INTERNSHIP REPORT

ON

ASHUGANJ POWER STATION COMPANY LTD

By

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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)

Fall, 2012

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ASHUGANJ POWER STATION COMPANY LTD. (APSCL)

(An Enterprise of Bangladesh Power Development Board)

APSCL

Certificate

For

Industrial Attachment Training Program

This is to certify that Md. Nuruddin Al-Masud , ID No. 2008-1-80-013 ,the Student of B.Sc in Electrical and Electronic Engineering from East-West University , Dhaka has successfully completed the Industrial Attachment Training Program held from 24-08-2012 to 07-09-2012. During the training period , he paid due attention to the practical work .

I wish him every success in life.

Manager (HRD)
Ashuganj Power Station Company Ltd.
Ashuganj, B-Baria

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I wish him every success in life.

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Dewan Sk. Moinul Haque Md. Nuruddin Al-Masud Md. Iftakhar Alam

East West University
Dhaka, Bangladesh
December, 2012.

Acknowledgment

We had a remarkable time during our internship at Ashuganj Power Station Company Ltd (APSCL). We very much acknowledge the encouragement and assistance given to us by the people at Ashuganj Power Station Company Ltd (APSCL). We are very grateful to Ashuganj Power Station Company Ltd (APSCL) for giving us the opportunity to complete our internship in their company. We want to specifically mention Md.Lutfar Rahman, who is the Manager (HRD) of Ashuganj Power Station Company Ltd (APSCL). With his support and guidance we could successfully complete our internship program at Ashuganj Power Station Company Ltd (APSCL).

We are grateful to our honorable supervisors Dr. Anisul Haque, professor, Department of Electrical & Electronic Engineering, East West University and Dr. Halima Begum, assistant professor, Department of Electrical & Electronic Engineering, East West University for providing us much needed assistance and also for encouraging us to prepare the internship report on Ashuganj Power Station Company Ltd (APSCL).

We would also like to mention the name of Dr. Mohammad Mojammel Al Hakim, Chairperson and Associate Professor, Department of Electrical & Electronic Engineering, East West University for being so kind during the period of our internship. Finally, we would like to thank Mr. Md. Lutfar Rahman, Manager (HRD), Engr. Moniruzzaman, and Engr. Rokon-Uz-Zaman who had given us appointment from their precious time to collect related data for our report and also helped us to understand many related matters and gave their precious time to us more than once.

But the most of all, we would like to thank the omnipotent Allah for giving us the ability to complete our internship and prepare the internship report.

Executive Summary

In order to fulfill the partial requirements of B.Sc in EEE, we have chosen the Industrial attachment or internship. We have done our internship at Ashuganj Power Station Company Ltd (APSCL). Our major area is Power. So as Power Engineers, power stations are related to our field.

In order to thoroughly understand the role of power sector in Bangladesh, the general electricity production, distribution and transmission system in the country must also be taken into account. The purpose of this report is to give a brief description about what we have learned and visited in the power station. In this regard we have ventured into history and have followed some significant data collected from APSCL. APSCL has 9 units with installed capacity of 777 MW. APSCL fulfills about 15% of power requirements of the country. Unit 1 and 5 are for steam power plant, unit 6 and 7 are gas tubine-1 (GT-1) and gas turbine-2 (GT-2), unit 8 is gas engine and unit 9 is combined cycle plant. Unit 1 and 2 produce 64 MW each, unit 3, 4 and 5 produce 150 MW each, unit 6 and 7 produce 56 MW each, unit 8 produces 50 MW and unit 9 produces 34 MW. Sub-station of APSCL plays a vital role for power distribution. Different kinds of transformers are being used to step up or step down voltage produced by the generators. Isolators, feeders, breakers are main equipments of sub-station. For protection purposes several switchgear and control equipments are present there.

During this internship our theoretical knowledge was verified to the practical field of power system. Our mentor has helped as a lot by giving us the proper introduction about the plant and we have observed different systems and devices under his observation. The systems or the devices that were observed during the internship include generator, boiler, water treatment plant, steam turbine, gas turbine, compressor, backup system, sub-station equipments, such as, power transformer, current transformer, potential transformer, protective relays, circuit breakers, insulator, lightning arrester and other essential equipments of the APSCL. In this report the main emphasis is on the explanation about generators along with the knowledge about power generation, transmission, maintenance and distribution system at APSCL. It is expected that in the future this practical knowledge will enhance our potential to grow up in power industries.

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Chapter 1: Introduction

Power generation sector is one of the most important sectors for any nation because the growth of the economy is vastly dependent on this sector. It is a great opportunity to accomplish the internship at Ashuganj Power Station Company Limited (APSCL). It is the second largest power station in capacity in our country [1]. There are three types of power plants at APSCL such as, thermal power plant, gas turbine power plant and combine cycle power plant. So there is a lot of opportunity to learn about various types of power plants. During our internship we closely observed generation section, operation section, sub-station section and instrumentation and control section. In this chapter we have discussed the overall idea about APSCL, including the background, present capabilities, future plan and also objective of our internship, sources and methods of data collection.

1.1 History of Ashuganj Power Plant

For a thermal power plant, infrastructure facility like river, transportation of heavy equipments either in highway, railway or waterway, and fuel sourcing (gas networks) are mandatory. Considering the above mentioned facilities of Ashuganj an agreement was signed in 1966 with a foreign construction company to establish a thermal power plant at Ashuganj. Ashuganj which is situated near the Titas Gas field and on the bank of river Meghna was selected as the suitable place for establishing the largest power plant of the country at that time. With the acquiring of 311 acres of land on the north-east side of the Meghna Railway Bridge the construction work of Ashuganj thermal power plant was started in 1966. With the financial assistance of the German Government two units of 128 MW capacities were established. In 1968 the erection of main equipments was started and by July 1970 the two units were commissioned. At that time to establish another three units in future some facility was preserved. After the post liberation period Ashuganj power plant has played an important role in the reconstruction and economic development of the war stricken country, Bangladesh.

While plan was taken to increase the capacity of Ashuganj power plant to meet the increasing demand of electricity, M/S Lahmyer International from Germany investigated the possibility of expanding the power plant and recommended to establish three units (unit 3, 4 and 5) having a capacity of 150 MW each.

These three units were commissioned on December, 1986 and May, 1987 respectively. As the plan of establishing unit 3 and 4 was going on, at the same time another decision was taken to establish a combined cycle plant in Ashuganj by British financial support. The total capacity of this combined cycle plant is 146 MW, where two gas turbine units have 56 MW capacity each and one steam turbine unit have a capacity of 34 MW. The main equipments of this unit are made and established by GEC from England (at present ALSTOM, UK). As of the combined cycle plant GT-1, ST, and GT-2 units were commissioned in 1982, 1984 and 1986 respectively.

