Pilot Generator in 150 MW generator of unit 3.

4.5.2External Excitation

In this type of generator the excitation gives from the external source. From the substation it draws power and make the excitation to the stator part. This type of generator are used in unit number 4 and 5.

Different parts of AC generator used in APSCL are given below:

- Stator
- Rotor
- Insulation
- Exciter
- Armature Windings
- Insulation
- Jacking Oil Pump

4.6 Generator Protection

Generators must be protected from electrical faults, mechanical problem and adverse system conditions. Some faults require immediate attention (shutdown) while others just require alarming or transfer to redundant controllers. In our intern time we have learned different type of generators protection and cooling system of generators which are using at APSCL. Important protection systems are given below-

- Over Current Protection
- Over Voltage Protection
- Reverse Power Protection
- Under Frequency Protection
- Negative phase sequence Protection
- Stator Earth Fault
- Rotor Earth Fault Protection and
- Winding differential protection

4.6.1 over Current Protection

Normally generators at APSCL are designed to operate always at rated MVA, frequency and power factor over a range of 95 to 105% rated voltage. Operating the generator at rated MVA with 95% voltage, 105% stator current is allowable. Operating of the generator further than rated

KVA may result in damaging stator. A result of over current in winding is stator core overheating and leads to failure of insulation. If alarm with relay annunciates at annunciation panel, then the controller reduce the stator current to the below the rated by reducing the MVAR power on the generator. If a generator becomes shut down for over current then relays are also act for the, unit Breaker, steam Supply (Shut off) off, field Breaker off and, unit Auxiliary Breaker off

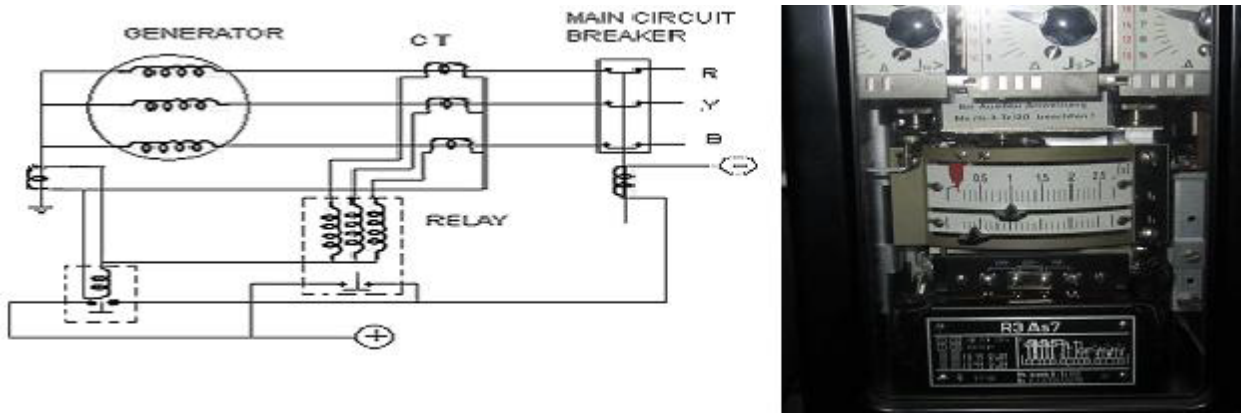


Figure 4.6.1: Over current protection and alarming relay.

4.6.2 Over Voltage Protection

If an over voltage occurs in the generator and if it is persist, the circuit breaker of the generator and the exciter field breaker should be tripe because it is not safe for a generator to continue to work under this condition. In a generator the over voltage can happened for, line fault, thundering, suddenly load rejection.

The over voltage protection contain two types of relay – one is the instantaneous relays which is set to pick up at 130 to 150% of the rated voltage and another is Time delay relay which is set to pick up at 110% of rated voltage.

4.6.3 Reverse Power Protection

It is backup protection to the low forward protection. Reverse power or Motoring of a generator occurs when the energy supply to the prime mover is cut off while the generator is still online.

When this occurs, the generator will act as a synchronous motor and drive the prime mover. The generator will not be harmed by synchronous motoring, where a steam turbine can be harmed through overheating during synchronous motoring if continued long enough. The motoring of the turbine output can be detected by reverse power protection. Avoid false tripping due to power swings in a time delay, is included before tripping signal is generated. The primary concern is the protection of the turbine that may be damaged during a motoring condition.

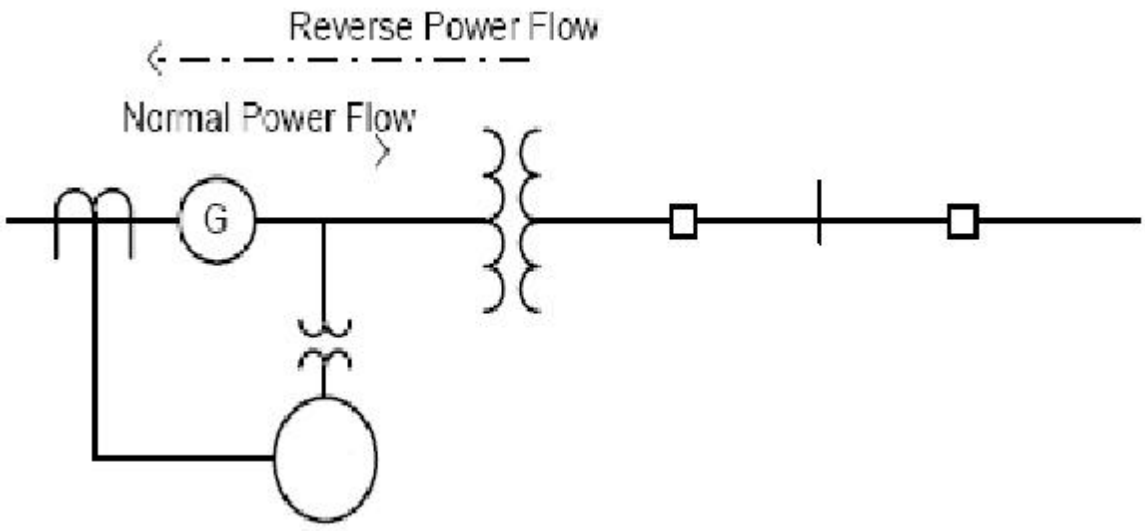


Figure 4.6.3: Reverse power protection.

4.6.4 Under Frequency Protection

A generator which is connected to the system, if it operates with a under frequency then that will be the result of sever system disturbance. The generator can accept reasonable under frequency operation provided voltage, which is within acceptable limits. The abnormal under frequency on the generator may be due to unacceptable speed control adjustment. Under frequency will be occurring when the generator will operate with over load. The power system survives only if we drop the load, the generator output becomes equal or greater than the connected load.

Relays acted: Flag operation at Protection panel. Indication at Annunciation Panel .Increase governor speed until machine reaches full speed. Even after two to three attempts, the machine are running at lower speed, probably the governor of turbine is faulty. Inform to maintenance staff for rectification of the same.

Figure 4.6.4: Under frequency relay.

