INTERNSHIP REPORT

ON

ASHUGANJ POWER STATION COMPANY LTD.

By

Faisal Md. Jiaur Rahman: 2007-2-80-031
Biddut Ranjan Sarker : 2007-2-80-016
Raktim Debnath : 2007-2-80-035

Submitted to the
Department of Electrical and Electronic Engineering
Faculty of Sciences and Engineering
East West University
In partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering
(B.Sc in EEE)

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Approved By

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Approval Letter

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Memo no. APSCL/MD/Trg.-10/2011/718 Date-14/05/2011

TO WHOM IT MAY CONCERN

This is to certify that Biddut Ranjan Sarker, SID 2007-2-80-016, Raktim Debnath, SID 2007-2-80-035 , Sharmin Kader, SID 2007-3-80-010, Sheikh Sakil Ahmed, SID 2008-1-80-025, Md. Abed Hossain , SID 2008-1-80-050 have successfully completed their internship from Ashuganj Power Station Company Ltd. (APSCL) from 2nd May to 14th May 2011. They have completed 100 hours of their internship on Power Generation, Transmission, Distribution and protection system of the equipments of APSCL. During the tenure of their training with us all the students put their best effort to comprehend the overall system of POWER STATION.

The undersigned on behalf of Ashuganj Power Station Company Ltd. (APSCL), recommending this work as the fulfillment of the requirements of EEE 499 (Industrial Training) of The East West University, Dhaka.

I wish their success in life.

14.5.2011

Engr. Md. Nurul Alam
Managing Director
APSCL

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Memo no. APSCL/MD/Trg.-10/2011/719 Date-14/05/2011

TO WHOM IT MAY CONCERN

This is to certify that Anik Das , SID 2008-1-80-028, Md. Maidul Islam, SID 2008-1-80-030, Rajesh Mondal, SID 2008-1-80-065, Kazi Shihab Hossain, SID 2008-1-80-062, Tanvir Ahmed, SID 2008-1-80-071, Faisal Md. Jiaur Rahman, SID 2007-2-80-031 have successfully completed their internship from Ashuganj Power Station Company Ltd. (APSCL) from 2nd May to 14th May 2011. They have completed 100 hours of their internship on Power Generation, Transmission, Distribution and protection system of the equipments of APSCL. During the tenure of their training with us all the students put their best effort to comprehend the overall system of POWER STATION.

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14/5/11

Engr. A.K.M Yaqub
Manager (generator division)
APSCL

Acknowledgment

First of all we would like to thank Engr. Md. Nurul Alam, Managing Director APSCL, Engr. Md. A.K.M Yaqub, our Superintendent Engineer and the Manager (Generator) of APSCL Ltd. for allowing us to do the internship and work in their team.

We would also like to thank our advisor Khondker Zakir Ahmed, Senior Lecturer, S. M. Shahriar Rashid, Research Lecturer, Department of Electrical & Electronic Engineering, East West University, Bangladesh.

We would also like to mention the name of Dr. Anisul Haque, Chairperson & Professor of the Department of Electrical & Electronic Engineering and Dr. Khairul Alam, Associate Professor, Department of Electrical & Electronic Engineering, Bangladesh for being so kind during the period of our internship. We also would like to thank Engr. Md. Rokan Mia, Senior Engineer (Generator & Switchgear Protection); Engr. Md. Monirujjaman, Senior Engineer(Generator & Switchgear Protection.), Engr. Nur Mohammed, Manager, Sub-Station, Engr. Md. Sahid Ullah, Assistant Engineer(Sub Station), Engr. Md. Azizur Rahman, Senior Engineer(Combine Cycle Power Plant), Engr. Fazle Abed, Junior Engineer, Control Room, Engr. Nur Mohammed, Manager, Sub-Station who had given us appointment from their precious time to collect related data of our report and also helped us to understand many related matters.

Executive Summary

Power sector is very important and sensitive side for any county for its industrial thus economical development. But, from the beginning of Bangladesh, this country is facing numerous problems in power sector. Among them the main problem is lack of generation of power. Day after day the demand is increasing but the generation of power is not increased so much. As a result, load shedding is occurring frequently. Power system is now dependent on weather. If temperature is high then load shedding occurs frequently. This is the situation when only 49% people are under electricity facility. New industries and households are not getting electric connection because of small power production. In the history of Bangladesh maximum generation of electricity in one day is 5125 MW [1]. But the demand of power is more than 6000 MW according to Bangladesh power development board (BPDB) and the actual demand is near about 8000 MW [2]. In this situation development in power sector is urgent. In this field Ashuganj power station Company limited played an important role in generation of power from 1964. Now it is the second largest power company in Bangladesh. The company is taken numerous development program for increase its generation which is the demand of time.

Our internship in APSCL (Ashuganj Power Station Company Limited), found the generation and distribution on the practical field of power sector. Through this internship we got the opportunity to work as a member of a team which was involved in Generator section, transformer section, steam turbine, Gas turbine and combine cycle power plant. The generation of electricity is one of the most complex processes in the world. After a lot of steps completion we generate it and supply it to the grid.

We gathered some experience in generator protection. We also had some experience to control a largest power plant working in the control room with the help of our superintendent engineer. On the complication of this internship we can relate the practical experience with the theoretical experience in power sector. In our internship we have gathered lots of knowledge about many real life problems.

Schedule

Date	Division	Working Period	Total time	Mentor
02-05-2011	Different parts of generator and back-up system (battery) of generator	8am to 5pm	8 hours	Md.Rokon Mia Senior Engineer
03-05-2011	Generator protection	8am to 5pm	8 hours	Md.Kamruzzaman Senior Engineer
04-05-2011	Control system of Generator and different control panel	8am to 5pm	8 hours	Md.Rokon Mia Senior Engineer
05-05-2011	Excitation and cooling system of generator	8am to 5pm	8 hours	Md.Kamruzzaman Senior Engineer
06-05-2011	Filter house and Turbine	8am to 1pm	5 hours	Md.Rokon Mia Senior Engineer
07-05-2011	Water reservation and treatment	8am to 5pm	8 hours	Md.Rokon Mia Senior Engineer
08-05-2011	Single hand diagram of a substation, overview on the substation	8am to 5pm	8 hours	Md.Shahidullah Assistant Engineer
09-05-2011	Transformers(step-up, step-down, tap changer) and circuit breakers(CT,PT)	8am to 5pm	8 hours	Md.Shahidullah Assistant Engineer
10-05-2011	Control system of a substation and battery back-up system	8am to 5pm	8 hours	Nur Mohammad Manager
11-05-2011	Single line diagram discussion and overview of gas turbine	8am to 1pm	5 hours	Md.Fazle Hassan Senior Engineer
	Fuel system, cooling system, lubrication system of gas turbine	2pm to 5pm	3 hours	Md.Azizur Rahman Assistant Engineer
12-05-2011	Excitation and process explanation.	8am to 1pm	5 hours	Md.Fazle Hassan Senior Engineer
	Generator protection and subsidiary System	2pm to 5pm	3 hours	Md.Azizur Rahman Assistant Engineer
13-05-2011	Sketch of combined Cycle plant, Pump used for supplying water, Control System for gas and combined cycle.	8am to 5pm	8 hours	Md.Azizur Rahman Assistant Engineer
14-05-2011	Combined cycle and turbine	8am to 5pm	8 hours	Md.Azizur Rahman Assistant Engineer

We worked at Ashuganj Power Station Company Limited from 2'nd May to 14'Th May, 2011. Total time that we worked at APSCL is 101 hours.

Table of Content

List of Figures

List of Tables

CHAPTER-01

1.1. Introduction

Developing country like Bangladesh it has become a great challenge to provide continuous supply of electricity. In our country presently only 49% of the total populations have access to electricity, which is very insufficient. Bangladesh government has given highest priority in the Power Sector development and is committed to make electricity available to all by 2021.The main reason for the power crisis is the shortage of supply and increasing the amount of demand day by day. That is why demand is never meet by supply. At present the maximum generation of electricity is around 5000 MW, where the actual demand is near about 8000 MW. Because of this huge gap between demand and supply, it is too much difficult to maintain the continuous supply of electricity in our country.

In this circumstance Ashuganj Power Station Limited (APSCL) is playing an important role in power sector of Bangladesh. From 1964 APSCL is supplying power to the national grid. For keeping balance with the increasing demand APSCL has been taken several programs for increased its production. For continuous power supply in national grid APSCL is known "Elite power station" by BPDB. Thus APSCL is contributing in the development process of Bangladesh.

1.2. Company Profile

Ashuganj Power Station is the second largest power station in Bangladesh. At present the total capacity of its 8 units is 642 MW. Ashuganj Power Station fulfills about 15% of loads through the country.

Vision

"To generate electric power and dispatch same through transmission line of PGCB Ltd. and ultimately to BPDB and to utilize available resources and capacity so that it can contribute towards the national economy through increasing generation of power aiming at maximization of net worth of the Company".

Mission

"To ensure long-term uninterrupted supply of quality power to the consumers in future"[3].

Objective

"To carry out the business of electric power generation and supply and sell of electricity thus produced to Bangladesh Power Development Board through National Grid for the purposes of meeting the need of electric power, and for all other purposes for which electric energy can be utilized".[3]

2.2.1 Background of Ashuganj Power Station

In 1966 the then government decided to setup a power station in Ashuganj. Ashuganj is situated near Titas Gas Field and at the bank of the river Meghna. So it was the most favorable place for power station because of availability of natural resources for power generation. For this purpose about 311 acres lands at the 1 kilometer north-east away from the Meghna Railway Bridge was acquired.

In the same year with the financial assistance of German Government the establishment work of two units each of 64 MW (Unit 1 & Unit 2) started. These two units were commissioned in July 1970. M/S BBC (Germany) and M/S Babcock & Wilcox (Germany) supplied the turbo-generator and boiler equipment. These two units played an important role in post-liberation war economic development in Bangladesh.

To face the growing requirements for power in the country- Government of Bangladesh decided to setup another two units (Unit 3 & Unit 4) each of 150 MW capacities in Ashuganj. IDA, KfW (Germany), ADB, Kuwait and OPEC provided the financial assistance for this project. Contracts had been made for supplying and installation of turbo-generator, boiler and other main equipments for these two units with M/S BBC (Germany), M/S IHI (Japan), M/S KDC (Korea) and M/S PCC (Korea).

After the agreements signing with the contractors, government found that another unit of 150 MW can be established from the left over funds by the donors. With the consent from the donors, Government decided to setup another 150 MW unit (Unit 5).

The work for installation of Unit 3 & 4 was started in 1984 and Unit 5 in 1985. Unit 3, Unit 4 and Unit 5 were commissioned in December 1986, May 1987 and March 1988 respectively.

During the planning of installation of Unit 3 & 4 it was decided to install a Combined Cycle Power Plant by financial assistance of British Government. According to that decision, works of two gas turbine units (GT1 & GT2) of 56 MW each and one steam turbine unit (ST1) of capacity 34 MW (with waste heat recovery Boiler) had been started. GT1, GT2 and CCST were commissioned in 1982, 1984 and 1986 respectively. [3]

1.2.2. Formation of the Company

As a part of the Power Sector Development & Reform Program of Government of Bangladesh (GOB), APSCL has been incorporated under the Companies Act 1994. APSCL has been registered in the office of the Register of the Joint Stock Companies & Firms of Bangladesh on 28 June 2000. Through a Provisional Vendor's Agreement APSCL Management has taken over all assets & liabilities of APS Complex consisting of the following assets and liabilities:

Total Assets: Tk. 1605, 76, 00,000
Total Liabilities: Tk. 1486, 10, 00,000
Equity of BPDB: Tk. 119, 66, 00,000

The Registration No. of APSCL is 40630 (2328)/2000 dated 28.06.2000. According to the Articles of Association of the company, 51% of total shares is held by BPDB and the rest 49% is distributed among Ministry of Finance, Ministry of Planning, Power Division, MOPEMR & Energy Division, MOPEMR of GOB. [4]

Authorized Capital: Tk. 1500, 00, 00,000
Paid up Capital: Tk. 10, 00,000

1.2.3. Number of Generator and their Production Capacity:

Sl. No.	PARTICULARS	GT# 1	GT# 2	ST(cc)	UNIT#1	UNIT#2	UNIT#3	UNIT#4	UNIT#5
1	Installed Capacity (Mw)	56	56	34	64	64	150	150	150
2	Present Contracted Capacity (MW)	40	40	20	64	64	102	140	140
3	Date of Commissioning	15/11/82	23/03/86	28/03/84	17/08/70	8/7/70	17-12-86	4/5/87	21/03/88
4	Cost of fuel per unit Gen.(TK)	1.30	1.30	0.00	0.93	0.87	0.90	0.90	0.79

1.1: Number of Generator and their Production Capacity in APSCL [3]

1.2.4 Present Situation of Generation

	Particulars	GT- 1	GT- 2	ST(cc)	UNIT - 1	UNIT - 2	UNIT - 3	UNIT - 4	UNIT -5
1	Model & Capacity of Turbo-Generator	GEC 69.6Mva 13.8 Kv	GEC 69.6 Mva 13.8 Kv	GEC 43 Mva 13.8 kv	BBC Germany 80 Mva 11.0 kv	BBC Germany 80 Mva 11.0 kv	BBC Germany 190 Mva 15.75 kv	BBC Germany 190 Mva 15.75 kv	ABB Germany 190 Mva 15.75 kv
2	Installed Capacity (Mw)	56	56	34	64	64	150	150	150
3	Present De-rated Capacity, MW	40	40	18	64	64	105	140	140
4	Date of Commiss-ioning	15/11/82	23/03/86	28/03/84	17/08/70	8/7/1970	17/12/86	4/5/1987	21/03/88
5	Total hours run since installation	150,516	114,768	87,034	231,011	204,371	186,821	183,865	164,933
6	Total Energy Generation to date , Gwh	5,936.68	6607.73	1,734.07	10,575. 44	9,744.33	22,328. 50	21,306. 43	29,767. 39
7	Plant Factor %, 2010	71.77	85.52	31.05	56.15	86.03	81.74	53.45	83.77
8	Availability Factor %, 2010	82.69	96.03	29.54	68.10	95.65	94.5	64.06	95.54
9	Station Thermal Efficiency %	20	20	28	30	31	31	36	36

1.2: Present Situation of Generation from the generators of APSCL. [3]

1.2.5 Company at a Glance

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: 724 MW
Total number of plants: 3
Total Number of Units: 8
Plant 1: Thermal Power Plant (TPP); Two Steam Units of 64MW- Unit No. 1 & 2 each-commissioned in 1970.
Plant 2: Combined Cycle Power Plant (CCPP); Gas Turbine Units-GT1 and GT2 of capacity 56MW each-commissioned in 1982 and 1986 respectively. One Steam Turbine (ST) of capacity 34MW with waste heat recovery Boiler commissioned in 1984.
Plant 3: Thermal Power Plant (TPP); Unit No. 3 of 150MW capacity was commissioned in 1986. Unit No. 4 of 150MW capacity was commissioned in 1987. Unit No. 5 of 150MW capacity was commissioned in 1988.
Fuel used: Natural Gas Supplied by Titas Gas Transmission & Distribution Co. Ltd., Bangladesh [5].