Main fuel used for this power plant is natural gas (coming from Titas Gas). For steam generation and cooling, the required water is taken from Meghna River. Huge amount of water used for cooling is discharged into river through discharge canal of power plant. It should be mentioned that in dry season the water coming from the discharge canal is used for irrigation of a large area on Ashuganj with the help of a sluice gate. With this water 36,000 acres of land is irrigated.

As a part of the Power Sector Development and Reform Program of the Government of Bangladesh, APSCL has been incorporated under the Companies Act 1994 on 28 June, 2000. Ashuganj Power Station Complex had been transferred to the APSCL through a Provisional Vendor's Agreement signed between BPDB and APSCL on 22 May, 2003. All the activities of the company started formally on 01 June, 2003. From that day the overall activities of the Company along with the operation, maintenance and development of the power station are vested upon a Management Team consisting of the Managing Director, the Director (Technical) and the Director (Finance).

According to the Articles of Association of the Company, 51% of total shares are held by BPDB and the rest 49% are distributed among Ministry of Finance, Ministry of Planning, and Power Division, Bangladesh Ministry of Power, Energy, and Mineral Resources.

To solve the huge deficiency of electricity of the country, the government has planned to establish new plants on quick basis. According to the direction of the government APSCL has taken a project of establishing a 50 MW plant with self finance. Accordingly for the completion of this project an agreement was signed with TSK, Spain (EPC) on 25 July, 2010. This unit is commercially generating 53 MW of electricity from 30 April, 2011 [1].

1.2 Company Profile

Vision

To become the leading power generation company in Bangladesh.

Mission

To increase Ashuganj Power Station's Generation Capacity to 1500 MW by 2014.

The Objective

Enhance the station's dependable capacity in order to comply with the government's target to provide electricity for all by 2021 and increase overall thermal efficiency of the station by installing new plant in order to generate more power consuming the same amount of gas [1].

1.3 Present Company Status

Present APSCL status is described below in table 1.

Table 1: Present status of APSCL.

Number of Generating Units	9 (6 Steam Turbines + 2 Gas Turbines + 1 Gas Engine).
	Two Steam Units of 64 MW - Unit 1 and 2 each commissioned in 1970.
	Gas Turbine Units - GT-1 and GT-2 of capacity 56 MW each commissioned in 1982 and 1986 respectively.
	One Steam Turbine (ST) of capacity 34 MW with waste heat recovery Boiler commissioned in 1984.
	Steam Unit # 3 of 150 MW capacity was commissioned in 1986.
	Steam Unit # 4 of 150 MW capacity was commissioned in 1987.
	Steam Unit # 5 of 150 MW capacity was commissioned in 1988.
	50 MW Gas Engine Power Plant was commissioned in 2011.
Installed Capacity	777 MW.
Present de-rated capacity	731 MW.
Area of Land	263.55 Acres.
Company Website	www.apscl.com [1].

1.4 Future Plan of APSCL

APSCL is currently constructing a 225 MW and 450 MW combined cycle power plant (southern side of APSCL). In addition to the ongoing projects APSCL is going to construct a 200±10% MW modular power plant and 450 MW combined cycle power plant (northern side of APSCL) [2]. Table 2 shows the future plan of APSCL.

Table 2: Future plan of APSCL.

Sl. No.	Plant	Construction period	Source of Finance.
1	Ashuganj 225 MW Combined Cycle Power plant	January, 2015	Export Credit Agency (ECA) Backed Financing.
2	Ashuganj 450 MW Combined Cycle Power Plant (South)	2015	ECA backed finance.
3	Ashugonj 200±10% MW Modular Power Plant Project		Tender evaluation going on.
4	Ashuganj 450 MW Combined Cycle Power Plant (North)		N/A

1.5 Objective of Internship

The objective of this internship is to gather practical knowledge and experience about implementation of the theoretical study in real world. In this regard this report presents the collection of knowledge and experience accumulated from the internship program. With the guidelines set by the EEE Department of East West University and our internship supervisors, 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. The project part deals with the operation of Generator Section and other divisions of APSCL. Our daily training schedule of the internship program is given in table 3.

Table 3: Our daily training schedule.

Date	Section	Time	Mentor
24-08-2012	Visiting APSCL	8.00am - 4.00pm	Md. Rokon-Uz-Zaman
25-08-2012	Generator Section	8.00am - 4.00pm	Md. Rokon-Uz-Zaman
26-08-2012	Generator Section	8.00am - 4.00pm	Md. Rokon-Uz-Zaman
27-08-2012	Winding Shop	8.00am - 4.00pm	Md. Rokon-Uz-Zaman
28-08-2012	Control Unit 1 and 2	8.00am - 4.00pm	Md. Rokon-Uz-Zaman
29-08-2012	Control Unit 3 and 4	8.00am - 4.00pm	Md. Rokon-Uz-Zaman
30-08-2012	Control Unit 5	8.00am - 4.00pm	Md. Rokon-Uz-Zaman
31-08-2012	Combined Cycle Power Plant	8.00am - 4.00pm	Md. Rokon-Uz-Zaman
01-09-2012	Battery Room	8.00am - 4.00pm	Md. Rokon-Uz-Zaman
02-09-2012	Generator Section	8.00am - 4.00pm	Md. Rokon-Uz-Zaman
03-09-2012	Generator Section	8.00am - 4.00pm	Md. Rokon-Uz-Zaman
04-09-2012	Boiler Section	8.00am - 4.00pm	Md. Rokon-Uz-Zaman
05-09-2012	Steam Turbine Section	8.00am - 4.00pm	Md. Rokon-Uz-Zaman
06-09-2012	Water Treatment Plant	8.00am - 4.00pm	Md. Rokon-Uz-Zaman
07-09-2012	Sub-station	8.00am - 4.00pm	Md. Rokon-Uz-Zaman

1.6 Sources and Methods of Data Collection

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

- By primary information we mean the information which we obtained at APSCL through hands on experience. Notes, lectures, sketches, diagrams, templates that are found in APSCL are the primary source of information.
- On the other hand the secondary information is based on internet search, reference books etc.

1.7 Report Organization

In this internship report we have mainly discussed about APSCL's generator section. We have also discussed other sections. Chapter 2 consists of Generators. Here we have discussed about working principle of an AC generator, excitation systems, other components of AC generators, excitation system, protection of generator, control units, cooling system of generator, battery backup system and repair of motor winding. Chapter 3 is about combined cycle power plant (CCPP). Here we have discussed about control unit of CCPP, generator rating of CCPP, turbine, components of gas turbine generator, steam turbine generator section. Chapter 4 consists of boilers. Here we have mentioned different components of a boiler. Chapter 5 is about sub-station. Here we have discussed about transformer, circuit breaker, relay, lightning arrester, transmission line and bus bar. In Chapter 6 we have discussed about water treatment plant. Here we have discussed about the total water treatment process done at APSCL. Chapter 7 is conclusion. Here we have mentioned the problems we faced throughout the internship. From the experience having from our internship, we have mentioned some recommendations of our own in this chapter.