4.6.5 Negative Phase Sequence Protection

The most common causes for the negative phase sequence are system asymmetries, unbalanced loads, unbalanced system faults, and open phases. .When a negative phase sequence occur then induce a double-frequency current in the surface of the rotor, the retaining rings, the slot wedges, and to a smaller degree, in the field winding.. For that reason the rotor will be overheated and generator can be damaged. For this imbalance current the shaft of the rotor can be vibrate .At APSCL current balance relaying equipment is used for protection against this kind of fault.

Figure4.6.5: Negative phase sequence relay.

4.6.6 Stator Earth Fault

Generally the stator of a generator is very close of the ground. When a fault is occur in a stator winding then it can easily connected with the ground. If a faulty phase winding connected to ground, the normal low neutral voltage will rise as high as line-to-neutral voltage which will be depending on the fault location. This fault may cause the serious damage .This fault can be detected by measuring secondary voltage of neutral grounding transformer. Here we have two zones for detect the fault. First zone cover 0% to 95% of the stator winding which is far from the neutral. And second zone cover 96% to 100% of the stator winding. A fundamental frequency neutral over voltage relay detect the fault of the first zone. Another third harmonic neutral under voltage relay detect the fault of the second zone.

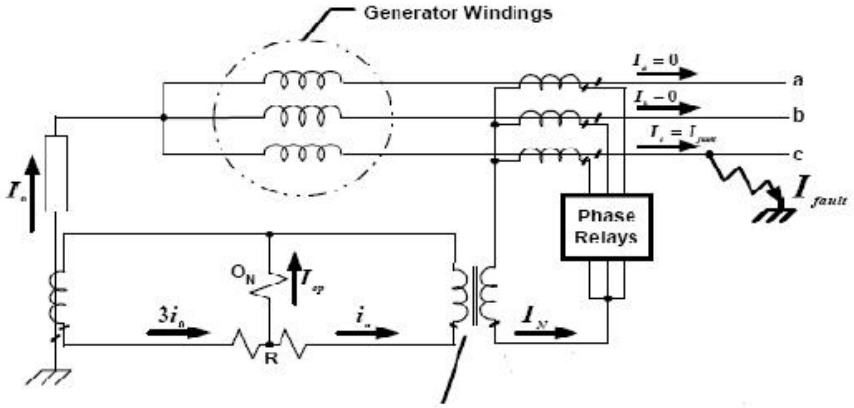


Figure 4.6.6: Stator earth fault protection.

4.6.7 Earth Fault Protection

Rotor earth fault protection is one of the major protections of generator. Rotor field winding of the generator is electrically isolated from the ground. Two or more ground faults in the winding will cause magnetic and thermal imbalance plus restricted heating and damage to the rotor metallic parts. Rotor earth fault may be caused due to insulation failure of winding. The separate relay to the ground neutral provides the sensitive protection. But ground relay can also detect the fault beyond the generator, the time co-ordination is necessary to overcome this difficulty

4.6.8 Winding Differential Protection

This protection system is similar for the generator and transformer winding. In a plant the generating current and the transmitting current should be equal, if this current become difference

then a large fault may occur and generator winding will be effected .Generally percentage differential is used for protection about 80% of the stator winding.

Figure 4.6.8: Generator Differential Relay.

4.6.9 Shaft and Bearing Protection

Generally a turbine is rotted with more than 3000 rpm speed. With this large speed sometime shaft and bearing may be vibrating. For this vibration the blade of the turbine may lose their position and can make a big damage. If shaft or bearing start vibration then turbine become shut off by shaft vibration sensor.

Figure 4.6.9: Shaft vibration sensor for unit 5 steam turbine connects with shaft.

4.6.10 Lube Oil Pressure Protection

The vibration of the shaft can be controlled by giving lube oil on the shaft. But the pressure and temperature of this lube oil should be controlled. If pressure increases more than 60% of the set value then turbine becomes shut off by the pressure switch.

Figure 4.6.10 Shows the Lube Oil Pressure Protection Switch

4.6.11 over Speed Protection

At APSCL the synchronizing speed of the generator is 3000 rpm. So the turbine rotation speed should be 3000 rpm. If rotation speed of turbine crosses over this limit then the turbine become shut off by the breaker.

4.7 Cooling System of Generator

Generator cooling is very important for getting more life time and efficiency for a generator .At APSCL generators are cooled by two processes-

- Air Cooling
- Hydrogen Cooling.

4.7.1 Air Cooling

A generator becomes heated for its winding temperature. This heat should remove by absorbing using any external element. Air is an element which can easily absorb this heat. In this process there have a chamber for circulating air through the generator to absorb heat. After this, hot air

exhaust to outside of the generator by external exhaust chamber. For the circulation of air there have an Air circulation motor.

4.7.2 Hydrogen Cooling

Hydrogen cooling is used for large generators rather than air. Hydrogen has inherently better heat transfer characteristic .Hydrogen can convey the heat 1.6 times more than the air. Here the cooling process is almost same as like air cooling, but it needs an external supply system which takes a large area. This system is very costly than the air cooling. APSCL has an additional supply system for the hydrogen cooling.

Figure 4.7.2 shows the Hydrogen Plant

4.8 Summery

For getting the constant electricity from a power plant is necessary to keep the generator steady and proper protected. This chapter highlights about the full overview of generator and its protection system which is a very important for continuity of power supply. Maximum protection systems are automated, some are operated manually.

Chapter 5

Substation

5.1 Introduction to Substation of APSCL

The substation in APSCL is outdoor type, step up, double bus bar type substation. APSCL uses double bus bar because it generates power and distributes the power by giving it to the grid. When generator starts it take power from the grid by bus bar one. The electric power is first produce at power station and then delivered to the consumers through a large network of transmission and distribution system. The electrical power distribution system is AC. so the electrical power is generated, transmitted and distributed in the form of alternative current. This is accomplished by substation apparatus. In this chapter we will discuss about different equipment's of the substation that are used by APSCL

Different types of equipment are used in the substation of APSCL. Some of these important components which we have seen in APSCL are described in the following.

5.2 Equipment of Substation

There are different types of equipment which are used at the sub-station of APSCL .The major equipment list are given below:

- Transformers.
- Isolators.
- Power Circuit Breakers.
- Earthing Switch.
- Lightning arrester.
- Relay
- Automatic Circuit Recloser.
- Power Capacitors.
- Bus Bar.
- Insulator.
- Transmission line.
- Wave Trap.

5.3 Transformer

The transformer is used in APSCL substation to step-up or step down the voltage. In Ashuganj

Power Station generated voltages are transformed from 31.15 kV, 15.75 kV, 13.8 kV and 11 kV to 132 kV, 230 kV using step-up transformer for long distance transmission. The step-down

Transformers which step down the voltage to 400V, 3-phase, 4-wire for internal use or supplying to the consumers. In substation mainly two types of transformers are used.