1.3 Objective of the Internship

The objective of this internship is to gather practical knowledge and experience and implementation of theoretical study in real world. To this regard this report is contemplating the knowledge and experience accumulated from the internship program. With the set guidelines by the EEE Department of East West University and our internship Supervisor, this report comprises of an organization part and a project part. The prime objective of the organization part is to present a background and introduction of APSCL. And the project part deals with the operation of Steam, Gas, Combine Cycle and Substation of APSCL.

1.4 Scope and Source of Data Collection

The scope of organization part covers the organizational structure, background, objectives, generation of power from steam and gas, combined cycle power plant, protection, maintenance, substation as a whole and especially this report focuses on generation process and protection of Ashuganj Power Station Company Ltd.

For prepare this report mostly primary information is used. However, secondary sources are also used in some places.

Primary Information: The primary source of information is hand on experience that we achieved in APSCL. Notes, lectures, sketches, diagrams, templates that are found in APSCL are the primary source of information.

Secondary Information: The secondary source of information is based on Internet Searching, Reference Books etc.

CHAPTER-02

STEAM POWER PLANT

Date: 2.05.2011 to 7.05.2011
Supervisor: Senior Eng. Md.Rokon Mia, steam power plant and control system.
Senior Eng. Md.Kamruzzaman, steam power plant and Protection Section.

2.1 Introduction

Ashuganj Power Station Company limited (APSCL) uses gas as fuel to burn and to generate the heat. This heat is used to heat water and create steam. Then the steam rises through a turbine which transfers the thermal energy of the steam to mechanical energy. This turbine is attached to a generator and the rotating of the turbine leads to the generation of electricity in the generator. Different section of the steam power plant and their working principle are discussed in this chapter.

APSCL have five units and five generators in the steam power plant. Their capacities are given below:-

Units	Generators	Production
1-2	2	2*64MW = 128 MW
3-4-5	3	3*150 MW= 450 MW

Table-2.1: Production Capacity According to the Units

2.2 Working Principle of Steam Power Plant

In the APSCL Steam Power Plant, gas is used as a fuel for producing the steam by concluding the some steps in the boiler section. After ending the boiler section we get heat energy. The heat energy is used to run the turbine. After finishing some steps in the turbine section, we get the mechanical energy. Turbine is coupled with generator. So mechanical energy goes to the generator and generator produce electrical energy. The block diagram of Power Generation Process in the steam power plant is given bellow:-

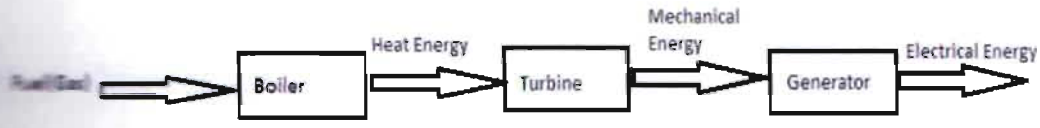

Figure 2.1: Power Generation Process of steam power plant

All of these functions of the boiler, turbine and generator are discused below-

2.2.1 Boiler

There are five boiler in the APSCL of steam power plant. Here in the boiler section we produce the steam and it is used to run the turbine. Among five boilers, one boiler is shown bellow:-

Figure 2.2: Boiler (unit-3 and its capacity is 150MW)

2.2.2 Water Purifying

Figure 2.3: 2 stages water purifying basin (is used to reduce the dust from the river water)

Water comes from the river in the water purifying basin directly. This water is purified in two stages in the basin. Next this purified water goes to the water filter house with the help of pipe. The next section, we discuss this purified water is filtered.

2.2.3 Water Filter House

Here high purity feed water reduces the use of boiler chemicals because boiler blow down is required less frequently with clean feed. This also results in lower fuel cost. Scale buildup is reduced due to a smaller absorption of impurities in the boiler feed water which polluted heat transfer surfaces. The lower level of impurities not only reduces corrosion rates in the boiler, but also reduces the erosion of the turbine blades. In the APSCL water filtering systems are designed to produce high purity feed water from many different water sources. For special applications, these systems can be combined with ion exchangers for more polishing of the feed water and de-gasifies to lower the oxygen content of the feed water. Next this filtered water is sent in the water treatment tank to ensure the water as much possible fresh that produced the steam qualityful.

2.2.4 Water Treatment Tank

Feed water for boilers needs to be as pure as possible with a minimum of reasonable solids and dissolved impurities which cause corrosion, foaming and water carryover. Various chemical treatments have been employed over the years in the APSCL, the most successful being De-hydronization treatment. This contains a foam modifier that acts as a filtering blanket on the surface of the water that considerably purifies steam quality.

2.2.5 De-Hydronization

The De-Hydronization process is about the decreasing pressure and increasing temperature. In general process temperature will increase with decreasing carbon number to maintain conversion at a pressure. Actually dehydronization means:-

> Recovering heat of condensation normally lost during separation of the various components of the dehydrogenation reaction overflow, especially of ethyl benzene from styrene, without need or use of a compressor.
>
> And using such heat to vaporize dissolved feed water mixture of ethyl benzene and intensity of water that is introduced into the dehydrogenation reactor, probably at about atmospheric pressure, thereby obviating the need to use steam to vaporize the liquid ethyl benzene feed and also enabling much of the thinner steam needed as sensible heat for the dehydrogenation reaction to be generated from water.

When these dehydrate water is fully fit to get the heat then this water is sent to the water tube and this water is heated at 2800° C to 3200° C. How the water tube is worked that is discussed in the next section.

2.2.6 Water Tube

Steam power plant of APSCL is engaged to offer a quality range of Water tube boiler that is used for high pressure boilers. In the Water tube boiler the water is circulated in tubes that is heated externally by the fire. The fuel is burned inside the furnace, creating hot gas which heats water in the steam generating tubes. The range of water boilers are easy to install and take apart and are highly efficient in the APSCL.

Some of the outstanding features of Water tube boiler in the Ashuganj Power Station are given below:-

1. Boilers drum design.
2. Covering wall furnace construction.
3. Total Petroleum Hydrocarbons (5 TPH to 100 TPH) that is 10.5 to 87 kgs/cm
4. Steam temperature up to 2800° C to 3200° C.

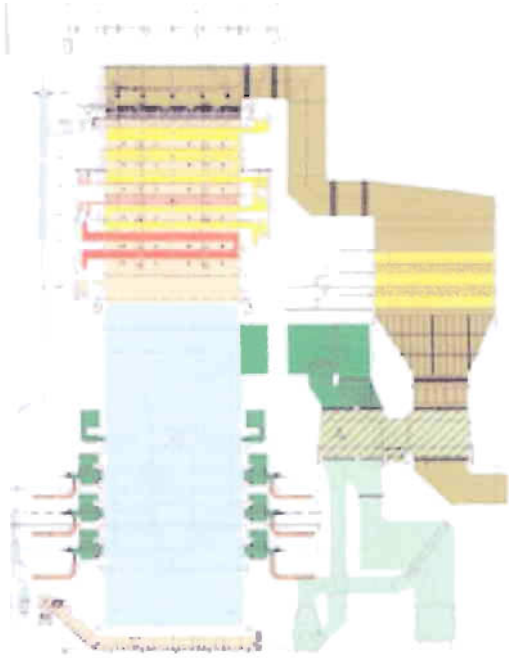

Figure 2.4: water tube boiler

2.2.7 Ash Pit

Exhausts reheat space of the main combustion chamber, where temperature reaches about 2800°c serves also as an ash pit that means ash pit is added in the steel bottom of the burning chamber ceramic and additionally covered by unmanageable concrete in the inside of the boiler.

2.2.8 Furnace

We know that the furnace is a device used for heating. The furnace can also refer to a direct fired heater, used in boiler for providing heat to chemical reaction. The heat energy to fuel a furnace is supplied directly by fuel combustion, by electricity through induction heating in induction furnaces.

2.2.9 Pressure Gauge

Instrumentation on a boiler is very important to help trained workers evaluate boiler performance. In the APSCL, Most of the data is measured by pressure gauges which are given below:-

Pressure gauges are used to determine:

1. Steam Pressure
2. Feed water Pressure
3. Gas Pressure

Figure 2.5: Meter for measuring the different types of pressure

Pressure may be recorded as gauge pressure or as absolute pressure. Gauge pressure is the pressure above that of the atmosphere. Absolute pressure is the pressure above zero pressure, equal to gauge pressure plus the atmospheric pressure. At sea level, atmospheric pressure is 14.7 psi (which means that a column of air one square inch in area rising from the Earth's atmosphere to space weighs 14.7 pounds.). Pressure gauges include many pressure measurement devices including bellows, Bourdon tubes, capsule elements and diaphragm element gages in the APSCL of boiler section.

2.2.10 Safety Tank

Many steam engines possess boilers that are pressure vessels that contain a great deal of potential energy. Steam explosions caused great loss of life in the past. While variations in standards may exist in different countries, stringent legal, testing, training and certification is applied to try to minimize or prevent such occurrences.

Failure modes include in the APSCL:-

1. Over pressurization of the boiler.
2. Insufficient water in the boiler causing overheating and vessel failure.
3. Pressure vessel failure of the boiler due to inadequate construction or maintenance.

2.2.11 Feed Water Pump

The engineer of the APSCL said that "a boiler feed water pump is a specific type of pump used to pump feed water into a steam boiler". The water may be freshly supplied or returning condensate produced as a result of the condensation of the steam produced by the boiler. These pumps are normally high pressure units that take suction from a condensate return system. Feed water pumps range in size up to many horsepower and the electric motor is usually separated from the pump body by some form of mechanical coupling. The force of the water into the boiler, the pump must generate sufficient pressure to overcome the steam pressure developed by the boiler. This process is usually able through the use of a centrifugal pump in the steam power plant of APSCL. In the APSCL the Feed water pumps sometimes run intermittently and are controlled by a float and it detects a lowered liquid level in the boiler. The pump then runs until the level of liquid in the boiler is largely increased. As liquid lowers to the trigger point of the first stage, the pump is activated. If the liquid continues to drop (perhaps because the pump has failed, its supply has been cut off or exhausted and its discharge is blocked), the second stage will be triggered. This stage may switch off the boiler equipment (preventing the boiler from running dry and overheating) trigger an alarm system in this plant.

2.2.12 Condenser

Condenser is used to make water distilled. Actually distilled water is condensed water vapor. In capturing a portion of the steam from the boiler and collecting it as distilled water. The working procedure is discussed below:-

Working principle of condenser

Condensing boilers are highly efficient boilers that have much lower fuel and running costs than conventional boilers. Condensing of the boiler is offered to real benefits by:-

1. Reducing carbon dioxide emissions and helping to combat global warming.
2. Improving household efficiency thus reducing fuel bills.

The main function of the condenser is to recover of the waste heat as much as possible which is normally rejected to the atmosphere from the flue of a conventional (none condensing) boiler. This is achieved by using an extra large heat exchanger or sometimes two heat exchangers within the boiler which maximizes heat transfer from the burner as well as recovering useful heat which would normally be lost with the flue gases. When in condensing mode (as condensing boilers do not condense all the time) the flue gases give up their latent heat which is recovered by the heat exchanger within the boiler and used to preheat the return water. As a result the temperature of the gases leaving the flue of a condensing boiler is typically 50-60°C compared with 120-180°C in a current none condensing boiler. At the same time an amount of condensate water is produced. A condensing boiler will always have a better operating efficiency than a conventional non condensing one, due to its larger and more efficient heat exchanger. The highest efficiency numbers occur when very cold return temperatures are combined with the ability of the boiler to reduce its firing rate by modulating or staging. Under optimum conditions, reduced firing rate efficiency of condensing boilers can exceed 95% in the APSCL.

2.3 Turbine

A turbine is a rotary engine that extracts energy from a fluid flow and converts it into useful work. Turbines of the steam generating plant have one moving part, a rotor assembly, which is a shaft with blades attached. Moving fluid acts on the blades so that they move and impart rotational energy to the rotor. The steam power plant of APSCL has a casing around the blades that contains and controls the working fluid.