Chapter 2: Generator

2.1 Introduction

Synchronous generators, also called alternators or AC generators are the principle sources of electrical power throughout the world. Generators basically follow Faraday's law of electromagnetic induction which states that, when magnetic flux changes through a circuit, an emf is induced in it and it remains only as long as the change in the magnetic flux remains through the circuit. At APSCL electric power is generated by steam turbines and gas engine. Steam of steam turbine is produced by using natural gas. In figure 1 we have shown an AC generator of APSCL [3].

Figure 1: AC generator of ST-2.

2.2 Working Principle of AC generator

AC Generator works on the principle of electromagnetic induction. In generator induced emf is produced by rotating a coil in a magnetic field. At APSCL, fuel is used to generate heat. This heat is used to heat water and produce steam. Then the steam rotates the blades of the turbine which transfers the thermal energy of the steam to mechanical energy. This turbine is attached to a generator rotor and the rotation of the turbine blades leads to the generation of electricity in the generator.

The nameplate data of AC generator-2 is given in table 4.

Table 4: Production capacity according to the units.

Rated speed	3000 rpm
Voltage	15750 V
Armature current	6965 A
Excitation voltage	323 V(at full load), 210 V (at no load)
Over speed	3600 rpm
Power factor	0.8
Output	190000 KVA

2.3 Excitation System

Generator needs direct current to energize its magnetic field. A separate source is used to obtain the DC field current. This separate source is called an exciter. Rotating type or static-type exciters are used for AC power generation systems. There are two types of rotating exciters: brush and brushless. The main difference between brush and brushless exciters is the method used to transfer the DC exciting current to the generator fields.

At APSCL three types of excitation systems are used. These are as follows:

- AC Excitation System (ST-1, 2): This system consists of a sub-pilot exciter of permanent magnet type, pilot exciter and the main ac exciter. These are all coupled to the main generator on the same shaft.
- Static Excitation System (ST-3, 4, 5): The generator field is fed from a thyristor network via brushes. Figure 2 shows a static exciter.
- Brushless Excitation System (GT-1, 2): This system consists of an exciter having stationary field system and a rotating armature diode rectifier assembly solidly coupled to the main generator rotor.

Figure 2: Static exciter used in unit 3, 4, and 5 of steam power plant of APSCL.

2.3.1 AC Excitation

The AC excitation system utilizes an AC generator as the system exciter. The AC generator, or the exciter, usually sits on top of the shaft of the main generator. Depending on how the rectification of the exciter output from AC to DC is handled, the AC excitation systems are divided in two different sub-categories. These sub-categories are stationary AC excitation system and rotating AC excitation system. For the static AC excitation system, the AC current is induced in a stationary winding. There, the AC output of the exciter is rectified to DC input of the main generator field winding. This means that the field current needs to pass from a stationary to a rotating reference system. This is mainly done through the use of carbon brushes that are in contact with slip rings on the rotating axis.

2.3.2 Brushless Excitation

Figure 3: Brushless thyristor exciter used in CCPP.

Due to brush wear and carbon dust, we constantly have to clean, repair and replace brushes, slip-rings, and commutators on conventional DC excitation systems. To eliminate the problem, brushless excitation system is used. Such a system consists of a 3 phase stationary field generator whose ac

output is rectified by a group of rectifiers. The DC output from the rectifiers is fed directly into the field of the synchronous generator. A brushless exciter is shown in figure 3.

2.3.3 Thyristor Excitation

This type of excitation system uses thyristor rectifier to directly control the generator field current and it can provide fast response by controlling the exciter field current. In thyristor excitation fed system, it is necessary to provide slip rings and brushes to connect to the machine rotor. This function is important to alert and respond to the error or fault for system stability due to critical application. But it has a disadvantage that, this system has not been developed commercially because it is expensive.

2.4 Other Components of an AC Generator

The main components of the generator are the following.

1) Stator,
2) Rotor,
3) Brush Gear,
4) Jacking oil pump.

2.4.1 Stator

The stator is also known as the armature. It is made of thin laminations of high permeable steel in order to reduce core losses. The stator lamination is held together by a stator frame. The frame is made of cast iron or mild steel plates. At APSCL cast iron and mild steel plates are both used as stator material in different units. The inside of the stator has a number of slots that are made to arrange thick armature conductors or coils or windings.

2.4.2 Rotor

The rotor is the non-stationary part of a rotary electric generator or alternator. The rotor contains magnetic fields which are established and fed by the exciter. When the rotor is rotated, AC is induced in the stator. The changing polarity of the rotor produces the alternating characteristics of the current. The generated voltage is proportional to the strength of the magnetic field, the number of coils and the speed at which the rotor turns.

2.4.3 Brush Gear

The carbon brushes as shown in figure 4 in a generator are used to connect external circuits in the generator to the rotor through the commutator. Brushes are connected to the slip ring which is connected to the rotor. Other ends of the brushes are attached to a spring, which helps the brushes to stay connected to the slip ring.

Figure 4: Carbon brush.

2.4.4 Jacking Oil Pump

The jacking oil pump is generally used for large turbine generators. It works when the shaft is rotated by the turning gear. When the generator shaft is at rest, it will squeeze oil from under the shaft at the bearing. When the generator shaft starts rotating there will be metal to metal friction until the oil can work its way below. If the generator is rotated by the turning gear, the shaft is not rotating fast enough to keep an oil hold between the shaft and the bearing. This results in metal to metal contact. To avoid this situation, the jacking oil pump injects oil at high pressure into the bearing. This tries to lift the shaft a few hundredths of a millimeter off the bearing so that there will be no metal to metal contact. When the turbine speed increased above the turning gear, jacking oil pump is no longer required. Jacking oil pump normally shuts down when the turning gear is shut down. Jacking oil pump is shown in figure 5.

Figure 5: Jack oil pump.

2.5 Synchronization of Generator

The process of connecting a generator to other AC generators is known as synchronization and is crucial for the generation of AC electrical power.

The following four conditions must be met before the generator can be connected to the power grid.

- Synchronization of frequency,
- Synchronization of voltage,
- Synchronization of phase sequence,
- Synchronization of phase angle.

2.5.1 Synchronization of Frequency

Synchronous speed is defined as rpm that corresponds to the grid frequency for a 50 Hz grid. A two-pole synchronous generator must spin at 3000 rpm. The generator must be driven by the prime mover at a speed such that the generated power frequency is equal its grid frequency.

2.5.2 Synchronization of Voltage

The stator line voltage must be equal to the line voltage of power grid. It is adjusted by a control rheostat located on the switch panel. This rheostat controls the current in the voltage regulator coil and causes the alternator magnetic field to increase or decrease, controlling in turn, the alternator voltage.

2.5.3 Synchronization of Phase Sequence

The phase sequence of the generator must be same as the phase sequence of the powers grid. If the phase sequence of the powers grid is R1-Y1-B1 then the generators phase sequence must be R2-Y2-B2. If the phase sequences are different then it can be corrected by interchanging any two terminals on the generator side or on the grid side.