(i) Power transformers

(ii) Instrument transformers

5.3.1 Power Transformer

The power transformer used in substation to step-up or step down the voltage. Step-up

Transformer is used to step-up generation voltage to a high voltage (132 kV or 230 kV or more) for transmission of electrical power. Except at the power station all the subsequent sub-stations use step-down transformers which are used to reduce the voltage of electric supply. Unit step-up

Transformer or 3 phase transformer can be used as power transformer. Modern practice is to use

3-phase transformer in substation although 3 single phase bank of transformer can also be used.

There are two advantages if 3-phase transformer is used instead of 3 single phase bank ofTransformers. Firstly, only one 3 phase load tap changing mechanism can be used. A transformer tap is a connection point along a transformer winding that allows a certain number of turns to be selected. This means, a transformer with a variable turns ratio is produced, enabling voltage regulation of the output. The tap selection is made via a tap changer mechanism. Secondly, its installation is much simpler than the three single phase transformers. The power transformers are generally installed upon lengths of rails fixed on concrete slabs having foundations 1 to 1.5 m deep. Most of the power transformers at the substation of APSCL are rated up to 100 MV.

APSCL uses both single phase & 3 phase power transformers. Most of the power transformer hasONAF/ONAN cooling system.

(a)

(b)

Figure: Power Transformer: (a) Three Phase Transformer (b) Single Phase Transformer

5.3.2 Instrument Transformer

The lines in sub-station operate at high voltages and carry current of thousand amperes. The measuring instrument and protective device are design for low voltages and currents. So they will not work if connected directly on the power lines. This problem is solved by installing instrument transformer on the power line. The function of the instrument transformer is to transfer the voltage or currents in power lines to values which are suitable for the operation of measuring instruments and relays. Instrument transformers are used in APSCL for measuring voltage and current in electrical power systems and for power system protection and control.

Where a voltage or current is too large to be conveniently used by an instrument, it can be scaled down to a standardized low value. Instrument transformers isolate measurement, protection and control circuitry from the high currents or voltages present on the circuits being measured or controlled. There are two types of instrument transformer:

(i) Current Transformer

(ii) Potential Transformer

5.3.2.1 Current Transformer

A current transformer (CT) is used for measurement of electric currents. A current transformer in essentially is a step-up transformer which steps down the current to a known ratio. When current in a circuit is too high to directly apply to measuring instruments, current transformer produces a reduced current accurately proportional to the current in the circuit, which can be conveniently connected to measuring and recording instruments. A current transformer also isolates the measuring instruments from what may be very high voltage in the monitored circuit. Current transformers are commonly used in metering and protective relays in the electrical power industry. In the APSCL sub-station there are different types of current transformers which are used in the switchyard of the substation. The current transformer is connected in series with equipment.

Figure 5.3.2.1 Shows the Current Transformer

5.3.2.2 Potential Transformer

Potential transformer or voltage transformer is used to step down voltage at a known ratio that can be effectively and safely used for operation of instruments such as ammeters, voltmeters, watt meters, and relays used for various protective purposes. In APSCL there are many outdoor type potential transformers with various ratings such as 6 kV, 133 kV and 230 kV.

Figure 5.3.2.2: Potential Transformer used at APSCL Substation (132 kV single phase outdoor types)

5.4 Circuit Breaker

A circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit. Circuit breaker serves two basic purposes one of them is switching during normal operating condition for the purpose of operation and maintenance. Another purpose is to switching during abnormal conditions such as short circuit and interrupting the fault current. Its basic function is to detect a fault condition and by interrupting continuity, to immediately discontinue electrical flow. Unlike a fuse, which operates once and then has to be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation. Circuit breakers are made in varying sizes, from small devices that protect an individual household appliance up to large switchgear designed to protect high voltage circuits feeding an entire city. There are different types of circuit breaker. It is classified on the basis of voltage level, construction type, interruption type and their structures.

According to voltage range we can classify them into three types such as high, medium and low voltage circuit breaker. We saw the three types of circuit breaker in the switchyard of APSCL.

We will discuss about these three types of circuit breakers that we have seen in the switchyard of APSCL.

(i) SF6 circuit breaker

(ii) Oil circuit breaker

(iii) Air blast circuit breaker

5.4.1 SF6 Circuit Breaker

The SF_6 circuit breakers are used at the substation of APSCL with 230 kV bus-bar. Sulphur hexafluoride (SF_6) gas is used as the arc quenching medium into the SF_6 circuit breakers. The

Sulphur hexafluoride (SF_6) is an inert, heavy gas having good dielectric and arc extinguishing properties and has a strong tendency to absorb free electron. The dielectric strength of the gas increases with pressure. The contacts of the breaker are opened in a high pressure flow of SF_6 gas and an arc is stuck between them. The conducting free electrons in the arc are rapidly captured by the gas to form relatively immobile negative ions. The loss of conducting electrons in the arc quickly builds up enough insulation strength to extinguish the arc. The SF_6 circuit breakers have been found to be very effective for high power and high voltage service.

Due to the superior arc quenching properties of SF_6 gas, the SF_6 circuit breakers have many advantages over oil or air circuit breakers. Some advantages of SF_6 circuit breakers are given below:

(a) Due to the superior arc quenching properties of SF_6 gas, this type of circuit breakers have very short arcing time.

(b) The dielectric strength of SF_6 gas is higher than air or oil so SF_6 circuit breakers can interrupt much larger current.

(c) There is no risk of fire in SF_6 circuit breakers because SF_6 gas is non-inflammable.

(d) The SF_6 circuit breakers have low maintenance cost, light foundation requirement and minimum auxiliary requirement.

(e) The SF_6 circuit breakers circuit breaker gives noiseless operation due to its closed gas circuit and no exhaust to atmosphere unlike the air blast circuit breaker.

Figure 5.4.1: SF_6 Circuit Breaker used at APSCL Substation

There are also some drawbacks of SF6 circuit breakers. SF6 circuit breakers are costly due to the high cost of SF6 gas. Since SF6 gas has to be reconditioned after every operation of breaker, additional equipment is necessary for this purpose.

5.4.2 Oil Circuit Breaker

The Oil Circuit Breakers are used at the substation of APSCL with 132 kV bus-bar. In such circuit breakers some insulating oil is used as the arc quenching medium. The contacts are opened under oil and arc is struck between them. The heat of the arc evaporates the surrounding oil and dissociates it into a subsequent volume of gaseous hydrogen at high pressure. The hydrogen gas occupies a volume about one thousand times that of oil decomposition. The oil is therefore pushed away from arc and expanding hydrogen gas bubble surrounding the arc region

and adjunct portion of the contacts. The gas inside the bubble is around 80% hydrogen, which impairs ionization. The arc extinction is facilitated mainly by two purposes. Firstly hydrogen gas has high heated conductivity and cools the arc, thus adding the de-ionization of the medium between the contacts. Secondly, the gas setup turbulence in the oil and forces into the space between the contacts, thus eliminating the arcing products from the arc path. The result is that the arc is extinguishing and current interrupted. There are some advantages of oil as arc quenching medium. It absorbed the arc energy to decompose the oil into gases which have excellent cooling properties. It acts as insulator and permit smaller clearance between the live conductors and earthed components. There are also some drawbacks of oil as arc quenching medium. It is flammable and there is a risk of fire. It may form an explosive mixture of air. The arcing products (carbon) remain in the oil and its quality deteriorates with successive operations. In this case to remove the problem periodical checking and replacement of oil are necessary.