2.3.1 **Working Principle of Turbine**

The heat energy is used to run the high pressure turbine (HPT). Next low pressure turbine (LPT) and the intermediate pressure turbine (IPT) are run by the help of high pressure turbine. Low pressure turbine and intermediate pressure turbine are coupled with the generator rotor. Next generator rotor is run by the help of the pressure of LPT and IPT. At the end of this stage mechanical energy is produced. This energy is used to run the generator and the output of the generator gives us electrical energy. We get 6.6kv power from the generator output. How the low pressure turbine, intermediate pressure turbine and high pressure turbine work? Discussed below:-

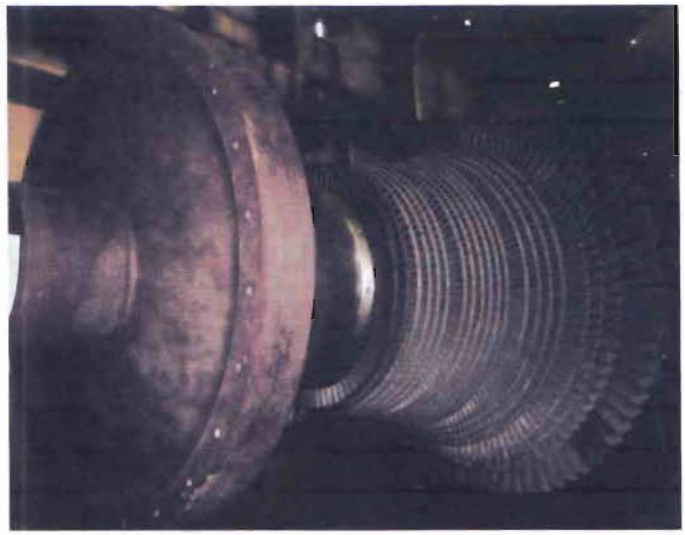

Figure 2.6: High Pressure Turbine (is used to run LPT and IPT)

Turbine section of the APSCL, reaction turbine is used as a low pressure turbine and impulse turbine is used as a high pressure turbine. The reaction turbine and intermediate pressure turbine help the impulse turbine to run the rotor blades themselves are arranged to form convergent nozzles. This type of turbine makes use of the feedback force produced as the steam accelerates through the nozzles formed by the rotor. Steam is directed onto the rotor by the fixed vanes of the stator. It leaves the stator as a jet that fills the entire circumference of the rotor. The steam then change direction and increases its speed relative to the speed of the blades. A pressure drop occurs across both the stator and the rotor, with steam accelerating through the stator and decelerating through the rotor, with no net change in steam velocity across the stage but with a decrease in both pressure and temperature, reflecting the work performed in the driving of the rotor.

2.3.2 Turbine Efficiency

To maximize turbine efficiency the steam is expanded, doing work, in a number of stages. These stages are characterized by how the energy is extracted from them and are known as either impulse or reaction turbines. Most steam turbines use a mixture of the reaction and impulse designs: each stage behaves as either one or the other, but the overall turbine uses both.

2.4 Equipments of Generator

The Nameplate Data of Generator-3 is given below-

	Rated speed	3000 rpm
	Frequency	50 Hz
	Voltage	15750 V 5
	Armature current	6965 A3~ INS.class F [class F- 165°c]
	Rotor weight	42.31 ton
	Stator weight	176.0 ton
	Excitation voltage	323 V(at full load) 210 V (at no load)
	Over speed	3600 rpm
	Power factor	0.8
	Output	190000 KVA
	Cooling air inlet	43°c
	Number of pole	2
	Direction of rotation clock wise from driven and energy constant= 1.5 KWs/KVA	

Table-2.2: The Nameplate Data of Generator-3 (which is given by the Brown Boveri Company)

Figure 2.7: Generator (Brown Boveri Company) of APSCL

2.4.1 De Humidity Fire

It is used for the absorbing of moisture when generator will be off. If moisture is inside the generator then the generator will be faulted. The absorb body of dehumidifier will absorbed the moisture. Here automation technique has been given inside the dehumidifier to absorb the moisture. The steam is going inside to the dehumidifier and the moisture is absorbed. The outside steam also goes inside and it will go outside after absorbing the moisture. The dehumidifier is rotated slowly.

2.4.2. Brush Gear

In the APSCL the Carbon brushes are used in the generator brush gear and engineer of the power plant said that carbon causes far less damage to the commutator segments. The higher resistance of carbon results in fewer problems from the dust collecting on the commutator segments. Also the engineer of the generator division said that Carbon brushes are better for high voltage and low current. Carbon only carries 40 to 70 amperes per square inch. The higher resistance of carbon also results in a greater voltage drop of 0.8 to 1.0 volts per contact, or 1.6 to 2.0 volts across the commutator. Actually carbon brush is used as brush for cleaning the dust.

Figure 2.8: Carbon Brush is used to remove the dust

2.4.3 Jacking Oil Pump

A jacking oil pump also called a lift pump is commonly used on rotor shafts of steam driven turbine generators to provide cooling of the shaft and eliminate rotor distortion caused by sags due to weight. The jacking oil pump uses high pressure oil supplied at the bearing journals to initiate an oil film and lift the shaft off its bearings. The rotor can then be put on a turning gear and rotated slowly to create cooling and roll out any distortions caused by the weight of the shaft while at rest. It also helps to maintain the oil between shaft and the bearing till the rotor speed is adequate enough to maintain the thickness and protects the shaft and bearing.

Figure 2.9: Jacking oil pump (is used to cool the shaft and eliminate rotor distortion)

2.5 Protection of Generator

In the APSCL steam power plant section; there are 15-20 generator protections. If there is any abnormal condition then the generator will be disconnected from the grid. The main protections are:

2.5.1 Over Current with Under Voltage protection

Over current through the line. It is passed through the current transformer and it will be given to the amplifier. If the amplifier negative input becomes higher than the positive input then the negative output will occur at the amplifier. If the amplifier's positive input becomes higher than the negative input then the negative output will occur at the amplifier. The relay will sense the over current then the circuit breaker will be tripped.

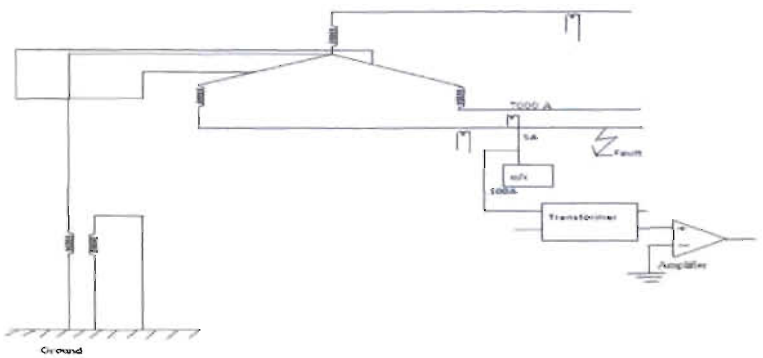

Figure 2.10: Over Current with under voltage Protection

2.5.2 Over Voltage protection

If the bus voltage is higher than the 15.75 KV (16KV) then the relay will operate. This overvoltage will be given to the potential transformer and the power transformer output will be given to the amplifier input 110V. Before giving the input a relay is used if the input voltage is become over 110V then the relay will be tripped.

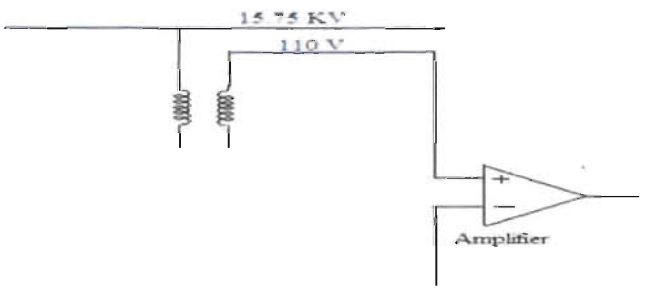

Figure 2.11: Over Voltage Protection for the generator

2.5.3 Generator Differential protection

Suppose 7000 A is the rated current and if the fault current is occurred then the fault current will flow in the rotor. Imagine 3500 A current is passing to the rotor so 3500 A current will pass through the line. This difference of current will sense the current transformer then the relay will trip. Here we need to multiply by the constant then we get the exact ratio. Here the multiplying factor is the current transformer ratio. In one zone there are 2 CB and one generator.

$I_r = \sum (I_U + I_A)$

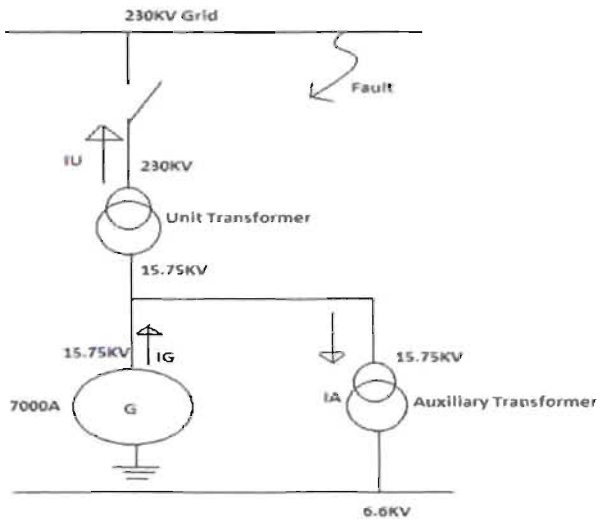

Figure 2.12: Generator Differential Protection

2.5.4 Negative Phase Sequence

The negative phase sequence is occurred when the fault is phase to ground. Then current will be increased but voltage will be decreased. If we analysis it we get-

1. Positive sequence
2. Negative sequence
3. Zero sequence

This is only possible when there is line to earth fault.

1. Positive phase sequence
2. Negative phase sequence

This is only possible when there is line to line fault.

When there is over current in one line then the negative phase sequence is occurred negative phase sequence is occurred due to over current. Main reason is that if the one phase current is higher than the negative phase sequences will occur.

2.5.5 Stator Earth Fault protection

When a ground fault occurs inside a generator, its protection system must be able to detect it and shut down the generator. This protection system has to be coordinated with the nearby fault clearing system in order to allow the external generator ground faults to be isolated by the circuit breakers. The generator ground fault protection system method is directly related with the grounding of the neutral. So, one must be aware that the schemes of the protection systems change depending on the grounding used, and some of the grounding methods cannot be used with some protection systems and vice versa.

Percentage phase differential protection

This device is able to detect most internal ground faults in the generator but if the maximum ground fault current is below the phase differential pick-up, the device will not be able to detect it. In these cases, a ground differential scheme may be needed. This protection is used for protection of the generator against phase to phase fault. It is based on the circulating current principle.

Ground differential protection

This device is defined as the one "that provides excellent security against disoperation for external faults while providing sensitive detection of internal ground faults". This device is able to detect ground faults to within 10% of the generator's neutral.

This protection is used for protection of the generator against phase to earth fault. It is based on the circulating current.

Instantaneous ground over current protection

It detects faults near the generator neutral and provides back-up protection for low magnitude external ground faults. This device is based in toroidal current transformer (this transformer is used for electrical measuring instruments and electrical protective devices. They are very useful in high power circuits where the current is large. That surrounds the generator phases and the neutral. This configuration permits to measure the ground current coming from the generator and the system and in this way, ground faults are detected.

2.5.6 Rotor Earth Fault

The flux will go inside of the rotor then flux will go outside at the middle point of the rotor. If the winding is slightly shorted to the rotor then the fault current will pass through the relay so the CB will trip. There are two types of rotor earth fault protection, like:-

Restricted Earth Fault

A Restricted Earth Fault (REF) means an earth fault from a restricted/localized zone of a circuit. The term Restricted earth fault protection method means not to sense any earth faults outside this restricted zone. REF is a type of "unit protection" applied to transformers or generators and is more sensitive than the method known as differential protection. An REF relay works by measuring the actual current flowing to earth from the frame of the unit. If that current exceeds a certain preset maximum value of milliamps (mA) then the relay will trip to cut off the power supply to the unit. Differential protection can also be used to protect the windings of a transformer by comparing the current in the power supply's neutral wire with the current in the phase wire, if the currents are equal then the differential protection relay will not operate, if there is a current imbalance then the differential protection relay operates. However, REF protection is also applied to transformers in order to detect ground faults on a given winding much more sensitively than differential protection can do.

Backup Earth Fault

Winding voltage is 10% high then the relay will not operate because adequate relay sensing current will not pass through the relay. If current is 10% high then the relay will sense. In the period of less than 10% of the winding voltage the winding differential will operate. If the restricted earth does not sense the backup earth fault will be sensed.
If there is any unbalanced in the three line phase sequence then the back earth fault will occurred. If the winding has become grounded then there will be high current will flow through the winding and result is that there will be huge amount of mechanical force will create in the stator. So it will burn out and fell down.

2.5.7 Over Frequency Protection

Over frequency results from the excess generation and it can easily be corrected by reduction in the power outputs with the help of the governor or manual control.

2.5.8 Under Frequency Protection

Under frequency occurs due to the overload. During an overload, generation capability of the generator increases and reduction in frequency occurs. The power system survives only if we drop the load so that the generator output becomes equal or greater than the connected load.

If the load increases, frequency will drop and load need to take away down to create the balance between the generator and the connected load. The rate at which frequency drops depend on the time, amount of overload and also on the load and generator variations as the frequency changes. It is not essential to remove the load first when refuse in frequency occurs. The setting of the under frequency relays based on the condition occurs and also depend upon the worst case possibilities. During the overload conditions, load shedding must occur before the operation of the under frequency relays. In other words load must be dropped before the generators are tripped.

There are some other protections in the generator section of APSCL. Like-

1. Magnetization fault
2. 230KV grid protection
3. Unbalanced loading protection
4. Definite/inverse time over excitation protection
5. Reverse power protection
6. Unit transformer protection
7. Unit auxiliary transformer protection

2.6 Cooling System of generator

Using the air, generator is cooled. Next air is cooled by the water in the APSCL.

2.6.1 Air cooling

Air cooling system is given in the generators of APSCL steam power plant. Actually when the generator is operating and producing electricity, it produces heat. As the heat increases, generator efficiencies decrease. As a result to solve this problem, the air cooling system is given in generators. This significantly reduces the high temperatures and thus improves the lifetime the generators.