2.5.4 Synchronization of Phase Angle

The fourth synchronizing variable is the voltage phase angle difference. If the phase difference between the voltages on either side of the open circuit breaker is not reduced to a small value, a large MW flow increase will suddenly occur once the circuit breaker is closed. The voltage phase angle difference is the difference between the zero crossings of the voltages on either side of the open circuit breaker. Ideally, the voltage phase angle should be as close to zero degrees as possible before closing the circuit breaker.

2.6 Protection of Generator

The following protections are used for generators in APSCL.

1. Over current with under voltage protection,
2. Over voltage protection,
3. Negative phase sequence,
4. Loss of excitation,
5. Under or over frequency protection,
6. Stator earth fault,
7. Rotor earth fault.

2.6.1 Over Current Protection

Over current means excess current flowing through the equipment or conductor over the rated current. It may happen due to overload, short circuit, or ground fault. Figure 6 shows an over current protection circuit. If the cables come into contact with each other there will be short-circuit and the generator windings could be damaged by excessive current unless the generator windings and cables are protected by a circuit breaker. The circuit breaker breaks the circuit anytime. There is a short circuit or overload condition in the load cables. If the load of the power generator decreases suddenly but synchronous speed is not adjusted on time, then a large current flows through the generator to bus bar line, which in turn may cause severe damage and hazard. To protect this

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

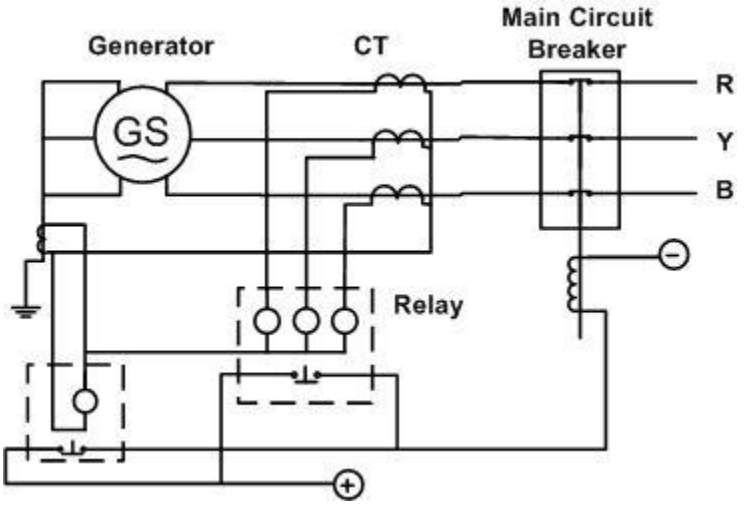

Figure 6: Over current protection circuit.

2.6.2 Over Voltage Protection

Over voltage occurs when prime mover speed is suddenly increased due to sudden loss on the generator load. The over voltage protection is required for the steam turbine generator and gas turbine generators. At APSCL the over voltage protection is provided by two over voltage relays. Each relay has two units – one is the instantaneous relay which is set to pick up at 130 to 150% of the rated voltage and another unit is Inverse Definite Minimum Time which is set to pick up at 110% of rated voltage.

The reason for 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.

2.6.3 Negative Phase Sequence

In a three phase AC circuit, current consists of 3 sequences, positive sequence, negative sequence and zero sequence current. The positive phase sequence current flows as per the load connected to

the circuit. The negative phase sequence current will flow due to difference of three phase voltages of the system. Whenever there is an unbalance in circuit, the unbalanced currents will have a negative phase sequence component. At APSCL a negative phase sequence relay is essentially provided for the protection of generators and motors against unbalanced loading which is caused due to phase-to-phase faults. Such relay has a filter circuit, which is responsive only to the negative sequence components. The zero sequence current is present only in case of earth fault otherwise it is absent.

2.6.4 Loss of Excitation

The loss of excitation of the generator may result in the loss of synchronism and slightly increase in the generator speed. The machine starts behaving as an induction generator. It draws reactive power from the system which is undesirable. The loss of excitation may lead to the pole slipping condition. Hence protection against loss of excitation must be provided. At APSCL the protection is provided using directional distance type relay with the generator terminals. The relay operates when generator first starts to slip poles. Then relay trips the field circuit breaker. And it disconnects the generator from the system, too. When the excitation is regained and becomes normal, the generator can then be returned to service instantly.

2.6.5 Under or Over Frequency Protection

(i) Over frequency :

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.

(ii) Under frequency :

Under frequency occurs due to the excess amount of generator load currents and over excitation. 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 to or greater than the connected load. If the load exceeds the generation, then frequency will drop and some loads are needed to be shed down to create a balance between the generator and the connected load. The rate at which frequency drops depends on the time, amount of overload and also on the load and generator variations as the frequency changes. Frequency decay occurs within seconds so it cannot be corrected manually.

Therefore automatic load shedding facility needs to be applied. These schemes drops load in steps as the frequency decays. Generally load shedding drops 20 to 50% of load in four to six frequency steps. Load shedding scheme works by tripping the sub-station feeders to decrease the system load. Generally automatic load shedding schemes are designed to maintain the balance between the load connected and the generator.

The present practice is to use the under frequency relays at various load points so as to drop the load in steps until the declined frequency return to normal.

During the overload conditions, load shedding must occur before the operation of the under frequency relays. In other words load must be shed before the generators are tripped.

2.6.6 Stator Earth Fault

Detection of this type of fault within a generator is one of the important protection tasks. When generator neutral is earthed through high impedance, differential protection does not protect the complete alternator stator winding against such earth faults; hence a separate sensitive earth fault protection is necessary. The method for sensitive earth fault protection depends upon the generator connection. At APSCL the neutral is connected through a voltage transformer. The earth fault current is limited to magnetizing current of the voltage transformer along with the zero-sequence current of generator.

2.6.7 Rotor Earth Fault

A sensitive rotor earth fault protection is required for large generators. Two protective stages are necessary due to the risk of a double earth fault and the possibility of big damages on the generator side. One is for alarm and one is for trip. A single ground fault does not cause flow of current since the rotor circuit is ungrounded. When the second ground fault occurs part of the rotor winding is by passed and the currents in the remaining protection may increase. This cause unbalances in rotor and may cause mechanical as well as thermal stresses resulting in damage to the rotor. In some cases the vibrations have caused damage to the bearings of rotor shaft. Such failures have caused extensive damage. Here a high resistance is connected across the rotor circuit. The center point of this is connected to the earth through a sensitive relay. The relay detects the earth faults for most of the rotor circuit except the center point of the rotor.

2.7 Control Unit

Control unit is one of the most important parts of the power plant. There will be a control room to operate the switchgear, generator, motor, relay, turbine etc. At APSCL there are four control rooms for different units.