Figure 5.4.2: Oil Circuit Breaker used at APSCL Substation

5.4.3Air Blast Circuit Breaker

The Air Blast Circuit Breakers are also used at the substation of APSCL with 132 kV bus-bar. These circuit breakers use a high pressure air-blast as an arc quenching medium. In the air blast circuit breakers the arc interruption takes place to direct a blast of air, at high pressure and velocity, to the arc. Dry and fresh air of the air blast will replace the ionized hot gases within the arc zone and the arc length is considerably increased. Consequently the arc may be interrupted at the first natural current zero. In air blast circuit breakers, the contacts are surrounded by compressed air. When the contacts are opened the compressed air is released in forced blast through the arc to the atmosphere extinguishing the arc in the process. A compressor plant is necessary to maintain high air pressure in the receiver. Air blast circuit breaker is better than oil circuit breaker. The growth of dielectric strength is so rapid that final contact gap needed for arc extinction is very small. This reduces the size of device. The risk of fire is eliminated. Due to lesser arc energy, air blast circuit breakers are very suitable for conditions where frequent operation is required. The arcing products are completely removed by the blast whereas the oil deteriorates with successive operations; the expense of regular oil is replacement is avoided. The energy supplied for arc extinction is obtained from high pressure air and is independent of the current to be interrupted. The arcing time is very small due to the rapid buildup of dielectric strength between contacts. Therefore, the arc energy is only a fraction that in oil circuit breakers, thus resulting in less burning of contact.

5.5.1Protective Relay

Protective relay is device that detects the fault and initiates the operation of the circuit breaker to isolate the defective element from the rest of the electrical network. There are different types of relay at the substation of APSCL. There are two principle regions for it. Firstly if the fault is not cleared quickly, it may cause unnecessary interruption of service of customers. Secondly, quick disconnection of faulted apparatus limits the amount of damage to it and prevents the effects of fault from spreading into the system.

Figure5.5.1: protective relay used at APSCL

5.5.2 Classical Relay

There are several types of classical relays in power system, but electromagnetic attraction type double quantity classical relays are used at APSCL substation. Classical relay is the first protection device. It is the most effective 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.

5.5.3 Buchholz Relay

A Buchholz relay is a safety device connected on some oil-filled power transformers and reactors, equipped with an external overhead oil reservoir called a conservator. The Buchholz

Relay is used as a protective device sensitive to the effects of dielectric failure inside the equipment.

5.5.5 Over Current Relay

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

5.6 Lightning Arrester

Lighting Arresters are used at APSCL substation to protect the equipment of substations from lighting surge. Lightning arresters are protective devices for limiting surge voltages due to lightning strikes or equipment faults or other events, to prevent damage to equipment and disruption of service. Also called surge arresters. Lightning arresters are installed on many different pieces of equipment such as power poles and towers, power transformers, circuit breakers, bus structures, and steel superstructures in substations. Lightning is a huge spark and takes place when clouds are charged to such a high potential with respect to ground or earth. It has a high voltage terminal and a ground terminal. 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 is grounded.

Figure5.6: Lightening arrester in APSCL.

5.7Types of Lightning Arrester

There are different types of lightning arresters. At the substation of APSCL we saw the following two types of lightning arresters.

Mainly six types of lightning arresters are used in outdoor type substations.

These are as follows.

- Metal oxide lightning arrester,
- Rod gap lightning arrester,
- Horn gap lightning arrester,
- Expulsion type lightning arrester,
- Valve type lightning arrester.

5.7.1 Rod Gap Arrester

It is a very simple type of diverter and consists of two 1.5 cm rods, which are bent at right angles with a gap in between as shown in Figure 6.13. One rod is connected to the line circuit and the other rod is connected to earth. The distance between gap and insulator must not be less than one third of the gap length so that the arc may not reach the insulator and damage it.

Generally, the gap length is so adjusted that breakdown should occur at 80% of spark-voltage in order to avoid cascading of very steep wave fronts across the insulators. The string of insulators for an overhead line on the bushing of transformer has frequently a rod gap across it. Figure 6.13 shows the rod gap across the bushing of a transformer. Under normal operating conditions, the gap remains non-conducting. On the occurrence of a high voltage surge on the line, the gap sparks over and the surge current is conducted to earth. In this way excess charge on the line due to the surge is harmlessly conducted to earth.

5.7.2 Horn Gap Lightning Arrester

These types of lightning arrester contain a 1.4mm horn gap. When lightning occurs arc is generated between the horn gaps and hence it will be shorted and grounded the lightning stroke.

5.8Isolator

The main function of isolator is to separate high voltage conductors from earth. Isolators are located on both sides of the circuit breaker. Isolators do not have any rating for current breaking or current making. Isolators are interlocked with circuit breakers. The failure of a single isolator can cause the shutdown of a distribution line, which can cause disruption of

power. Low resistance path for transferring this high voltage to the earth. There is a counter with each lightning arrester, where it counts the number of lightning on this device

Transmission line contains high voltage. So the high voltage carrying conductor cannot touch the transmission pole. So insulator is used to connect the transmission line onto the pole.

In APSCL we have observed two types of insulator:

1. Pin type insulator
2. Suspension type insulator.

5.8.1Pin Type Insulators

Pin type insulator is basically used for low voltage distribution line isolation purpose. Current carrying conductor cannot touch the tower. If it touches the tower then tower will also conduct the current. As a result insulators are used to isolate the tower from conductor

5.8.2Suspension Type Insulator

This type of insulator is used at high voltage transmission line isolation. For that case the insulator contains several numbers of disks. The number of disk will be determined by the voltage ratings of the transmission line.

5.9Wave Trap

Line trap also is known as Wave trap. What it does is trapping the high frequency communication signals sent on the line from the remote substation and diverting them to the telecom/teleportation panel in the substation control room (through coupling capacitor and

LMU). This is relevant in Power Line Carrier Communication (PLCC) systems for communication among various substations without dependence on the telecom company network. The signals are primarily teleportation signals and in addition, voice and data communication signals. Line trap also is known as Wave trap. What it does is trapping the high frequency communication signals sent on the line from the remote substation and diverting them to the telecom/teleportation panel in the substation control room (through coupling capacitor and LMU).

Figure 5.9: Wave trap used on APSCL substation.

This is relevant in Power Line Carrier Communication (PLCC) systems for communication among various substations without dependence on the telecom company network. The signals are primarily teleportation signals and in addition, voice and data communication signals. The Line trap offers high impedance to the high frequency communication signals thus obstructs the flow of these signals in to the substation bus bars. If there were not to be there, then signal loss is more and communication will be ineffective/probably impossible.

At previous day wave trap was used for substation to substation communication.

5.10 Bus Bar

Bus bar is an electrical conductor linking all generators and/or batteries and distributing power to all operative branches. It is essentially a metallic bar used to carry a large current and to make common connections between several circuits. In APSCL we have seen two double line bus bars.