2.6.2 Water Cooling

If the production rate of the generator is 300KVA, then water cooling can be used for this type of generator. The water cooling system in the APSCL generator division is-

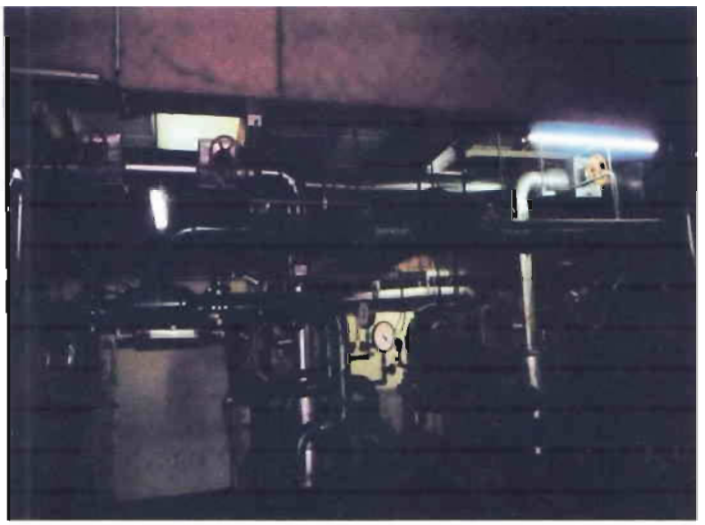

Figure 2.13: Water cooling system of generator

Actually the cooling medium is filled in a completely closed cycle system, and driven by the main circulating pump to take heat out from the cooling part. Electric three way valve can control cooling medium ratio that flows through air radiator according to coolant temperature. There is a voltage regulation system parallel with circulation line, it can maintain constant pressure in the cooling system and buffer cooling medium volume change of the water cooling system, and then ensure normal operation of the system.

2.6.3 Hydrogen Cooling

If the production rate of the generator is 200KVA, then Hydrogen cooling can be used for this type of generator. The Hydrogen cooling system in the APSCL generator division is-

A system for cooling hydrogen which is used for cooling an electric power generator, cooling of the hydrogen being affected by transfer of heat from hydrogen leaving the generator to cooling water extracted from a source which has a temperature determined by external conditions. The system is composed of an indirect heat exchanger for bringing cooling water into heat exchange communication with hydrogen leaving the generator and cooling water is supplied to the heat exchanger partially from the source and partially from cooling water leaving the heat exchanger. A temperature monitoring unit produces an indication of the temperature of the cooling water extracted from the source and a control unit is coupled to the temperature monitoring unit to cool the hydrogen to a desired temperature while maintaining a constant flow rate of cooling water into the heat exchanger. While small generators may be cooled by air drawn through filters at the inlet, larger units generally require special cooling arrangements. Hydrogen gas cooling, in an oil-sealed casing, is used because it has the highest known heat transfer coefficient of any gas and for its low viscosity which reduces wind age losses. This system requires special handling during start-up, with air in the generator enclosure first displaced by carbon dioxide before filling with hydrogen. This ensures that the highly flammable hydrogen does not mix with oxygen in the air. The hydrogen pressure inside the casing is maintained slightly higher than atmospheric pressure to avoid outside air ingress. The hydrogen must be sealed against outward leakage where the shaft emerges from the casing. Mechanical seals around the shaft are installed with a very small annular gap to avoid rubbing between the shaft and the seals. Seal oil is used to prevent the hydrogen gas leakage to atmosphere. Generally in the APSCL generator division also uses water cooling and Dematerialized water of low conductivity is used.

2.7 Battery Back-Up System

Battery is used to supply the power to the control room and also save the generator, if needed. The DC power is used in control system always. If the control system fails the control power must not fail. The electricity that is coming from the battery is produced due to the chemical energy is converted into electrical energy. For the backup purpose we use the battery. In this power plant they use two kinds of battery:-

1. Led acid
2. NICD battery

NICD battery is costly. The difference is that in led acid the sulfuric acid is used and in NICD battery the potassium hydrochloric acid is used. The rectifier is used to convert the DC to AC.

The rectifier is nothing just like battery charger in technical point of view it is called rectifier. The voltage of NICD is 1.2 V. for battery capacity we use AH (amp hour). If we connect the battery in parallel we are adding the capacity and if we connect the battery we are added the battery in series. For example, 10 hours the capacity is 50 AH. It means that 50A current will run the battery through 10 hours. There is a performance curve will be given by the manufacturer which will indicate that the battery will operate in which point. Initially there will be high amp of current will flow then afterwards it will become steady. After that it will be discharged. Then current will be constant to the battery to charge initially. The steady condition when the constant voltage will be given this condition is called the floating position for energy gaining. This floating condition can be changed if the product is same and the same material is used but the chemical reaction is changed. It charged in high voltage which is called booster. It will equalize the charge.

Figure 2.14: series connected battery (No of batteries: 184, Voltage level of each battery: 1.2v, Total voltage: 220v)

Figure 2.15: parallel connected battery (+24v to -24v, Used to increase the capacity of the series connected battery)

In the control room there are some mechanical works which are done for testing the battery:-

1. To clean the room
2. Connection test: this test is done for checking the connection of the battery. If there is any abnormal connection then it will be removed.
3. Breathing test: if there is any chemical reaction occurred inside then this test is done to remove the chemical reaction.
4. Liquid level test: the nickel cadmium is emerged in to the potassium hydrochloric acid. There is a maximum point and a minimum point inside the battery. It means that the nickel cadmium is emerged in between two points. If acid level is higher than the maximum level the breathing test will be needed. But the acid level cannot go under the minimum level. For this reason the specific cell is kept on observation.
5. Specific gravity test: The specific gravity is tested by the hand hydrometer of the acid. The specific gravity is in the range of 1180-1220 or 1.2 liter (compared to 1 liter water).
6. The cell voltage test

Here, 220 V rectifiers are used. One rectifier is redundant. It is the subordinate rectifier if one fails then the other rectifier will be operated. The battery is energized and discharged. When the constant voltage will be supplied then the floating condition will be occurred. If we want to boost the battery then the data will be stored and it has been charged by the automation inside the rectifier.

2.8 Control System

We observed the control room of steam power plant of unit-3, 4 which is given bellow:-

Figure 2.16: Control room of steam power plant of unit-3, 4

2.8.1 Control Functions of Generator

The automates all aspects of the turbine control, protection, start-up, and shutdown sequences. It interfaces directly to existing instruments. There are different types of controlling equipments,

1. Governing Steam Valve Control
2. Sequencing
3. Protection
4. Monitoring
5. HMI operator interface / data historian
6. Vibration Monitoring
7. Control interface to generator / mechanical drive
8. Remote Monitoring and Communications

The control software is built from a library of proven Functional Control Algorithm modules. This allows ICS to use standard governor code, ensure a high standard, proven software, and reduced commissioning time. Common Functional Control Algorithms for Steam Turbine control include,

1. Inlet Pressure Controller
2. Inlet Pressure Limiter
3. Single & Multiple Extraction Pressure Control
4. Extraction Pressure Control
5. Exhaust Pressure Control
6. Inlet / Extraction Valve Ratio Control

7. Turbine Speed Control
8. Generator load control
9. Generator load limit
10. Hot well Level Control
11. Generator Stator Temperature Limiter

The STC is very flexible, allowing for a high degree of customization as required incorporating project specific unit or customer needs and features not possible with black box controllers.

2.9 Excitation of Generator

Excitation systems have a powerful impact on generator dynamic performance and availability; it ensures quality of generator voltage and reactive power that means quality of delivered energy to consumers. There are four types of common excitation systems:-

1. Brushless excitation systems, with rotating exciter machines and Automatic Voltage Regulator (AVR)
2. Static excitation systems (SES), feeding rotor directly from thyristor bridges via brushes.
3. AC excitation systems
4. DC excitation systems

DC excitation system is used in APSCL steam power plant. Excitation is given to the field coil of the rotor to produce the electromagnetism. Main functions of excitation system are:-

1. To provide variable DC current with short time overload capability,
2. Controlling terminal voltage with suitable accuracy,
3. Ensure stable operation with network and other machines,
4. Contribution to transient stability subsequent to a fault,
5. Communicate with the power plant control system and to keep machine within permissible operating range.

2.10 Summary

We observe that the production of electricity is a lengthy process in the steam power plant division. Here At first we produced the heat energy by the help of boiler. Next this heat energy is used to run the turbine and the turbine act as a rotary engine. We get the mechanical energy from the turbine output. This energy is used to run the generator and at last we get the electrical energy from the generator output. The output voltage level is 6.6KV of generator and 6.6KV is stepped up as 132KV or 230KV by the help of step up transformer. Next 132KV or 230KV power is supplied in the transmission line.

CHAPTER - 03

COMBINED CYCLES

Date: 11.05.2011 to 13.05.2011
Supervisor: Senior Eng. Azizur Rahman, Manager, Gas Generator and Protection Section.
Assistant Eng. Fazle Hassan, Gas Generator and Protection Section.

3.1 Introduction

In this chapter combined cycle plant of Ashuganj Power Station Company LTD. (APSCL), its working principle, equipments and others necessary parts of combined cycle is discussed.

In combined cycle plant there are two gas turbine (i.e. GT-1 and GT-2) and one steam turbine plant(ST-1). Where steam turbine power plant (ST-1) is run by the exhausted gas and steam of gas turbine power plant one (GT-1). That's why in combined these two power plants are called combined cycle power plant. The power generation of these units is given below:-

Units	Date of Commission	Year of last Overhauling	Capacity(MW)		Generation (Kw.h.)	Fuel Consumption	
			Commissioned	De-rated (present)		MCF	m^3/kwh
GT-1	15.11.1982	2008	56	35	846774	14007.69	0.4684
GT-2	23.03.1986	2004	56	40	774542	12812.79	0.4684
CC-ST	28.03.1984	2000	34	16	400525	-	CC 0.318

Table-3.1: Power generation of combined cycle power plant of APSCL [4]

In Combined Cycle plant of APSCL, GAS is the main raw material of the plant. Which comes from Titas Gas, Brahmanbaria.

3.2 Total sketch of combined power plant of APSCL and its working principle

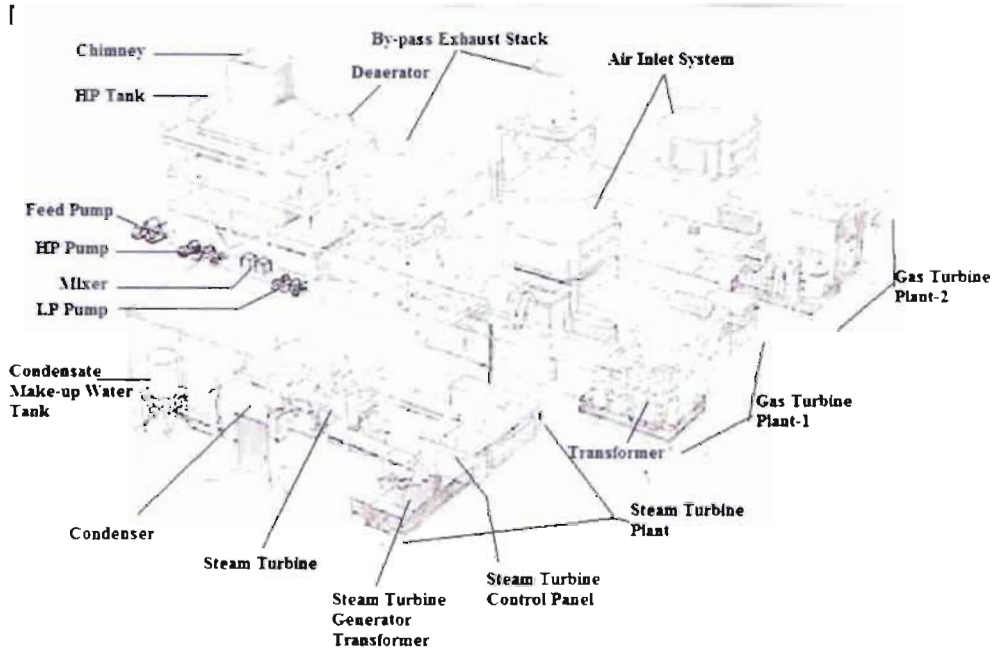

Figure 3.1: Pencil sketch diagram of APSCL Combined Cycle power plant showing some significant gadgets of Steam and Gas Turbine Plant

GAS Turbine Plant in APSCL

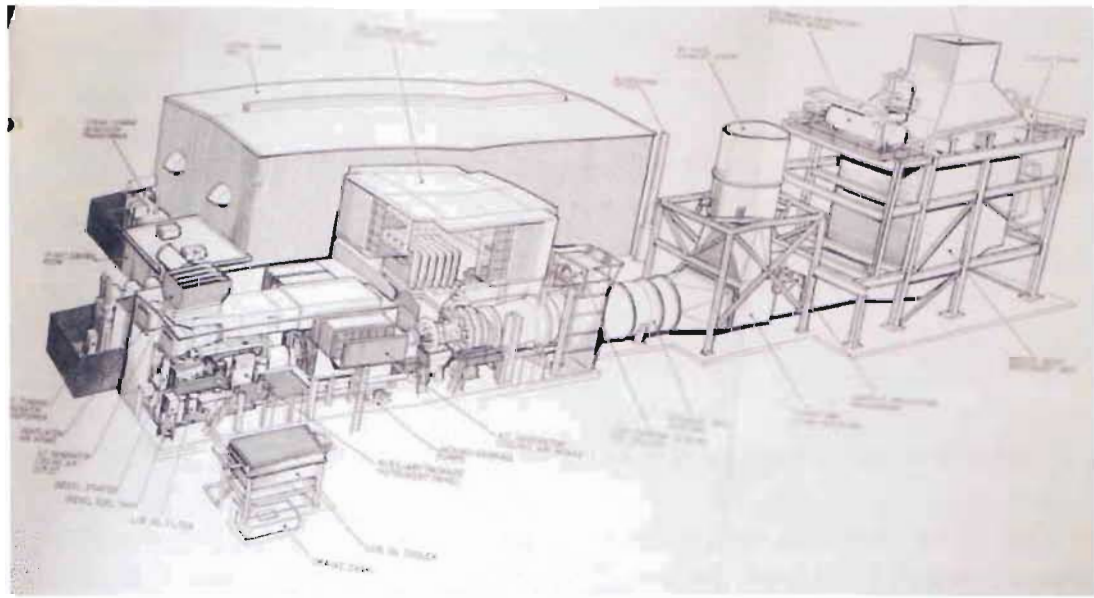

Figure 3.2: Drawing of Gas Turbine Plant-1 with notification of the instrument.