1. Control room of unit 1 and 2,
2. Control room of unit 3 and 4,
3. Control room of unit 5,
4. Control room of Combine Cycle Power Plant (CCPP).

2.7.1 Control Unit 1 and 2

In control room 1 and 2 of APSCL, the operating system is totally manual and analog. This control room is for generators 1 and 2. All the auxiliaries such as, boiler, condenser, burner, feed water pump, Low Pressure (LP) and High Pressure (HP) heater etc of generators 1 and 2 are controlled from this control room. In figure 7, we can see the meter board and control switches of control room of unit 1 and 2.

Figure 7: Control room of unit 1 and 2.

2.7.2 Control Unit 3 and 4

Control unit 3 and 4 are used for generator 3 and 4. In this control room auxiliaries like LP, Intermediate Pressure (IP), HP turbine, boiler control system, automatic tripping system, feed water flow transmitter etc are controlled. In unit 3 and 4, APSCL is using PLC (Programmable Logic Controllers). These are digital computers. These are used for automation of electromechanical process. These function in such a way that these can store instructions for instance timing, arithmetic, sequencing, counting, data manipulation and communication.

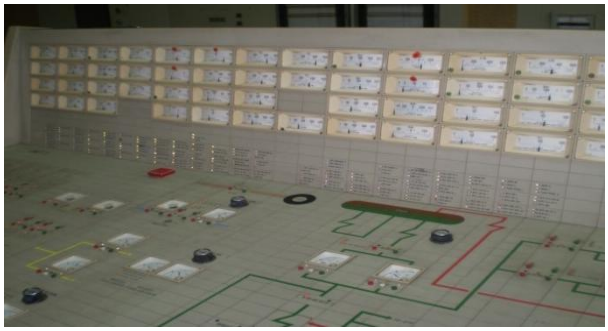

Figure 8: Control room of unit 3 and 4.

In figure 8, we can see the meter panel board displaying every reading of the system.

2.7.3 Control Unit 5

Control unit 5 is fully computer operated. The operating system of the computer is Linux based operating system. In this control room all the auxiliaries connected to the generator are controlled by computer.

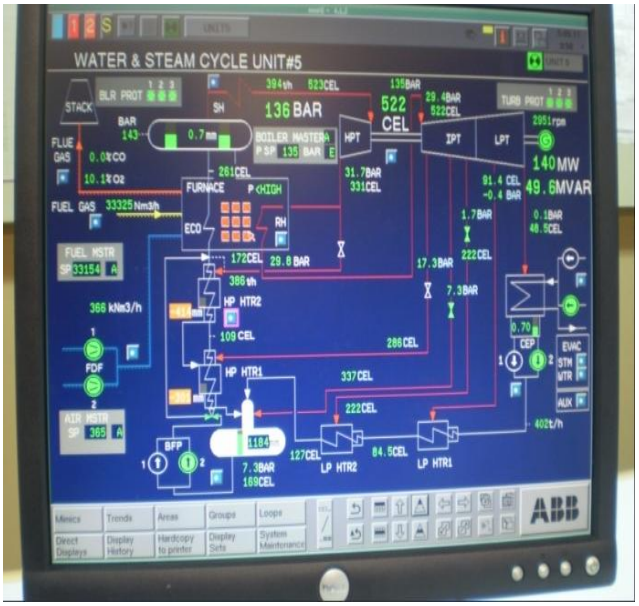

Figure 9: Control system of unit 5.

Figure 9 shows the control system of unit 5. We can see that there is no meter board or display board except a computer. The whole generation system of this unit is controlled by the operating system.

2.8 Cooling System of Generator

When current flows through a conductor, heat is generated. A generator has a lot of conductors and a very high amount of currents flow through these which produce a lot of heat. If the heat is not removed the windings of generator will be damaged.

There are three kinds of systems for generator cooling.

1. Water cooling,
2. Air cooling,
3. Hydrogen cooling.

In APSCL, we learned about water cooling and air cooling systems of generator.

2.8.1 Water Cooling

Steam turbine generators of APSCL are cooled by water. The stator winding of the turbo generator is cooled by circulating de-mineralized water through hollow conductors of stator winding bars in a completely closed cycle. A turbo generator is an electric generator driven by a steam turbine for the production of electric power. The pump drives the water through the cooler filters and windings and discharges it into a separate compartment of a sealed expansion tank mounted 5 meter higher from the center line of generator. The water from the center of the expansion tank drawn by the circulating pump is again cooled and re-circulated. If the pressure of the de-mineralized water falls below a particular value, the other pump automatically starts. The closed cycle de-mineralized water is in turn cooled by de-mineralized water supplied from the de-mineralization plant. The temperature of cooling water is 34° C [4].

2.8.2 Air Cooling

In gas turbine generator plant of combined cycle, air is used for the purpose of generator cooling. Air is used to cool a generator by circulating it through the generator to absorb heat and then exhausting the air to another area outside of the generator. A continuous flow of air from the outside of the generator, through the generator, to another area outside of the generator will cool the generator and rotor. The air entering the generator is cooler than the generator. The cooling air inlet of the generators is 43° C.

2.9 Battery Backup System

Battery is used to supply the power to the control room and also to save the generator, if needed. The DC power is always used in control system. The electricity that is coming from the battery is produced due to the conversion of chemical energy to electrical energy.

For the backup purpose we use the battery. There are two kinds of battery in APSCL.

1) Lead acid battery,
2) NiCd battery.

Figure 10: Battery arrangement of back-up system.

We visited the battery room of unit 3 and 4. NiCd battery cells are used there. In figure 10, we can see the arrangement of NiCd battery cells.

NiCd battery is expensive. The difference is that in the lead acid type battery the sulfuric acid is used and in NiCd type battery potassium hydrochloric acid is used. Inverter is used to convert the DC voltage into AC. The voltage of each NiCd battery is 1.2 V. Total battery section output is 220 V. To get 220 V, the batteries are connected in series. There are 184 NiCd battery cells.

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

1) The tightness capacity: This test is done to check any loose connection in the battery. If there is any loose connection then it will be fixed.
2) Breathing test: This test is done to find any chemical reaction inside the battery.

3) Liquid level test: Nickel cadmium is emerged into 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. So battery cells are kept at regular observation to maintain the liquid level.

5) Specific gravity test of battery cells: The specific gravity is tested by the hand hydrometer of the acid. The specific gravity should be in the range of 1.180-1.220. It is a unit less parameter.

6) Cell voltage test: Here voltage level of each battery is checked. For NiCd battery, nominal voltage: 1.2 V, floating voltage: 1.4 V, boost voltage: 1.6 V.