One of them was for 132KV and the other is for 230KV.

Double line Bus bar is used for safety purpose. For that case one bus bar always remains active and the other one will be standby. If any fault occurs on the active bus bar then the standby bus bar will be active with the help of Bus coupler.

Bus bar is an important element in the substation. It's an electrical conductor that helps to make a common connection between several circuits. The maximum amount of current that flows through bus bar depends on the cross sectional area. Solid copper bus bars are used at APSCL and the diameters of these bus bars are about 50 mm or more. Three types of bus bar designs are available. These are as follows.

- Single circuit,
- Double circuit and
- Ring circuit bus bar.

We have seen double circuit bus bar is used in APSCL substation.

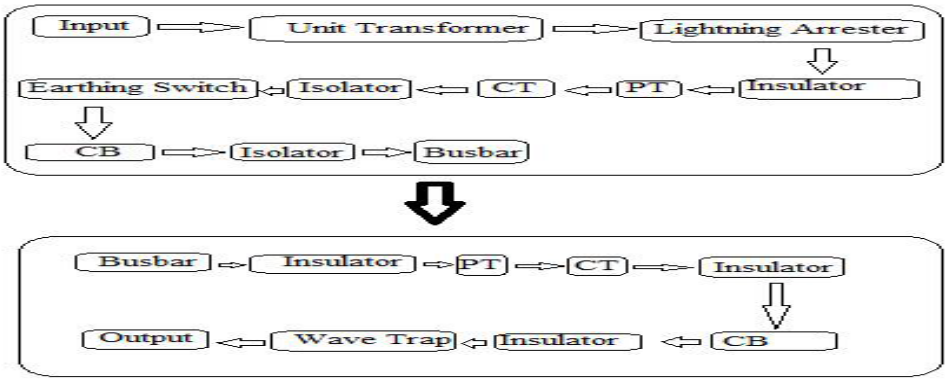


Figure 5.10: shows the flow diagram the input is the generator room and Output is the transmission line.

5.11Underground Power Cables

There are different types of power cable. Power Cables are used to carry the power. They are single core and three cores. Types of power cables are PVC insulated, XLPE insulated. There are used XLPE cables at APSCL.

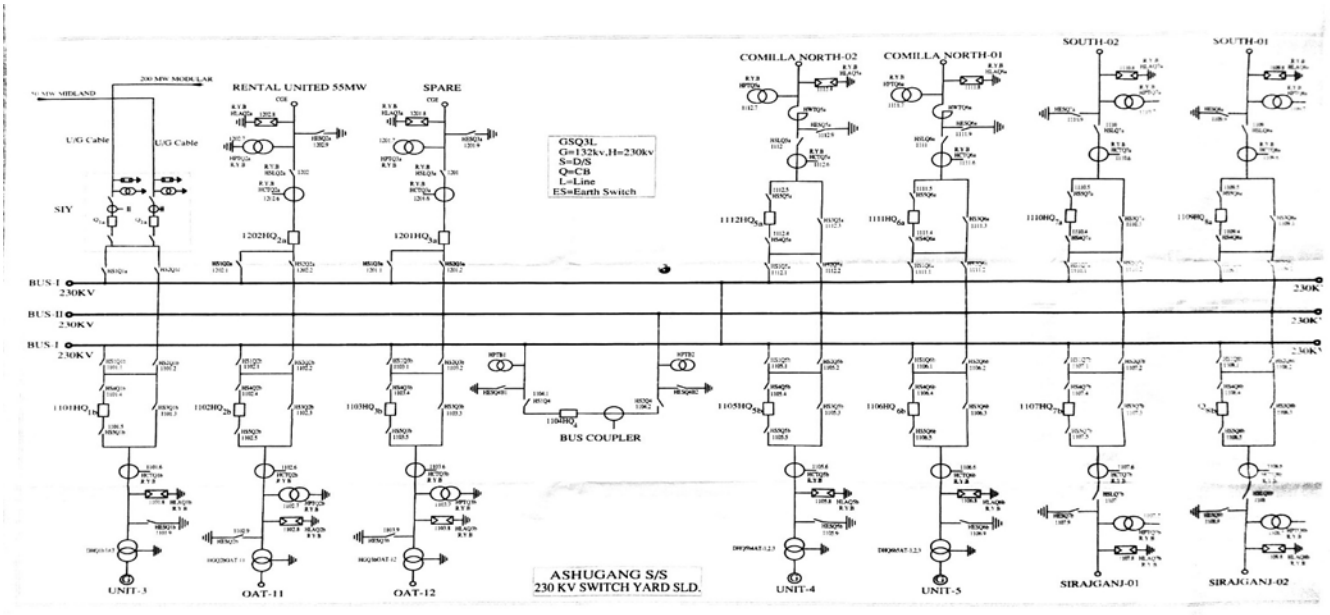
Figure 5.11: XLPE insulated Underground Power Cable used in APSCL

5.12Transmission Coverage Area

Ashuganj Power Station has 11KV, 33KV, 132KV, 230KV transmission line and also 400KV is also installing for upcoming transmission system. APSCL mainly transfer the electric energy to the comilla, Brahmanbaria, Shahjibazar**,** Kishoregonj and also Ghorashal. We have order the substation area in table. It can be seen at a glance.

Table 5.11: Transmission coverage area

Serial Number	Coverage Area	Line Voltage
1	Rental United Power Station Company	230KV
2	Comilla North 01	230KV
3	Comilla North 02	230KV
4	Shahjibazar	132KV
5	Brahmanbaria 01	132KV
6	Brahmanbaria 02	132KV
7	Ghorashal 01	132KV
8	Ghorashal 02	132KV
9	Kishoregonj 01	132KV
10	Kishoregonj 01	132KV