Steam Turbine Plant in APSCL

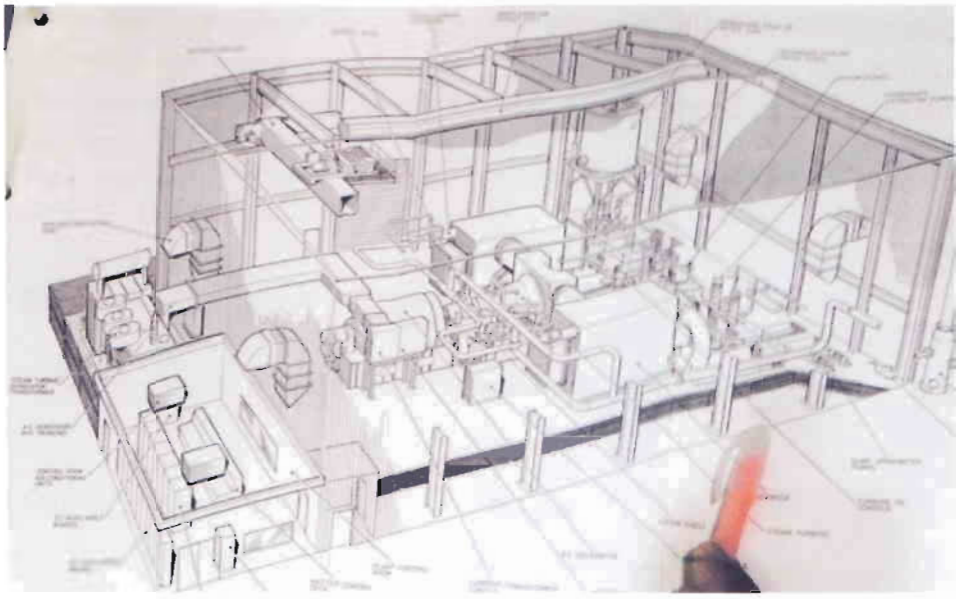

Figure 3.3: Steam Turbine Power Plant in APSCL

Working principle of Combined Power Plant:

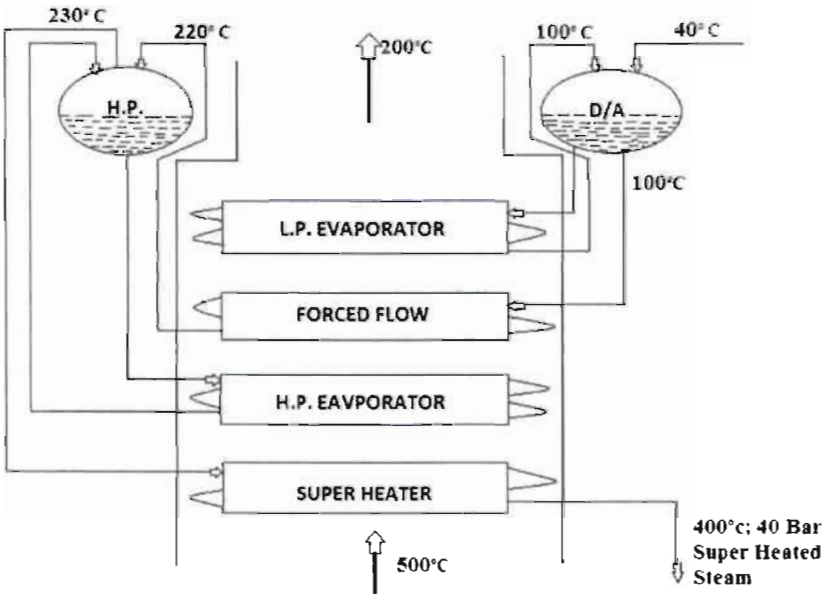

Figure 3.4: Working principle sketch of gas plant given by Eng. Azizur Rahman

In combined cycle power plant 40°c steams from steam turbine plant is coming to the deaerator, where from the another way 100°c temperature steam also coming from low pressure evaporator. Both these two different temperature steam is stored in deaerator and in combined produce 100°c

temperature water. This 100°c temperature water forcedly flows to the high pressure tank where its temperature increases to 220 °c. On the same time another 230 °c temperature steam is coming to the high pressure tank from the high pressure evaporator. The output of this tank is 230 °c steam which flows through the supper heater, where it is heated by 500 °c temperature steam and produces 400 °c temperature and 40 bar super heated steam. Finally this 400 °c super heated steam passes through the condenser A and B and supplied to the turbine.

3.3 WORKING PRINCIPLE OF GAS TURBINE

Compare to the other turbine working principle of Gas turbine is very simple. They have three important parts:

A compressor is to compress the incoming air to high pressure.

A combustion area is to burn the fuel and produce high pressure. high velocity gas.

A turbine is to extract the energy from the high pressure, high velocity gas flowing from the combustion chamber.

The following figure shows the general layout of an axial-flow gas turbine(which is used in APSC)-

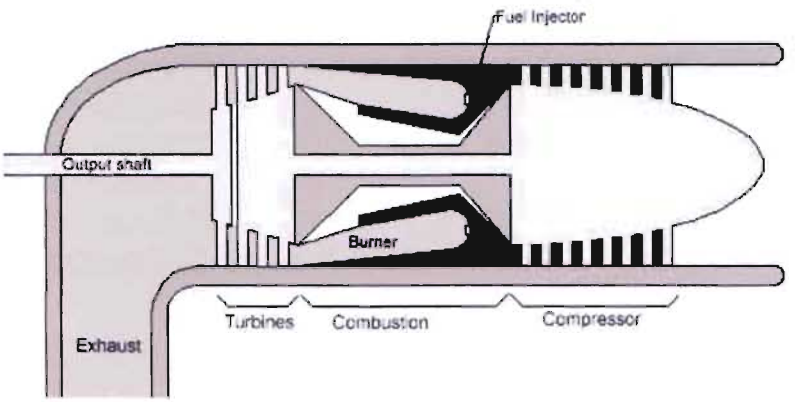

Figure 3.5: Axial flow gas turbine

In this engine air is sucked in from the right by the compressor. The compressor is basically a cone-shaped cylinder with small fan blades attached in rows (8 rows of blades are represented here). Assuming the light black represents air at normal air pressure, then as the air is forced through the compression stage its pressure and velocity rise significantly. In some engines the pressure of the air can rise by a factor of 30. The high-pressure air produced by the compressor is shown in dark shade.[15]

This high-pressure air then enters the combustion area, where a ring of fuel injectors injects a steady stream of fuel. In the combustion area - entering this area is high-pressure air moving at

hundreds of miles per hour. The injectors are at the right. Compressed air enters through the perforations. Exhaust gases exit at the left. From the above figure that a second set of cylinders wraps around the inside and the outside of this perforated can, guiding the compressed intake air into the perforations.

At the left of the engine is the turbine section. In this figure there are two sets of turbines. The first set directly drives the compressor. The turbines, the shaft and the compressor all turn as a single unit.

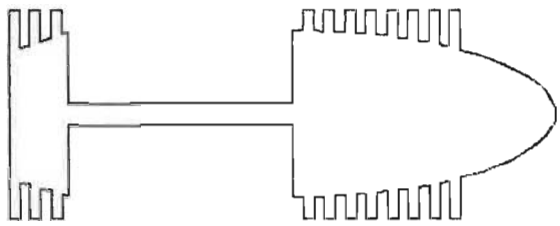

Figure 3.6: Blade of Turbine of Gas Turbine-1

At the far left is a final turbine stage, shown here with a single set of vanes. It drives the output shaft. This final turbine stage and the output shaft are a completely stand-alone, freewheeling unit. They spin freely without any connection to the rest of the engine.

In the case of the turbine used in a gas power plant, there really is nothing to do with the exhaust gases but vent them through an exhaust pipe, as shown in fig.4.5. Sometimes the exhaust will run through some sort of heat exchanger either to extract the heat for some other purpose or to preheat air before it enters the combustion chamber.

3.4 Some Basis System of Combined Cycle:

3.4.1 Fuel System

The function of the fuel system is to store and supply fuel to the cylinder chamber where it can be mixed with air, vaporized, and burned to produce energy. The fuel, which can be either gasoline or diesel, but in APSCL they use diesel because of high price of gasoline is stored in a fuel tank. A fuel pump draws the fuel from the tank through fuel lines and delivers it through a fuel filter to either a carburetor or fuel injector, then delivered to the cylinder chamber for combustion.

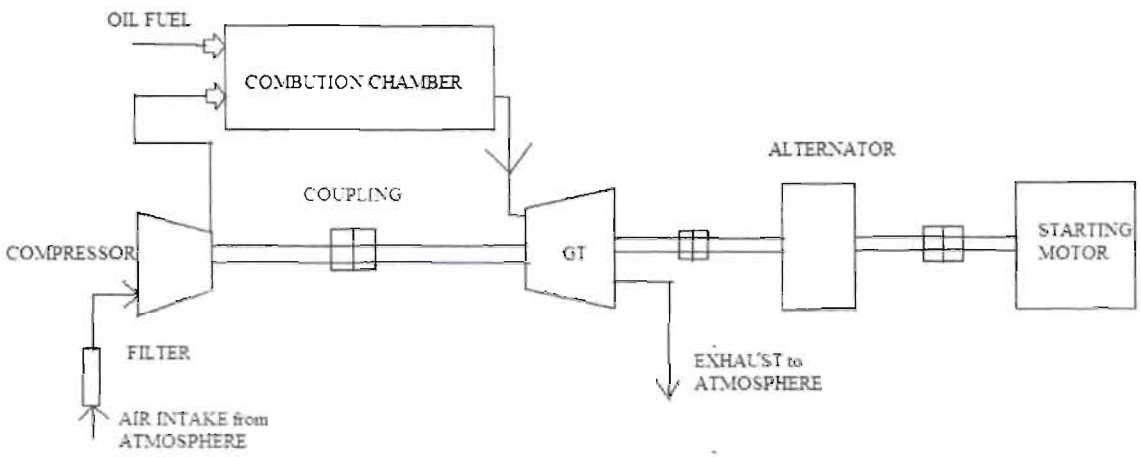

Figure 3.7: Fuel System and circulation of fuel in Combined Cycle Power plant in APSCL

3.4.1.1 Governor System

The governor system is the most important element of fuel system. The governor system is like a cruise control system. It keeps the engine running at the speed which would be selected, regardless of changes in the load. It controls the amount of fuel supply and the level of fuel in the combined cycle.

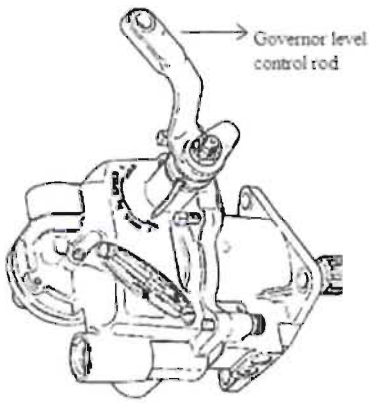

Figure 3.8: Governor System

3.4.2 Air Injection System

An air injection system forces fresh air into the exhaust ports of the engine to reduce HC and CO emissions and cooling. The exhaust gases leaving an engine can contain unburned and partially burned fuel. Oxygen from the air injection system causes this fuel to continue to burn. The major parts of the system are the air pump, the diverter valve, the air distribution manifold, and the air check valve.

The AIR PUMP is belt-driven and forces air at low pressure into the system. A hose is connected to the output of the diverter valve.

The DIVERTER VALVE keeps air from entering the exhaust system during deceleration. This prevents backfiring in the exhaust system. Also, the diverter valve limits maximum system air pressure when needed, releasing excessive pressure through a silencer or a muffler.
AIR DISTRIBUTION MANIFOLD directs a stream of fresh air toward each engine exhaust valve. Fittings on the air distribution manifold screw into a threaded hole in the exhaust manifold or cylinder head.
AIR CHECK VALVE is usually located in the line between the diverter valve and the air distribution manifold. It keeps exhaust gases from entering the air injection system. When the engine is running, the spinning vanes of the air pump force air into the diverter valve. If not decelerating, the air is forced through the diverter valve, the check valve, the air injection manifold, and into the engine. The fresh air blows on the exhaust valves. During periods of deceleration, the diverter valve blocks air flow into the engine exhaust manifold. This prevents a possible backfire that could damage the exhaust system of the machine. When needed, the diverter valve will release excess pressure in the system. In APSCL they have 2 layer air check valve in two side of the generator. First layer contains 59 blades and second layer contains 79 blades in each side of gas generator.

In this air injection system APSCL have three stages filtering system. Those filter the fresh air before interring into the exhausted port of the gas generator engine. These are:

i. Metallic filtering system
ii. Permanent filtering system
iii. Disposable filtering system

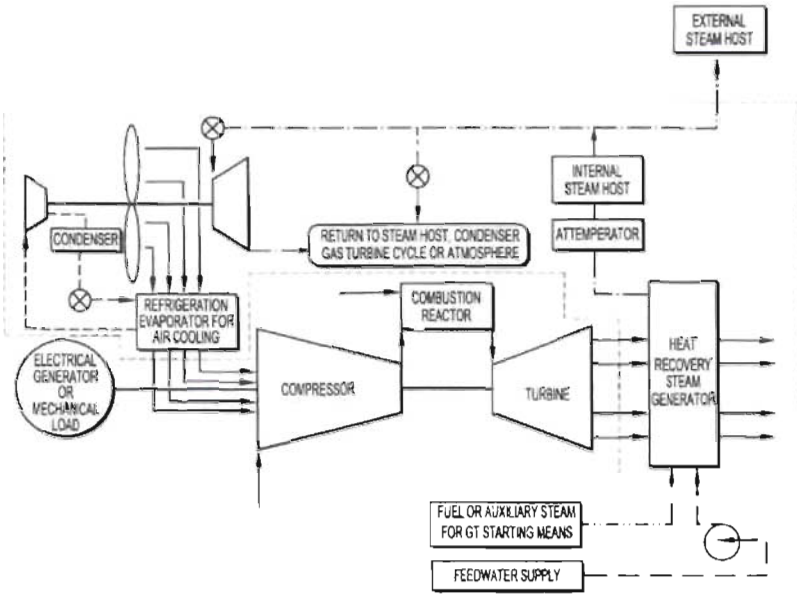

Figure 3.9: Air Injection system and the direction of air circulation in gas generator

3.4.3 Starting System

Starting system is one of the most important auxiliary systems of gas generator. In APSCL normally generator starts by a diesel engine and turbine rotates. In 700rpm speed there is a firing and gas engine began operating. After 1700rpm speed compressor delivery pressure (CDP) will decide whether the gas engine will run as self or it will run in combined with diesel engine. Usually after 1800rpm speed diesel engine stops and gas engine began working independently. On the time of starting the engine if there is any fault occurs related with firing or starting of gas engine, immediately they turn off the diesel engine and reset the machine in first position.