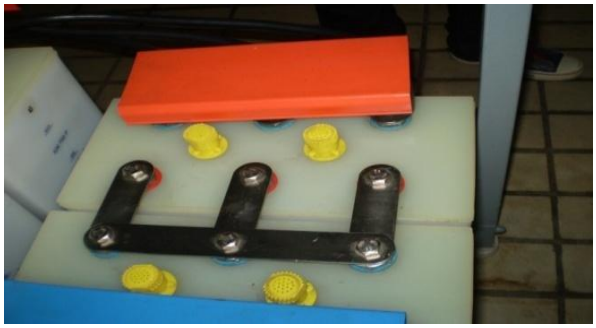

Figure 11: Series connection of batteries.

From figure 11, we see that how the battery cells are connected in series in battery room.

2.10 Repair of Motor Winding

The first and most important job of motor repairing is to identify the damaged part of the motor. For this purpose the following steps are taken.

2.10.1 Observation

Observation of the motor is very important to identify the damaged part. If any part inside the motor is damaged, sometimes it can be easily found by careful observation without any electrical test. If the motor is burnt then by observing the internal and external part of the motor one can easily find that out.

2.10.2 Megger Test

The insulation resistance test is commonly known as megger test. The device uses an applied DC voltage (typically 250 Vdc, 500 Vdc or 1,000 Vdc for low voltage equipment (<600 V) and 2,500 Vdc and 5,000 Vdc for high voltage equipment) for measuring the insulation resistance in either kΩ, MΩ or GΩ. The measured resistance indicates the condition of the insulation between two

conductive parts. The higher the resistance, the better the condition of the insulation. As the device is portable, megger test is often done in the field for final checking of the equipment insulation. It also checks the reliability of the circuit [5].

Figure 12: Megger testing.

In figure 12, we can see that a faulty motor is being checked by the megger device.

2.10.3 Sketching of the Winding Configuration of the Motor's Stator

APSCL keeps sketches of various types of motor winding in case any new type of winding motor comes into repairing shop. When a motor of a new configured winding comes for repairing, the sketch is drawn prior to re-winding of the motor. This is done by sketching the faulty motor's windings. Therefore it becomes easy to un-wind and then re-wind the coil of the motor. Figures 13 interprets the sketching of motor coil windings of one of the vacuum pump motors of unit 3.

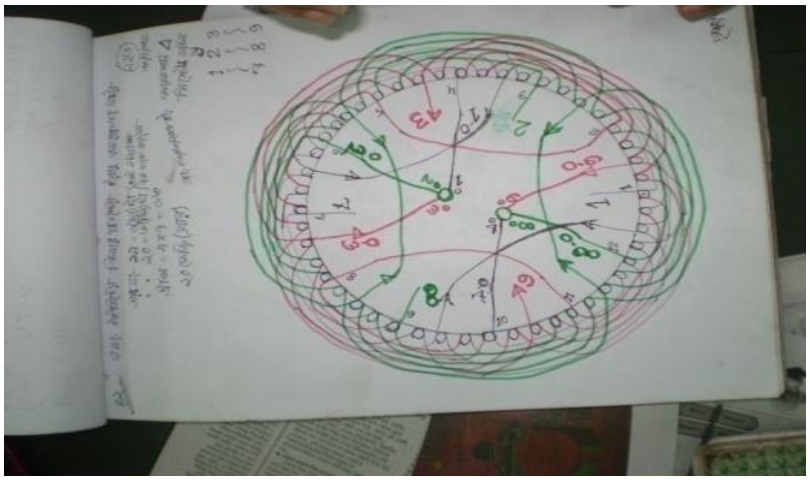

Figure 13: Sketching of motor windings.

2.10.4 Replacing with New Coil

While repairing the damaged winding of the stator or rotor the worker will unwind the winding coil and re-wind it with fresh new coil. This is carefully done by following the winding design which is

sketched earlier. After the winding is done the coil is again tested by megger. While re-winding is performed the delta-wye connection is carefully observed. In figure 14, we can see how a new coil is introduced in the motor.

Figure 14: Re-winded motor.

Chapter 3: Combined Cycle Power Plant (CCPP)

3.1 Introduction

When we visited Combined Cycle Power Plant (CCPP) as per our schedule, the instructor gave us a brief lecture about it. It is a different type of power generation plant from others in APSCL. Here, the gas turbine generates power initially and then produces more power from the exhaust gas. The secondary generator is steam turbine type generator. It takes heat energy from the exhaust gas. It has the temperature of about 450°- 650° C. Combination of the two types of generator has made the system more power efficient. Normal gas turbine fuel efficiency is 50%. The remaining heat from combustion is generally wasted. Combination of two or more thermodynamic cycles results in an improved overall efficiency and reduction in fuel costs [6].

In APSCL, there are two sections in Combined Cycle Power Plant.

a) Two Gas Turbines (GT-1 and GT-2) ,
b) One Steam Turbine plant.

In Combined Cycle plant of APSCL, the main fuel of plant is gas, which comes from Titas Gas.

In figure 15, we can see the whole design of CCPP. We can see gas turbine 1, gas turbine 2, steam turbine and boiler section in the diagram.

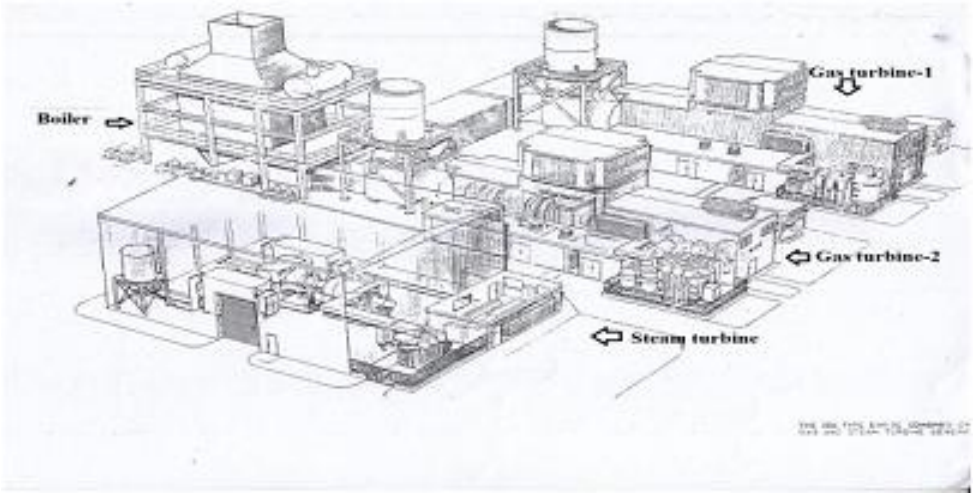

Figure 15: Top view of CCPP in APSCL.

3.2 Control Unit of CCPP

Control unit of the CCPP is one of the most important parts of the plant. From the control unit each and every part of the system can be controlled or monitored.

Control unit consists of fault checking display, meter panel, temperature checking panel, vibration checking meter, boiler water level checking meter etc.

3.2.1 Fault Checking Interface

Fault checking interface is an interface device which indicates whether any fault occurs or not in a display board. If any fault occurs in the system, there glows the light on particular parameter in the display board. If the fault is removed from the system, light is automatically turned-off. Figure 16 shows the display system of checking faults in the system of CCPP.