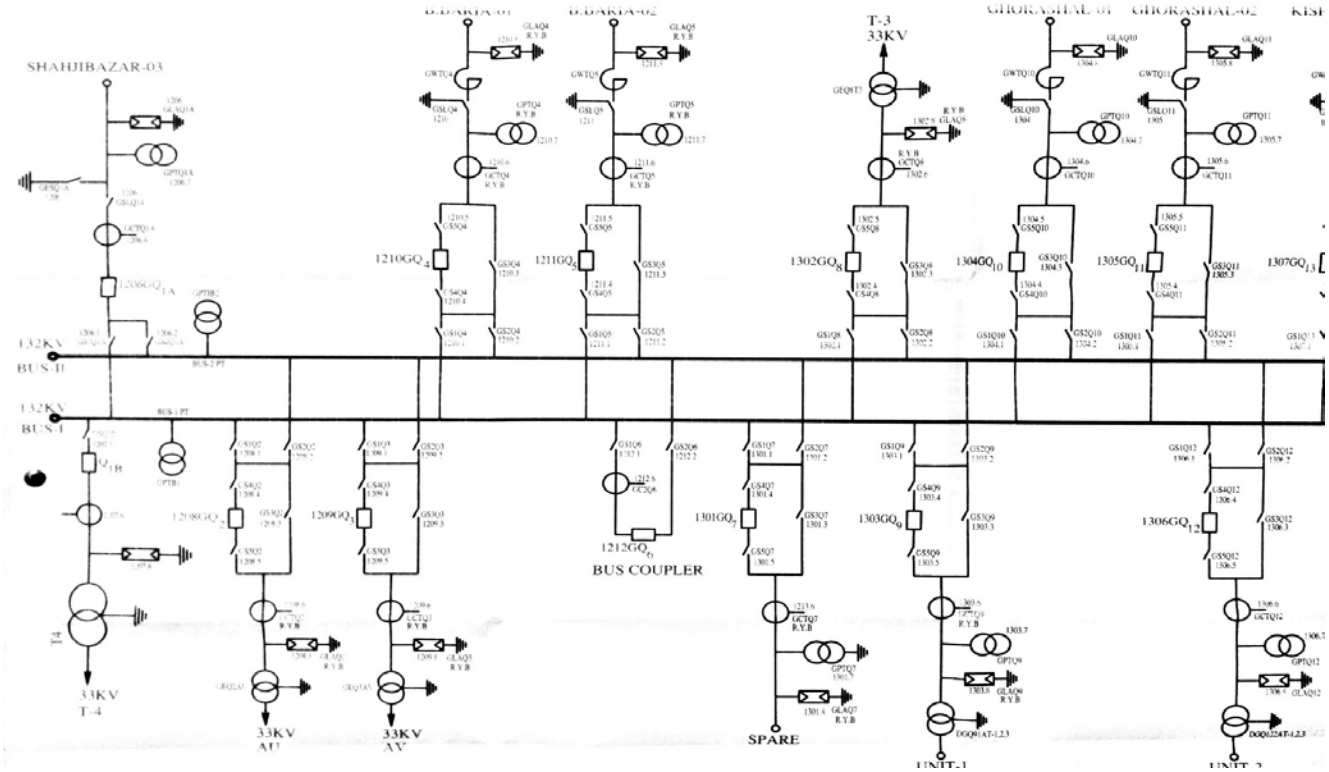


Figure 5.12.1: Shows the Transmission coverage area part -1

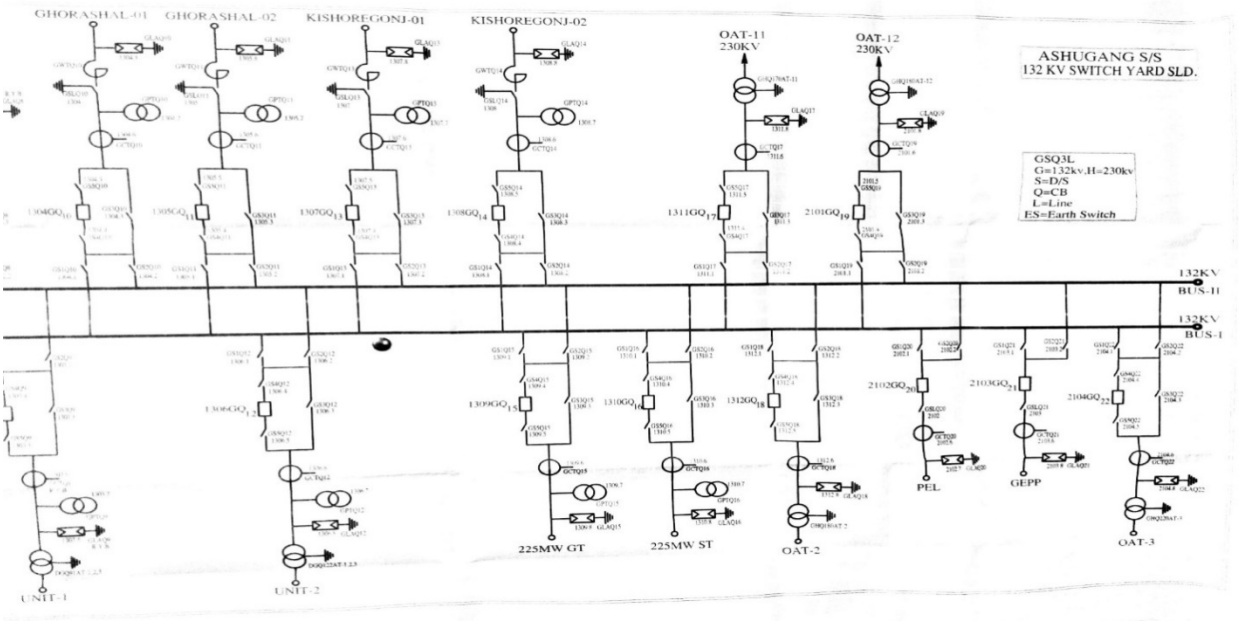


Figure 5.12.2: Shows the Transmission coverage area part -2

5.13Summary

Substation is an essential element on a power plant. Substation is primarily responsible to distribute power to the consumers. Most of the generators generate a low output voltage with a higher current. Through power transformer that voltage is step up to require voltage level. By the arrangement discussed before, power gathers at the bus bar. Through bus bar voltage is distributed to the transmission line system. We have achieved a great knowledge about substation, substation auxiliaries and transmission procedure. As the huge amount of electricity is transmitting to different areas to cover, it is important to make all the connection in mechanism in a very proper way. All the equipment must be accurate and well serviced. Substation is not always transmitting the power to the grid. Sometimes it may draws power from the grid. In our internship period Mr. Sohag Kumar Saha the Assistant Engineer in substation division helped us a lot by providing much about the substation. Though he was busy in his work but somehow managed to give us his valuable time. All the question from us has answered in a very gently and briefly. In support of distributing the power to the grid and in favor of ensures the protection of substation and its equipment's are essential. Inside this report functions of equipment's exists in substation like transformers, relays, breakers are all explained. From this report we tried to make an overview of APSCL substation

Chapter 6

Conclusion

6.1Overview

This chapter is designed to give an overview about the problems and findings at APSCL during the internship period. These will be discussed briefly and then there are some recommendations which could be regarded as a suggestion from our point of view.

6.2Problems

During our internship program we faced, practical participation of different works and overhauling of equipment would give us experience but APSCL does not provide this type of facility to their apprentice.

6.3Recommendations

Some recommendations are given below for the students to do their internship program in a better way.

- Internship program should be scheduled in such a way so that it does not clash with the university regular classes.

- Student should complete the relevant courses to their internship program before doing internship.

- The tenure of our internship program with APSCL was only for 15 days. 15 days is not enough to be able to understand the functions of a power plant efficiently.

- Electrical and Electronic Engineering department of Daffodil International University should give more co-operation on this path.

- Also should give MoU (Memorandum of Understanding) with prospective companies like Energypac,Summit Power etc. for ensuring internship program for the students.