3.4.4 Cooling System:

Cooling is one of the most important elements of any power station. Before starting the machine it is mandatory to check the cooling of the machine. If there is any problem related with cooling we have to solve the problem before starting the engine. Otherwise because of very high heat engine can be tripped or be burned away.

In APSCL, in combined cycle power plant there are two types of cooling system they have used. One is water cooling and another is air cooling. There are also two types of water cooling system of the gas generator. One is jacket cooling & another is after cooler.

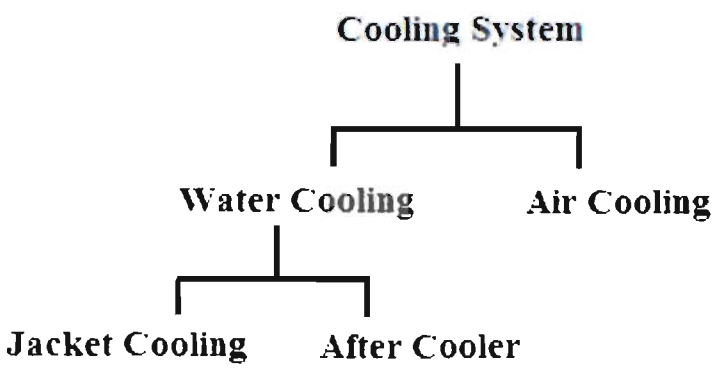

Figure 3.10: Cooling system of Gas generator

For jacket cooling system there are two tanks above the generator from where the water for the jacket cooler comes. The water in the tank for jacket cooler doesn't change. It is always recycling. Cool water goes to the jacket from the tank, takes the heat of the parts of the generator then the hot water goes to the after cooler to give up the heat and the cool water returns to the tank for another cycle. In this way the jacket water flows.

Figure 3.11: Water cooling system of the generator

In the after cooler the hot water of the jacket cooler flows within a coil & the cold water of about 20 °c flows from the outside of the coil. The cold water takes the heat of the jacket water raises at 40-45°c and goes back for cooling and the jacket water send back to the tank by a pump.

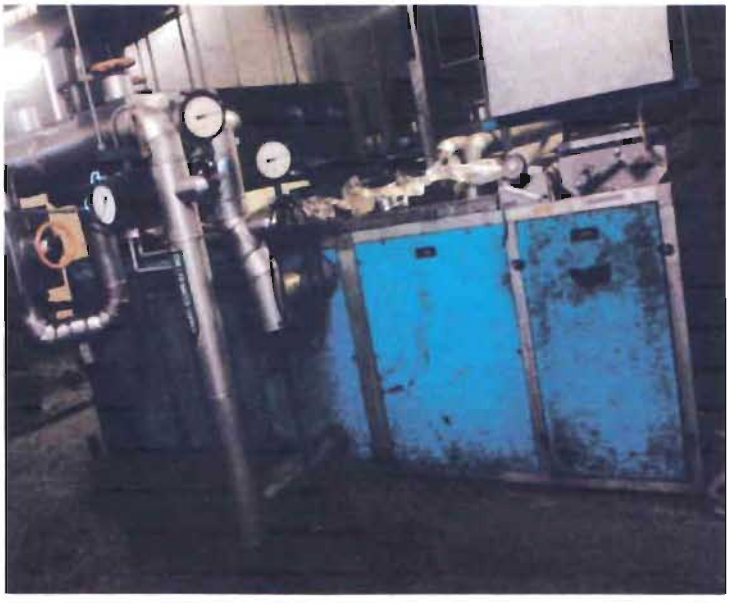

Figure 3.12: Water cooling pump in APSCL

In the after cooling system the normal water from the supply is used. The water first send to cool the jacket water, then it sends to the cooling tower to cool the water. The water from the after cooler reaches to the cooling tower by a water pump. In the cooling tower the water is sprayed by different tubes in a tank. Above the tank there is a fan, which blows out the heat of the water. Then the water goes to the pump from where it is send to the after cooler.

Figure 3.13: Cooling water supply pipe in APSCL

In the air cooling system, they collect air from the environment, after filtering it in different levels (i.e. which is briefly discussed in air injection level) they use it for cooling the different elements of the gas generator. The list of cooling mechanism in APSCL is given bellow:-

For oil cooling there is two fans in two sides of the oil tanker.
For cooling the turbine, there are two ventilation gaps.
For cooling the generator, there are two fans in both of the generator and besides these there are two air inlet systems.
Besides these there is one internal air circular path for cooling the generator.

Figure 3.14: Air Inlet system in gas turbine in APSCL

3.4.5 Lubricating System

The engine lubrication system is designed to deliver clean oil at the correct temperature and pressure to every part of the engine. The oil is sucked out the sump into the pump, being the heart of the system, than forced through an oil filter and pressure feuded to the main bearings and to the oil pressure gauge. From the main bearings, the oil passes through feed-holes into drilled passages in the shaft and on to the big-end bearings of the connecting rod. The cylinder walls and piston-pin bearings are lubricated by oil fling dispersed by the rotating shaft. The excess being scraped off by the lower ring in the piston. A bleed or tributary from the main supply passage feeds each shaft bearing. Another bleed supplies the timing chain or gears on the shaft drive. The excess oil then drains back to the sump, where the heat is dispersed to the surrounding air of the atmosphere.[16]

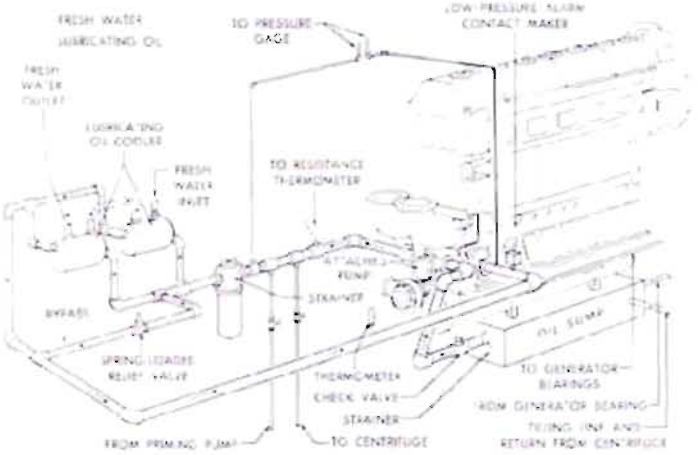

Figure 3.15: Lubrication system in the gas turbine plant and arrow shows the direction of oil flow [17]

Basically lubricating system is done for reducing friction and heat of the turbine and for smoothing the rotation at 3000rpm. In lubricating system there are two major elements:

1. Baring Oil system
2. Jacking Oil system

1. **Baring oil system:** In Baring oil system there is a baring pump which creates a high pressure around 40-50 bar to the oil and forcedly flow to the generators. It helps to reduce the friction of the turbine with shaft, reduces generated heat and provides the long liability to the turbine.

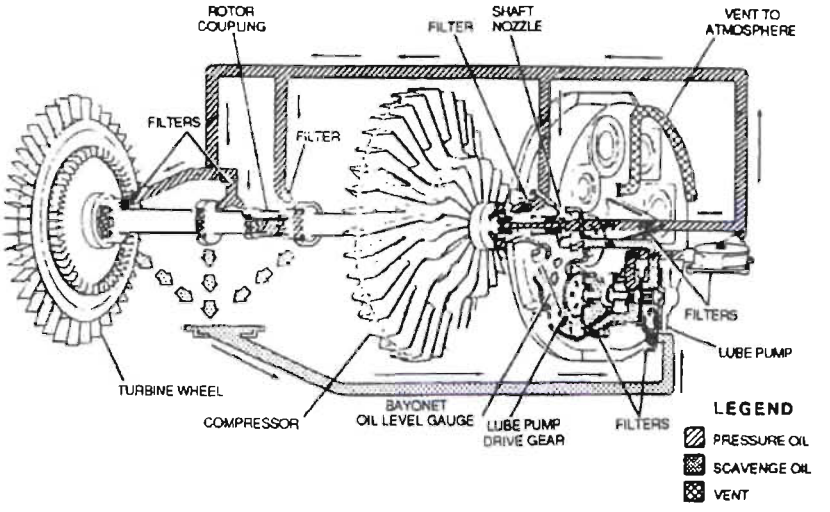

Figure 3.16: Baring oil system in a gas turbine, where direction of oil flow is mentioned by arrow direction and in legend types of oil is mentioned

2. **Jacking oil system:** At the time of turbine start up, the shaft journals are in contact with the white metal of the bearings due to the weight of the rotor. The low pressure of the lubricating oil supply and baring oil system is insufficient to separate the metal to metal contact between journals and bearing shells. In order to prevent the metal to metal contact, which is damaging in the long term, an oil pocket machined into the bottom shell of the journal bearing is supplied with oil under high pressure. This high pressure oil supplied at the bearing journals to initiate an oil film and lift the shaft off its bearings. This is called jacking oil system of turbine.[18]

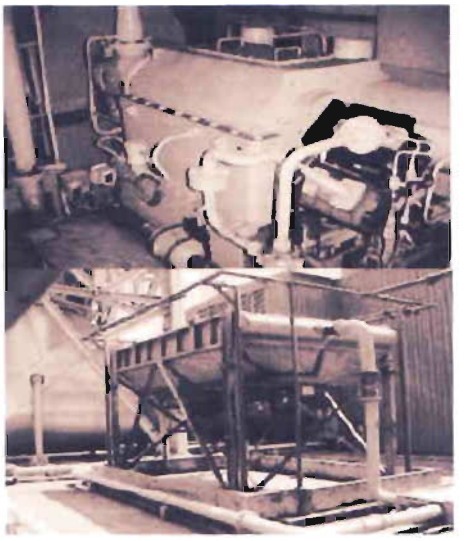

Figure 3.17: Jacking oil pump and system in APSCL

3.5 Protection and Control System:

Protection and control system is the most important section of any power station. If there is any abnormality, protection and control system would propel the alarm or shows the notification on the control panel and finally trip the circuit breaker for protecting the station by sensing the level of abnormality. In APSCL there are 18 types of protection is used for protecting the generator, turbine and overall system. In between these, they have discussed some most important protection system and their working principle. Those protection system and control panels of combined power plant are given below:-

Generator Protection:

1. Generator vibration protection
2. Over current or load protection
3. Over voltage protection
4. Over and under frequency protection
5. Stator earth fault protection
6. Standby earth fault protection
7. Differential relay protection
8. Winding temperature protection

Turbine Protection:

1. Bearing vibration protection
2. Temperature Protection
3. Over speed protection
4. High pressure protection

3.5.1 Generator Protection:

3.5.1.1 Generator Vibration Protection:

Generator vibration protection is very important protection system in between all protection schemes. It is essential for the long liability of generator and maximum working efficiency.
Vibration is defined as continuous, repetitive or periodic oscillation relative to a certain fixed reference. The physical motion of rotating machine generates vibration, which gives a physical indication of the machine. In APSCL, our supervisor Eng. Fazle Hasan told us, there are some reasons behind this generator vibration problem. Those are:-

Lube oil film failure
Low oil header temperature
Shaft misalignment
Water in oil
Sudden change in combustion dynamics
Abnormal closure of bleed air valves
Rotor unbalance
Faulty measuring device(pickup or cable problem

That's why generator vibration is always monitored by the plants condition monitoring system of the power plant. Machinery protection is provided when vibration (or other) measurements are installed permanently on a machine and connected to a dedicated machinery protection system. The machinery protection system has alarm set points (typically Alert and Danger), which automatically activate an alarm when it is reach at 4mils (1mils=$\frac{1}{1000}$ inch). The machinery protection system have an alarm relays which can automatically shut down (or trip) the machine when it reaches at 6mils. Alternatively, instructions to shut down the machine may be issued by an operator when an alarm occurs.

3.5.1.2 Over current or load Protection:

In generator over current or over voltage fault can be occurred in two ways. One is for load dissipation and another is for thundering. If the load of the power generator decreases suddenly but synchronous speed is not adjusted on time, then a large current is flows through the generator to bus bar line may cause severe damage and hazard. To protect this differential relay is used in generator. If the current goes above certain level or amps, the relay first give the warning to the operator or switch alarm and then is break or trip the circuit breaker to protect the generator.

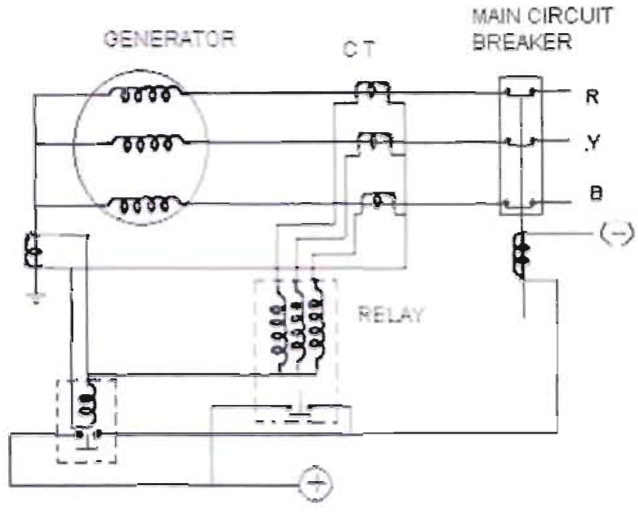

Figure 3.18: Over current protection scheme for generator in APSCL

3.5.1.3 Over voltage protection:

The over voltages on a power system is divided into two main categories:

1. Internal causes:(i) Switching surges (ii) Insulation failure (iii) Arcing ground (iv) Resonance
2. External causes: Lightning or thundering.