Figure 16: Fault checking interface of control unit.

3.2.2 Meter Panel

Meter panel is the device which is only used for monitoring purpose. Meter panel shows every reading of the system, such as: output power (active and reactive power), output voltage, frequency etc. Figure 17 shows the meter reading of every parameter in the system.

Figure 17: Meter panel of CCPP control unit.

3.2.3 Temperature Checking Panel

Boiler temperature can be checked from the control room, by using this panel. And also control of the temperature of every stage of the boiler can be performed from control room. It is necessary to maintain a specific temperature at every stage. Figure 18 shows the panel board of temperature checking of various stage of boiler.

Figure 18: Temperature measuring panel of CCPP control unit.

3.2.4 Vibration Checking Meter

Shaft vibration can be checked from the control room by using vibration checking meter. If shaft vibration exceeds a minimum range it becomes unbalanced, so it should be checked. Figure 19 shows the meter reading of vibration of the shaft.

Figure 19: Vibration checking meter of CCPP control unit.

3.3 Generator Rating of CCPP

CCPP of APSCL includes two gas turbine generators (GT-1, 1982 and GT-2, 1986) and one steam turbine generator (ST, 1984). One gas turbine generator (GT-1) is combined with steam turbine generator (ST) and other gas turbine generator (GT-2) is open cycle, which means its exhaust

wastes heat in the atmosphere. But at first GT-1 and GT-2 were both combined with ST, but it was not as efficient as expected. So now GT-1 is combined with ST.

From table 5, we can have a general idea of CCPP generation system and process.

Table 5: Specifications of combined cycle power plant.

	Gas Turbine 1 (GT-1)	Gas Turbine 2 (GT-2)	Steam Turbine (ST)
Manufacturer	GEC, England	GEC, England	GEC, England
Year of commissioning	1982	1986	1984
Output Voltage level (KV)	13.8	13.8	13.8
Installed capacity (MW)	55.67	55.67	34
De-rated capacity (MW)	35 - 38	40	16 - 18
Inlet temperature (ºC)	1010	1010	569
Outlet temperature (ºC)	569	569	80 - 120
Rotational speed (rpm)	3000	3000	3000
Efficiency (%)	20.14	20.14	27.79

3.4 Turbine

3.4.1 Gas Turbine Generator Section

The generator section of a combined cycle power plant which employs gas turbine as the prime mover for the generation of electrical energy is known as a gas turbine section of a combined cycle power plant. Gas turbine generator section is one of the most important sections of the combined

cycle. Here gas is used as a fuel. Compressor sucks the air from the atmosphere through the three stage air filter, and sends it to the combustion chamber.

In figure 20, we can see the different sections and parts of gas turbine generator.

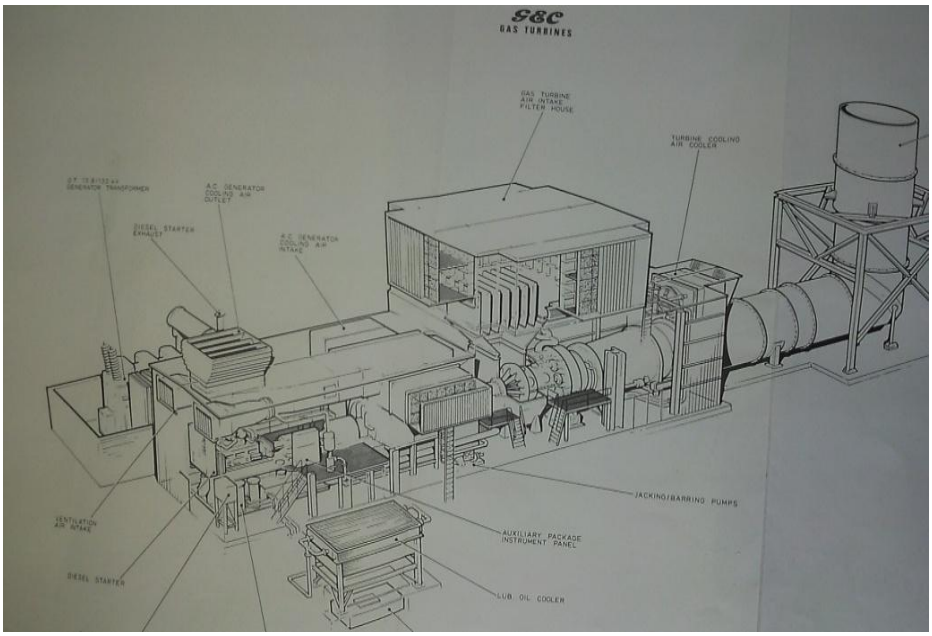

Figure 20: Gas turbine generator section, 55.67 MW.

3.4.2 Operation

This power station is run with natural gas as fuel. The turbines draw in air at the front of the unit and then compress, mix with fuel and ignite the mixture at high pressure. The hot gas released expands through the turbine blades connected to the turbine shaft. The shaft turns thus developing mechanical energy which is converted into electrical energy by the generator. Compared to the steam turbine power plant in APSCL, the area of the gas turbine power plant is less. This gas turbine produces a huge noise compared to the steam turbine plant. The gas turbine plant has an advantage that it starts faster than steam turbine plant.

3.5 Components of the Gas Turbine Generator Plant

Gas turbine generator plant consists of diesel engine, compressor, combustion chamber, turbine, AC generator etc.

3.5.1 Diesel Engine

It is an essential part in gas turbine power plant. The gas turbine is not a self starting machine. Before the turbine starts the air cannot be sucked by the compressor automatically because the

compressor is coupled to the turbine. So a diesel engine is coupled to turbine to rotate the turbine at the beginning for helping to suck air by the compressor. Figure 21 shows a diesel engine of gas turbine of generator section.

Figure 21: Diesel engine of gas turbine generator section.

3.5.2 Compressor

In gas turbine section, compressor is one of the most important parts. Compressor is a mechanical device that sucks the air from atmosphere through the three stage air filter. It increases the pressure of the air by reducing its volume and delivers it to the combustion chamber. There are two types of blades. One is rotating type blade and another is stationary type blade. The rotating type blade sucks the air from the atmosphere and pushes it between the stationary type blades and increases its pressure at a ratio of 1:8 bar. There are two types of compressors. These are centrifugal compressor and axial compressor. In APSCL, axial compressor is used. The gas turbine and the compressor are mounted on the same shaft. If the gas turbine speeds up, it also causes the compressor to speed up and it forces more air through the combustion chamber.

3.5.3 Combustion Chamber

The combustion chamber in gas turbines is called the combustor. The combustor is activated by feeding high pressurized air and compressed gas mixture. The gas is fed through the chamber through narrow pipes at high pressure. A rod known as ‘ignition rod’ made up with carbon is injected to turn the burner on. The process is same as using spark plugs to ignite petrol engines. The combustion chamber consists of 10 burners. Here the temperature is very high (1010° C).