6.4 Concluding Remarks

We passed some remarkable days at APSCL during our internship program. APSCL can be regarded as the practical ground of learning about a power station. The theories that we learned at the university were observed at APSCL. We consider ourselves very much lucky to have our internship program with a reputed power station company like APSCL. It gave us an opportunity to apply our theoretical knowledge in practice. In case of power generation APSCL is the combination of steam, gas and combined cycle plant. We visited Gas Engine power plant at the very first of our internship program. In Gas Engine power plant we observed how electricity is produced by Gas Engine. There are several switch gear rooms and control rooms to control the overall system and power generation. Various types of relays are used for protective purposes that are also controlled from the control room. There we have seen how natural gas, supplied by Bakhrabad (Titas) Gas transmission and distribution company limited (BGTDCL), is used as fuel to burn gas. For protective measures, relays are also used and controlled in switch gear room.

Our achievements from APSCL are:

- Industrial training provided by APSCL has enriched our practical knowledge.
- It has opened our eyes about practical operation of different equipment of a power station.
- APSCL gave us the unique experience of observing the equipment closely.

The authorities of APSCL were very concerned about all kinds of safety. The friendly environment at APSCL encouraged us to cooperate with each other. We learned a lot and obtained practical knowledge from our internship at APSCL, which will help us in our future career path.

References

[1] Company profile, Power production, “About APSCL”.

Available: http://www.apscl.com, [Accessed: 5 March 2018]

[2]Switchgear Protection and Power System, 12th Edition, by Sunil S. Rao

[3]Principal of power system, 4th revised edition, by V.K. Mehta, Rohit Mehta

[4] About four stroke engine http://courses.washington.edu/engr100/Section_Wei/engine/UofWindsorManual/Four20Stroke20Cycle20Engines.html

[5]For annual data of APSCL website http://www.apscl.com/Board_of_Directors.asp

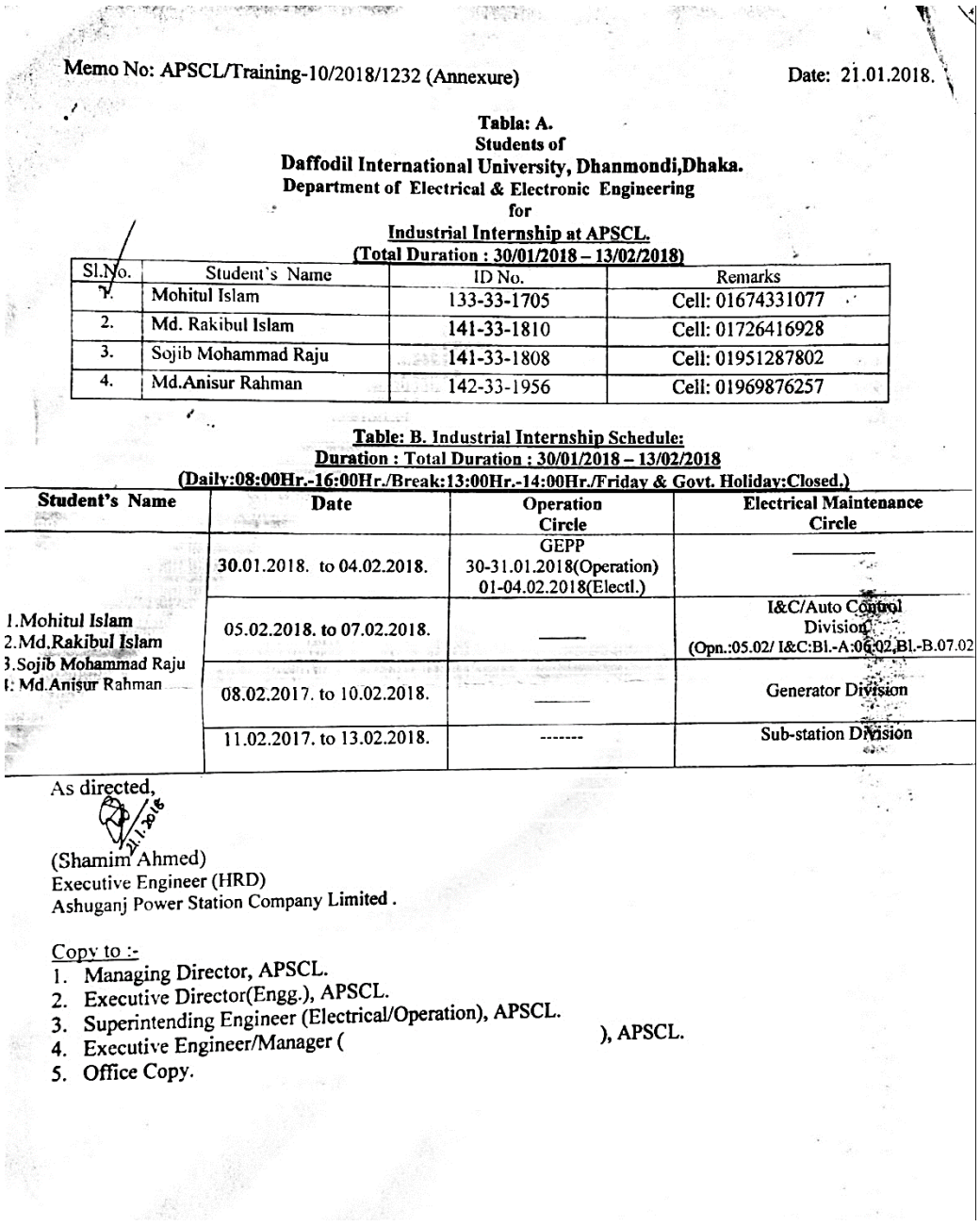
[6]Power Plant furnace details http://engineering.wikia.com/wiki/Power_plant_furnace

[7] Gas engine briefings https://www.gepower.com/gas/reciprocating-engines/jenbacher

[8] GE jenbacher engine configuration is from the engine manual book given by the APSCL authority.

APPENDIX- A

Scan copy of time schedule given by APSCL authority



Memo No: APSCL/Training-10/2018/1232 (Annexure) Date: 21.01.2018.

Tabla: A.
Students of
Daffodil International University, Dhanmondi,Dhaka.
Department of Electrical & Electronic Engineering
for
Industrial Internship at APSCL.
(Total Duration : 30/01/2018 – 13/02/2018)

Sl.No.	Student's Name	ID No.	Remarks
1.	Mohitul Islam	133-33-1705	Cell: 01674331077
2.	Md. Rakibul Islam	141-33-1810	Cell: 01726416928
3.	Sojib Mohammad Raju	141-33-1808	Cell: 01951287802
4.	Md.Anisur Rahman	142-33-1956	Cell: 01969876257

Table: B. Industrial Internship Schedule:
Duration : Total Duration : 30/01/2018 – 13/02/2018
(Daily:08:00Hr.-16:00Hr./Break:13:00Hr.-14:00Hr./Friday & Govt. Holiday:Closed.)