Surges due to internal causes hardly increase the system voltage twice the normal value. Generally, surges due to internal causes are taken care of by providing proper insulation to the equipment in the power system. But surges due to lightning or thundering are very severe and may increase the system voltage to several the normal values. If the equipment in the power system is not protected against lightning surges, these surges may cause considerable damage. That's why in APSCL for external over voltage protection they have used delay type relay

3.5.1.4 Over and Under frequency protection:

Over frequency operation: Over frequency results from the excess generation and it can easily be corrected by reduction in the power outputs with the help of the governor or manual control.

Under frequency operation: During an overload, generation capability of the generator increases and reduction in frequency occurs. The power system survives only if we drop the load so that the generator output becomes equal or greater than the connected load. If the load increases the generation, then frequency will drop and load need to shed down to create the balance between the generator and the connected load. The rate at which frequency drops depend on the time, amount of the overload and also on the generator variations as the frequency changes. Frequency decay occurs within the seconds so we cannot correct it manually. Therefore automatic load shedding facility needs to be applied.

3.5.1.5 Stator Earth Fault Protection:

In APSCL for stator earth fault protection and over current or load protection same kind of protection system is used.

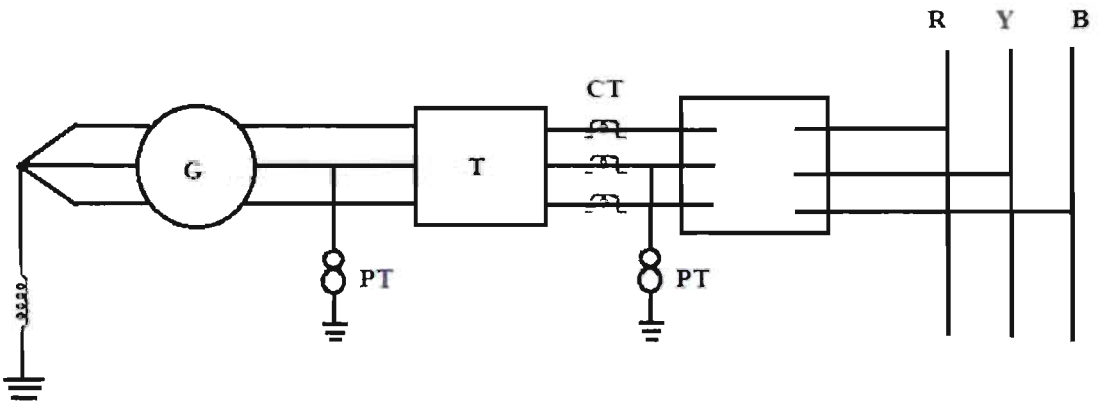

Figure 3.19: Stator Earth Fault Protection Scheme in APSCL

But in stator earth fault protection there is one extra protection and that is the standby earth fault protection. In this protection scheme there is a internal generator protection system and if there is any standby faults occurs, which immediately open the power system from the generator and mention the safety of it.

3.5.1.6 Differential Relay Protection:

Difference between generated current and transmission current should be equal. If it is not, then a fault is taken place in the power station. To protect this in APSCL differential type relay protection scheme is used. When this types of fault are occurs, immediately relay will trip and as well as the circuit breaker will open.

3.5.1.7 Winding Temperature Protection:

In APSCL there are many types of temperature protection system is available. Among them most important and widely used some protection devices are given below:-

Thermometer: Used for measuring the temperature
Thermostat: Used for measuring the meter
Thermocouple: It gives the protection by coupling two different metals
Resistance Thermocouple detector (RTD): It is the modern protection system used in APSCL. It can be used in very high range and quickly responsible.

3.5.2 Turbine Protection:

3.5.2.1 Bearing vibration protection:

Usually Gas Turbine bearings are equipped with radial, axial and seismic vibration probes. The bearing protection system is based on fast response vibration detection. The radial probes will detect the vibration faster as the seismic. Because of the oil film and the bearing casing is a kind of barrier which damps the vibration before reaching the seismic. In general, the vibration detection by seismic should be proportional to the radial vibrations.

The following scenarios might cause high vibration to rotating equipment:-

1) Bearing stiffness
2) Misalignment
3) Resonance
4) Aerodynamic forces
5) Tooth wear, coupling
6) Disturbed bearing lubrication

Unbalance is the main cause of high vibration. This can be caused due to rotor bow due to unequal cool down, damaged blades and buckets, and deposits embedded on the axial compressor of the turbine.

3.6 Summary:

In combined cycle of APSCL, the main raw material for power generation is gas, which comes from Titas gas. Gas comes to the burner, burned the air and forcedly flows to the turbine. Here, pressure is restricted by vacuum pumps and temperature is controlled by cooling pump (i.e. water cooling, oil cooling etc.) of the power plant. In this stage plant lost some water which is being making up from make-up water tank. After generating the electricity the exhausted gas and steam of gas turbine-1 plant is used to run the steam turbine plant-1 and in combined these two plants are called combined cycle power plant. Here, exhausted gas and steam temperature and pressure is controlled very carefully. The metal temperature, steam temperature and casing temperature of the plant should be same (i.e. 480~520°c) in this stage, otherwise because of abnormality turbine of steam turbine power plant will not start.

CHAPTER - 04

4 SUBSTATION

4.1 Introduction

Date: 08.05.2011 to 10.05.2011
Supervisor: Senior Eng. Nur Mohammad, Manager, Substation operation and maintenance.
Assistant Eng. Md. Shahidullah, Substation operation and maintenance.

In this chapter equipments of substation and their operation, how a substation works and maintenance of substation equipments is discussed.

After generation of electricity to distribute it to the customer substation is needed. Because, generated electricity voltage 15.6 KV is not suitable for all consumers (especially to the house hold) and also if 15.6 KV line is used for long transmission than it will not be efficient so we need a substation which will convert voltage level in a satisfactory level. So, in substation generated voltage is categorized for the demand of distribution. In Asuganj Power Station Company generated electricity is transformed from 15.6 KV to 132 KV, 230 KV and as well as 440 V line. 440 V line is used for transmit electricity in local area like inside of Asuganj Power Station to their resident. 132 KV line is used for medium distance transmission like for transmit power to Brahmanbaria. Whereas, 230 KV line is used for long transmission like to transmit power to Dhaka or Sirajganj. So, for convert voltage to 15.6 KV to 440V or 132 KV or 230 KV; we need step up as well as step down Transformer. That means, Transformers is one of the most important equipment of Power Station. But, the working area of substation is not only changing voltage level but it also ensure the security of bus bar as well as used for communicate with other substations, SCADA.

The substation in APSCL is a outdoor type, step up, double bus bar type substation. APSCL used 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. If there is no supply on national grid then APSCL has its own motor driven power producing back-up system.

4.2 Equipments of Substation

Equipments that are used by APSCL is given below in a list. Further discussions on those equipments are given below consequently. At the end, a single line diagram is given and explained for giving an overview on APSCL.

Here is list of equipment in APSCL substations-

1. Transformer
   - Tap-Changing Transformer
   - Current Transformer
   - Potential Transformer
2. Circuit Breaker
   - Oil Circuit Breaker
   - SF6 Circuit Breaker
   - Air blast circuit Breaker
3. Relay
4. Lightning Arrester
5. Wave trap
6. Control Room
7. Battery and Battery charger room
8. Transmission Line
9. Bus bar

4.3 Transformer

In substation current transformer and voltage transformer is widely used. Details about this two kind of transformer is given below-

4.3.1 Tap-Changing Transformer

At APSCL generating site voltage is 15.6 kv. But, for supply it to the bus we need 132 kv or 230 kv. For perform this operation tap-changing transformer is used. Name plate data is given in below figure-

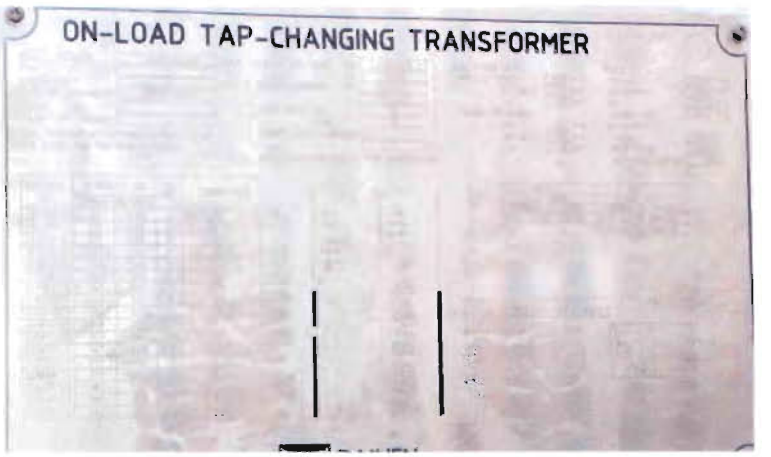

Figure-4.1: Name plate data of an on-load tap-changing transformer used in APSCL

An on load tap-changing transformer used in APSCL is shown in Figure 4.2

Figure-4.2: An on-load tap-changing transformer,
changed voltage level from 15.6 kv to 132 kv

4.3.2 Current Transformer (CT)

At Ashuganj Power Station Company current transformer is used for measurement of current. The engineers of substation informed us about the usage of current transformer in series with equipment for the protection. Current transformer or CT is used for measuring the current of electric equipment. For the safety of the system, current transformer's secondary winding checked regularly, because if it gets unloaded or open, then it can create arc, which is harmful.

A typical current transformer is shown in Figure 4.3

Figure 4.3: Current Transformer used in APSCL's substation

4.3.3 Potential Transformer (PT)

APSCL use outdoor type 132 KV rated voltage Potential transformer. Potential transformer mainly used for protective relaying purpose and operation of other instruments such as ammeter, voltmeter and watt meter etc. In table 5.1.2 name plate data of 132 kV single phase outdoor types Potential Transformer is given-

Rated voltage	132 kV
Construction	Out door
No. of phase	Single
Ratio	(132000/1.73) / (110/1.73)
Burden	60 VA
Serial no.	132 P.S.
Highest system voltage	145 kV
Insulation level	275/650 kV
Rated frequency	50 Hz
Total weight	600 Kg
Class of accuracy	0.2
Years of manufacturing	2009

Ratio	Primary Connection	Secondary Connection
(132000/1.73) / (110/1.73)	A-N	a-n

Table-4.1: 132 kV single phase outdoor type Potential Transformer made by ENERGYPAC.

In Figure 4.4, potential transformers used by APSCL are shown.

Figure 4.4: 132 kV single phase outdoor types Potential Transformer used in APSCL substation

4.3.4 Maintenance and protection of Transformers

APSCL maintain some routine test and give some protection for transformers. They are listed below-

Maintenance

1. Check of physical condition and the insulation resistance
2. Check tightness of primary side & secondary terminals
3. Check the ratio and Justify the accuracy
4. Check for oil leakage for oil immerged CT and PT
5. Check the dielectric strength of oil

Protection

1. Buchholz relay
2. Differential relay
3. Over fluctuation protection
4. Directional over current
5. Earth fault protection
6. Thermal over heating protection

4.4 Circuit Breaker

Circuit Breaker is a protective device which protects electric load devices and electric power cables from a large fault current caused by an electrical shortage and a ground fault that can be generated on an electrical circuit [12].

Circuit Breaker those are used by APSCL is as follows –

Oil circuit breaker
SF6 circuit breaker
Air blast circuit breaker

4.4.1 Oil Circuit Breaker

The rated voltage of Low Oil Circuit Breaker which is used by APSCL is 132 KV. The weight of oil is 330 kg and the total weight of the breaker is 3280 kg. Rated current of this type of circuit breaker is 1250 A and breaking capacity is 5000 MVA. Nameplate data of a circuit breaker used by APSCL is given below-

Year of Construction	S 69/30756803
Type	H 801-132/1250-5000E
Rated Voltage	132 kV
Max. Service Voltage	170 kV
Rated current	1250 A
Frequency	50 Hz
Breaking capacity	5000 MVA
Natural frequency	1.5 kHz
Amplitude factor	1.6
Making current	55/43 kA
Short time current	1 sec 32 kA
Operating duty	0-0.3s-CO-3min-CO
Operating mechanism	220 V d.c.
Weight incl. oil	3280 kg
Oil filling breaker poles	330 kg

Table-4.2: Name plate data of a 132 kV rated voltage Oil circuit breaker made by SIMENS, made in Germany

In Figure 4.5, we have shown a Minimum Oil Circuit Breaker.

Figure 4.5: 132 KV rated voltage Minimum oil Circuit Breaker used in APSCL substation

4.4.2 SF6 Circuit Breaker

APSCL use 36 kV and 145 kV rated SF6 circuit breakers. ALSTOM and SIMENSE are the main suppliers of SF6 circuit Breaker. Here, the weight of SF6 gas is 26.0 kg and the total weight of the device is 3530 kg. The temperature range of the circuit breaker is -25 to +55° C. The name-plate data of a 145 KV rated voltage SF6 circuit breaker is given below-

Type	3AP1DT
Year of manufacturing / No.	02/35076681
Rated voltage	145 kV
Rated lightning impulse withstand volta	650 kV
Rated power frequency withstand voltag	275 kV
Rated frequency, f	50 Hz
Rated normal current, Ir	3150 A
Rated short circuit breaking current, Isc	40 KA
Rated duration of short-circuit t	3 s
Rated out-of-phase breaking current Id	10 KA
First-pole-to-clear factor	1.5
Rated line-charging breaking current	50 A
Rated operated sequence	0-0.3s-CO-3min-CO
Rated pressure of SF6 at +20° C	6.0 bar
Weight of SF6 filling	26.0 kg
Weight including sf6	3530 kg
Temperature class	-25 to +55° C

Table-4.3: 145 kV rated voltage SF6 circuit breaker made by SIMENSE

In Figure 4.6, we have shown a SF6 circuit breaker.