Student's Name	Date	Operation Circle	Electrical Maintenance Circle
1.Mohitul Islam 2.Md.Rakibul Islam 3.Sojib Mohammad Raju 4. Md.Anisur Rahman	30.01.2018. to 04.02.2018.	GEPP 30-31.01.2018(Operation) 01-04.02.2018(Electl.)	———
	05.02.2018. to 07.02.2018.	———	I&C/Auto Control Division (Opn.:05.02/ I&C:Bl.-A:06.02,Bl.-B.07.02
	08.02.2017. to 10.02.2018.	———	Generator Division
	11.02.2017. to 13.02.2018.	-------	Sub-station Division

As directed,

21.1.2018

(Shamim Ahmed)
Executive Engineer (HRD)
Ashuganj Power Station Company Limited .

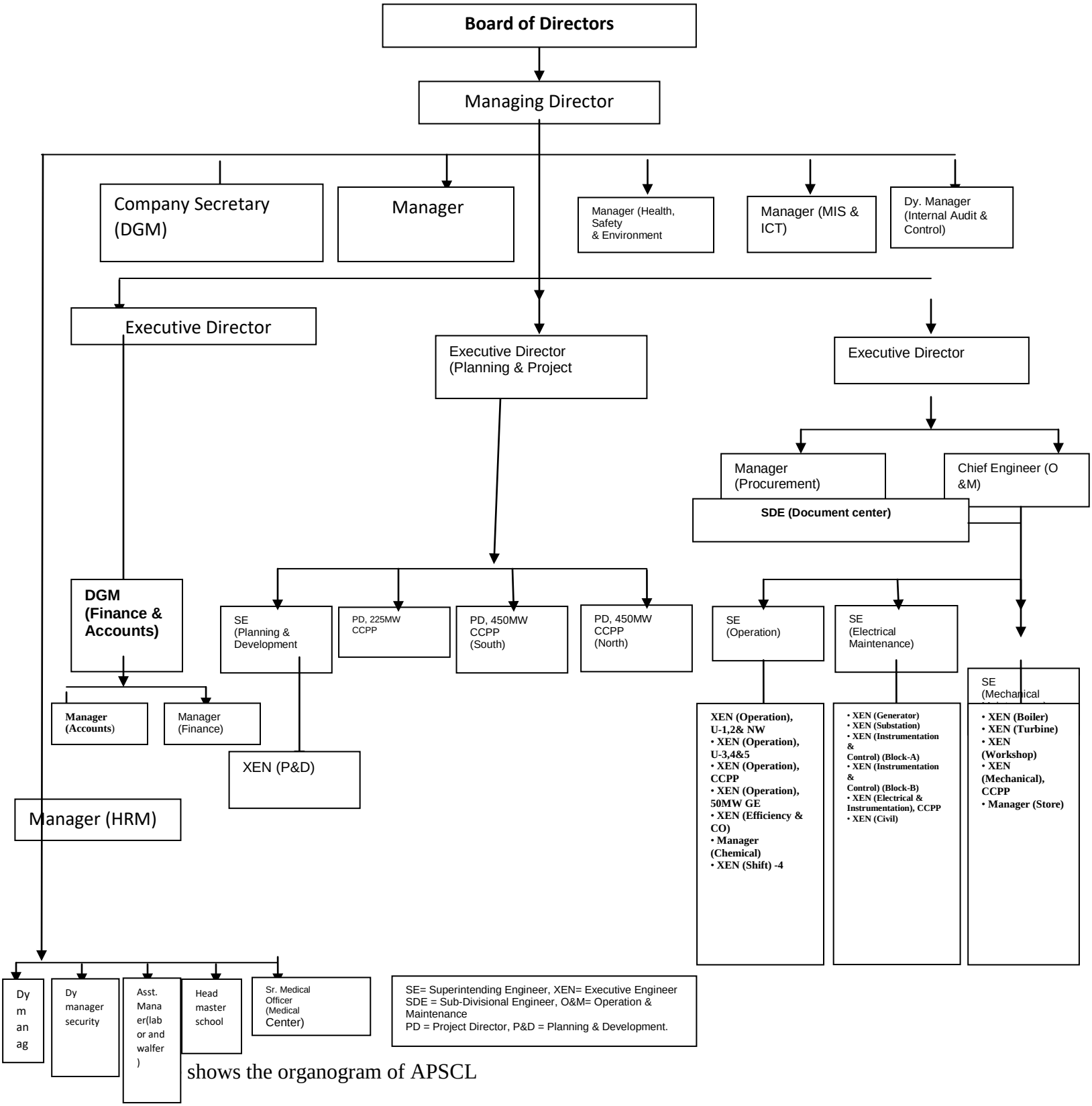
Copy to :-
1. Managing Director, APSCL.
2. Executive Director(Engg.), APSCL.
3. Superintending Engineer (Electrical/Operation), APSCL.
4. Executive Engineer/Manager ( ), APSCL.
5. Office Copy.

APPENDIX- B

laicnaniF statement of APSCl

	2016-17	2015-16	2014-15	2013-14	2012-13
Operating Performance					
Net Generation in Kwh	**6,431,716,061**	4,393,395,192	3,985,518,888	3,708,939,994	4,243,123,911
Revenue	**15,660,032,053**	8,413,064,246	7,094,702,639	6,971,021,960	7,537,809,811
Cost of Sales	**9,634,141,942**	6,957,617,482	5,858,336,963	5,573,109,110	5,860,299,920
Gross Profit	**6,025,890,111**	1,455,446,764	1,236,365,676	1,397,912,850	1,677,509,891
Operating Profit	**5,040,595,293**	717,907,435	552,855,273	773,142,674	1,158,209,320
Net Profit	**1,507,187,203**	240,617,081	367,634,407	681,179,955	718,594,879
Financial Position					
Total Asset	**98,108,867,184**	90,719,006,926	77,516,624,833	55,122,428,169	43,264,051,182
Total Liability	**80,515,384,555**	74,533,486,499	61,538,646,486	39,479,009,230	29,358,999,999
Total Equity	**17,593,482,629**	16,185,520,427	15,977,978,347	15,643,418,939	13,905,051,184
Net Fixed Asset	**16,343,387,814**	18,071,893,749	19,839,586,457	21,586,111,577	16,778,318,947
Current Asset	**10,458,718,872**	7,638,066,633	5,083,144,790	4,455,070,967	6,208,071,774
Current Liability	**6,593,031,853**	2,327,370,864	2,116,362,792	1,812,000,162	2,895,942,252
Financial Ratios					
Current Ratio	**1.59:1**	3.28:1	2.40:1	2.46:1	2.03:1
Gross Profit Margin	**38.48%**	17.30%	17.43%	20.05%	22.25%
Operating Profit Margin	**32.19%**	8.53%	7.79%	11.09%	15.37%
Net Profit Margin	**9.62%**	2.86%	5.18%	9.77%	9.53%
Return on Net Fixed Assets	**9.22%**	1.33%	1.85%	3.16%	4.28%
Return on Equity	**8.57%**	1.49%	2.30%	4.35%	5.17%
Debt Equity Ratio	**3.62**	3.83	3.08	1.75	1.15
Debt Service Coverage	**1.47**	2.18	3.5	3.67	3.82
Average Collection Periods in Months	**2.58**	4.03	4.26	6.04	6

APPENDIX- C



shows the organogram of APSCL