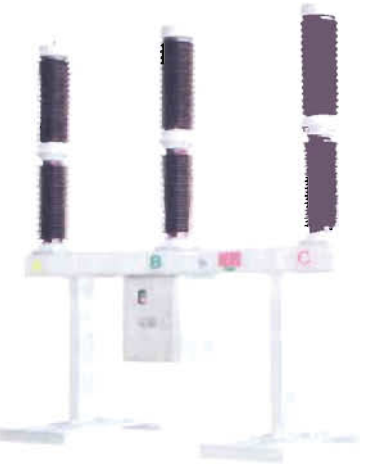

Figure 4.6: SF6 Circuit Breaker, contain 1 kg SF6 gas at 6.0 bar pressure

4.4.3 Air Blast Circuit Breaker

In 132 kV bus line APSCL use air blast circuit breaker. This type of circuit breaker is used for high voltage applications, where faster breaker operation is required [13].

Air Blast Circuit Breaker is shown in Figure 4.7-

Figure 4.7: Air blast Circuit Breaker used in APSCL's substation for protection [13]

4.4.4 Maintenance of Breakers

1. Check condition of oil gauges and oil level
2. Check for oil leakage & integrity of gasket joints
3. Check the tightness of nuts & bolts
4. Check the insulation resistance of bushing
5. Check that silica gel crystals are blue
6. Re-greasing of bearings
7. Check the performance of oil temperature & winding temperature meter
8. Change the oil of OLTC
9. Check the control system and driving mechanism of OLTC
10. Check insulation resistance between each winding and ground.
11. Calculate the Dielectric Absorption Ratio- DAR = (I.R. of 60 sec)/(I.R. of 15 sec)

4.5 Relay

A relay is an electrical switch which is used where several electrical circuits are controlled by one signal. Relays are used at the both side of the circuit breaker. Types of relay used in APSCL substation is given below and discussed.

4.5.1 Types of Relay used in APSCL

There are various types of protective relays. At APSCL they use following types of relay.

1. Classical relay

There are several types of classical relays in power system, but at APSCL they use electromagnetic attraction type double quantity classical relay. This relay has instantaneous operation, means operation time is constant. The construction of this relay is very simple and operating current can be adjusted easily. This type of relay uses most of the cases.

2. Induction type relay

This type of relay is basically used for inductive load and over current protection in APSCL's substation. It has Inverse Definite Minimum Time (IDMT) characteristic. Here angular force is used for time adjustment. This type of relay is made by the help of energy meter's principal. It is sensitive to direction. There is a Time Setting Multiplier (TSM) and Plug Setting Multiplier (PSM) at the upper part of the relay for controlling the characteristic curve of the relay. This type of relay is basically used for providing protection of Generator, Motor and feeder.

3. Percentage differential relay

To provide protection of power transformer at APSCL Percentage differential relay is used. This type of relay is capable to identify internal fault only. In Percentage differential relay there are two current transformers (CT) connected to the two end point of the protection part. The difference between two CTs current passes through the operating coil of the percentage differential relay. If difference is greater than zero then relay will operate.

4. Impedance type distance relay

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

5. Pilot relay

For sending signal to the fault part pilot relay is used in APSCL. If any kind of fault occurs in any zone of transmission line, immediately the fault should be cleared by using a signal, which comes from pilot relay. At APSCL they use microwave type pilot relay and power line carrier type pilot relay for protecting the transmission line.

4.6 Lighting Arrester

Lighting Arrester is used for giving protection equipments of substations from lighting surge at APSCL substation. Lightning is a huge spark and takes place when clouds are charged to such a high potential with respect to ground or earth. Lightning arrester is also known as surge arrester. 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.

Figure 4.8: Lightning Arrester in the substation;
which protect equipments from lighting

4.6.1 Types of Lightning Arrester used in APSCL

Basically lightning arrester could be various types. But, APSCL contain these two types of lightning arresters. They are-

1. **Rod gap arrester**

Rod gap type arrester is used mainly for protect power transformers, tap changing transformers in APSCL. So, this type of arrester is placed around transformers. It is very simple type of lightning arrester which consists of two rods and is bent at right angle with a very short gap. One rod is connected to the line and other is connected to the ground.

2. **Horn gap arrester**

Horn gap arrester is used in APSCL mainly for protect breakers, wave traps, bus bar. Horn gap arrester is also another types of arrester which consists of a two horn shaped metal rods separated by a small gap. One end of the horn is connected with line circuit and other end is connected with the ground. The gap between of the horn is so adjusted that normal supply voltage is not enough to cause an arc across the gap.

4.7 Wave Trap

Wave Trap is used for communication with other substation from APSCL substation. It is also used for communicate with SCADA from APSCL control room. We observed in APSCL, that lighting arrester is used surround of wave trap for giving protection from lighting surge. Wave trap is also known as line trap. It is an electronic filtering device. Its main purpose of the use is for communication between two substation and also use the same transmission line between those substations. Through coupling capacitor and Line Matching Unit (LMU), this device traps the high frequency signal which is sent from the remote substation and diverts that signals to telecom panel in the substation control room. These signals are mainly teleportation signals and also there are voice and data communication signals. In wave trap, there is high impedance, thus this communication frequency cannot flow through the substation bus bar and transformer. If there is no high impedance in the wave trap, then data could get lost and then communication between those substations would be ineffective or may be impossible.

Figure 4.9: Wave Trap in the substation; which is used for communication in APSCL

4.8 Control Room

Control Room is a place where controlling is performed. For every section of a power plant a control room is necessary. APSCL have totally separated control room for controlling the substation. If any fault occurs in the substation then first the message reach to the substation and Engineers who are present there immediately fix the problem. Some problems can fix from the control room where for fixing some problem it is necessary to go to the substation. From substation control room how much electricity will deliver to which area is also controlled. How much electricity is given to the national grid is observed and for that proper frequency, voltage and current are maintained from the control room of substation.

Figure-4.10: Control room of substation in APSCL

4.9 Battery and Battery charger room

Battery is the most important source in the grid station. It is the heart of the station because most the equipment is run on DC power. Battery is the only back up source of DC supply. Without DC power supply, the grid is unprotected, because security lighting, fire alarm circuit, breaker control circuit, heating equipment and relay get energized by the DC supply. In the APSCL they have a battery charger room and there were 120 nickel cadmium battery cell. Those batteries are purchased from Rahimafrooz Batteries Ltd.

4.10 Transmission Line

Transmission line is needed for transmit the electricity that produced from the plat. In APSCL after producing the electricity it is given to the transmission line for distribution.

4.11 Bus Bar

Bus bar is used to carry a very large current or to distribute current to multiple devices within switchgear or equipment. There are several types of bus bar like single bus bar, double bus bar, double bus bar with reserved bus bar, ring bus bar etc. APSCL used double bus bar. Because, APSCL is a generation company, it generates power and distributes to the grid. If any generator need power for starting then it collect the power from the grid by bus bar.

4.11.1 Bus Bar Protection

In APSCL bus bar is protected by following relays-

1. Bus protection by differential protection
2. Bus protection by over current relay
3. Frame leakage earth protection

4.12 Single line Diagram of Substation

Single hand diagram of a substation is the sketch of total substation that denotes how equipments are arranged in the field. It is helpful for understand the total system because it's gives a total overview about the system. The single hand diagram of APSCL substation is given below-

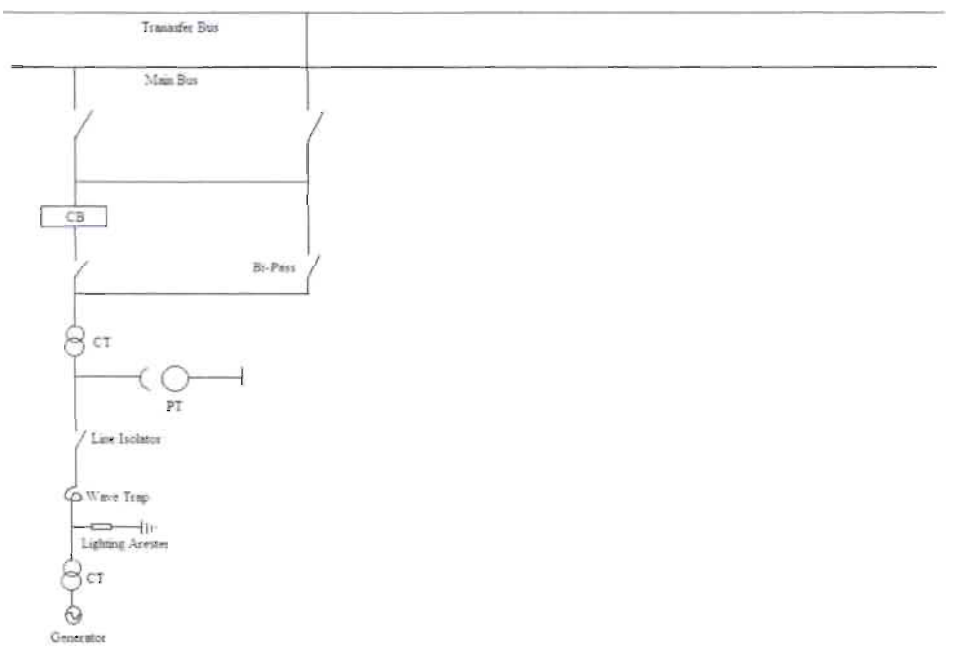

Figure 4.11: Single line diagram of APSCL substation

In the substation of APSCL, first from generator (that dose generates 15.6 kv) line goes to CT. After CT, Lighting Arrester, Wave Trap, Line Isolator, PT, CT, CB, Line Isolator is connected. Then it goes to the Main Bus.

CT = Current Transformer
PT = Potential Transformer
CB = Circuit Breaker

4.13 Summery

In APSCL generating site voltage is 15.6 KV. First, by tap changing transformer voltage is step up to 230 kV. This voltage is supplied to the grid. For supplying this power to the grid and for ensures the security of bus bar substation and its equipments are necessary. Equipments of substation like transformers, breakers, arresters, relays, wave trap are all ready discussed in this report. Maintenance of those equipments is also mentioned. At the end with the single line diagram of APSCL substation total process and arrangement of those equipments is shown.

5 PROBLEMS AND RECOMMENDATIONS

5.1 Problems

1. Blades of turbine or internal condition of boiler are not possible to observe without in the overhauling time. So, we could not able to see all equipments or operations.
2. Gas turbne-1, 2 and combined cycle power plant was built long before. In these plants enough space for human move was not kept. So, we were not able to see some parts of gas turbine and combined cycle power plant.
3. Because of heavy noise in generation room it is not possible to communicate verbally with the respective instructor. So, we phase some problem in generation room.

5.2 Recommendations

1. We suggest to student if possible visit APSCL when overhauling process is running on.
2. Must complete power station and power system protection courses. These two courses helped us very much to understand process and operations of APSCL.

6 FUTURE PLAN OF APSCL

APSCL is currently constructing a 50 MW gas engine power plant. In addition replacement program is also taken for outlived plants. Under this program gas unit 1 and 2 will be replaced by a new 450 MW higher efficient combined cycle power plant and APSCL have a plan to construct gas base 1510 MW CCPP within APSCL's premises in place of GT-1, GT-2 and ST. Moreover, after re-powering unit 3, 4, 5 by installing 3 GT units about 100 MW will increases and thus total station capacity will rise to 1050 MW by 2013.

The details future development plan is given below in a table [4] –

Sl. No.	Plan	MW increas Over presen capacity	Construction period	Source of Finance
1	Turbine blade of Unit-3 change in this year, after end of this Work 45 MW generation will increases.	45	June 2011	APSCL own Finance
2	Rehabilitation and modernization of unit-3, 4 & 5 for reliable power generation 150 MW each unit for net 15 years.	20	2010-2011	Finance by KfW & DRGA
3	50 MW gas engine power plants.	5	March-2011	APSCL own finance
4	1.0 Mw solar panel installation	1	2010-2012	APSCL own finance
5	150 Mw combined cycle power plant (replacement project)	54	2010-2013	Looking for Finance
6	450 MW combined cycle power plant (replacement project)	322	2010-2013	Looking for Finance
7	To re-powered unit – 3, 4 & 5 by installing three GT units about total100 MW capacities.	100	2010-2014	Looking for Finance
	Total Increase	592		

5.1: Future development plan of APSCL [4]

7 CONCLUSION

Although production of power is insufficient compare to demand but the good thing is that supply of power in national grid is rapidly increasing now-a-days. No doubt that the power sector of Bangladesh has to go for a long way in future. For achieving the target government has taken some initiatives to increase the generation of electricity. As power sector is a capital-intensive industry, huge investment will be required for addition generation capacity. Public sector is not in a position to secure this huge investment for power generation. Recognizing these trends, Government of Bangladesh modified its industrial policy to enable private investment in the power sector. Already, some private companies have come forward in power sector like Summit Power and Atobi. Recently near about 800 MW of electricity is coming from rental Power Company although it is very much expensive.

APSCL is playing an important role in producing power for the nation and thus contributing to the country's economy. We are glad that we got a chance to compete our internship program in APSCL; which is the second largest power company in Bangladesh. We believe that, the practical experience that we gathered in APSCL will help us in our professional life.

8 REFERENCE

[1] Source: 4'Th August, 2011. Website of BPDB.
[2] 5125 MW of power is supplied in 4.00 A.M. when maximum industries, shopping mall and offices keep close. When all of them become open then the demand will rise near about 8000 MW.
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9 APPENDIX

APSCL = Ashuganj Power Station Company Limited
CT = Current Transformer
PT = Potential Transformer
BPDB = Bangladesh Power Development Board
CB = Circuit Breaker
IDMT = Inverse Definite Minimum Time
TSM = Time Setting Multiplier
PSM = Plug Setting Multiplier
MW = Mega Watt
LPT = Low pressure turbine
IPT = Intermediate pressure turbine
HPT = High pressure turbine