3.5.4 Gas Turbine

Gas turbine is very important part of a gas turbine generator plant and it is a mechanical device, which converts the heat energy to mechanical energy. Here in APSCL axial flow gas turbine and impulse type turbine is used. Flue gas from the combustion chamber with high temperature and pressure hits the turbine and thus do the mechanical work. The turbine capacity depends on ambient temperature, in APSCL's turbine capacity is 55.67 MW for 35º C temperature, but it was designed such as that it can produce 70 MW output power in 15º C temperature.

3.5.5 Gas Generator

Generator is an electromechanical device, which converted mechanical energy into electrical energy, for gas generator, gas is used as a fuel. APSCL uses three phase generator, whose output voltage is 13.8 KV and output power is 55.67 MW.

In table 6, we can see the characteristics and features of gas generator.

Table 6: Gas generator features.

Number of Poles	2
Rated Speed	3000 rpm
Output voltage	13.8 KV
Output power	55.67 MW
De-rated output power	34 MW
Manufacturer	GEC, England

3.5.6 Gearbox

Gearbox is a mechanical device, which is used for connecting or disconnecting the diesel engine with the shaft. Initially the diesel engine is used as a starter for gas turbine. When gas turbine is rotating at 1800 rpm, diesel engine disconnects automatically with the help of the gearbox from the shaft and gas turbine keeps rotating to the rated speed.

3.6 Steam Turbine Generator Section

Steam turbine generator plant is one of the major parts in a combined cycle. In steam turbine generator, steam is used for rotation of turbine. In combined cycle, for steam turbine generator there is no fuel cost required for producing steam. Here in APSCL steam is produced by the use of waste heat, which is exhausted from the gas turbine. So steam turbine generator plays a vital rule in the combine cycle power plant.

In steam generation process there are several equipments. In CCPP of APSCL following equipments are used.

3.6.1 Waste Heat Recovery Unit (WHRU)

Waste heat recovery unit is a unit, where steam is produced by using waste heat from the exhaust of gas turbine generator. Waste heat recovery unit is a very important part of the steam turbine generator plant of combined cycle. In APSCL, steam generating capacity of waste heat recovery unit is 126 ton/h, but present de-rated capacity is 80 ton/h.

Waste heat recovery unit consists of many parts such as Low Pressure (LP) evaporator, forced flow section or High Pressure (HP) economizer, HP evaporator, HP super heater, deaerartor, HP & LP boiler drum, makeup water tank, feed water pump, circulating water pump etc.

3.6.2 Deaerator

A deaerator is a device that is widely used for the removal of air and other dissolved gases from the feed water to steam-generating boilers. In this case it is also used as the preserver of feed water which comes from the condenser by extraction pump. At this stage the temperature of feed water which enters the deaerator is 40° C. From deaerator the feed water is flowed to the low pressure boiler drum through low pressure economizer. From the LP boiler the feed heating steam is flowed inside the deaerator which has 100° C temperature.

3.6.3 Low Pressure Economizer (LP Economizer)

The feed water is heated in this section before it goes to the low pressure boiler at low pressure. Boiler feed pump is used to circulate feed water to the low pressure economizer. Feed water is inside the tubes and exhaust gas is flowed over the tubes. This part is at the top of the boiler where the temperature of exhaust gas becomes relatively low. From the LP economizer the feed water goes to the LP boiler drum.

3.6.4 Low Pressure Boiler Drum

The feed water is reserved into this drum after it passes through the LP economizer. The feed water is pumped from the LP boiler drum to the low pressure evaporator. At the top of the low pressure boiler drum steam gathers. This steam is then transferred to the low pressure turbine.

3.6.5 Low Pressure Evaporator

At the low pressure evaporator the feed water is heated at low pressure. It is placed below the LP economizer. Feed water flows through the tubes and exhaust gas is flowed over the tubes. From the low pressure evaporator the evaporated feed water is again transferred to LP boiler drum. From the LP boiler drum, evaporated feed water is then flowed to the high pressure economizer.

Then from HP economizer, the feed water is supplied to the high pressure boiler drum. The feed water is pumped from the HP boiler drum to the high pressure evaporator where the feed water becomes saturated steam by the help of the heat of exhaust gas. From the HP evaporator the steam is then transferred to the HP boiler. From the HP boiler drum the steam then flows to the super heater. From the super heater the super heated steam goes to the high pressure turbine at a temperature of 400° C and pressure of 40 bars.

3.7 Steam Turbine

The steam turbine used in CCPP is almost the same as steam turbine used in the steam power plant. In CCPP of APSCL there is one steam turbine. This steam turbine has two sections or chambers. These are:

1. High pressure turbine chamber,
2. Low pressure turbine chamber.

There is another section or chamber of steam turbine. That is Intermediate Pressure (IP) turbine. The size and characteristics of the blades of the turbines of these sections are different from one another.

3.7.1 High Pressure Turbine (HPT)

The high pressure (HP) turbine is the first main engine turbine to receive steam from the super heater. It is designed to efficiently extract work out of high pressure steam. As steam impacts the moving blades, it pushes the blades forward. This impact causes the steam to lose velocity without losing pressure. Figure 22 shows the arrangement of three types of turbines on a single shaft which is rotating at a speed of almost 3000 rpm.

Figure 22: Arrangements of three turbine section.

3.7.2 Intermediate Pressure Turbine (IPT)

From the boiler re-heater, the steam enters into the intermediate pressure turbine. IPT blades are larger than HPT blades and blades are fixed with the shaft. Thus, steam hits the blades to rotate the shaft.

3.7.3 Low Pressure Turbine (LPT)

The LPT is located next to the IPT. Steam comes from IP turbine to LP turbine. In low pressure the steam expands and creates pressure on the turbine blades. LPT blades are comparatively larger than others. So the steam entering LP chamber is at a lower pressure than others [7].

Chapter 4: Boiler

4.1 Introduction

There are five boilers in APSCL to generate steam for the power plant. On September 04, 2012 we observed the boiler section. The main purpose of the boiler section is to produce the steam which is used to run the turbine. The basic task of a boiler is to turn water into steam, in this case super-heated steam. The boilers are stack drum type, which means there are drums within the boilers and flue gas passes through the stack to atmosphere. The upper drum is called a boiler drum from where saturated steam leaves the boiler. The lower drum is called the mud drum, where liquid feed water enters. Tubes are used to connect the two drums. All the energy required within the boiler is produced by the combustion of a fuel. In this section we discuss about water tube boiler, furnace, pressure gauge, feed water pump, condenser, burner, boiler drum, super heaters, and economizer. The boiler is shown in figure 23. The capacity of different boilers used in steam power plant of APSCL is shown in table 7.

Figure 23: Generator unit 3 boiler.

Table 7: The capacity of different types of boilers used in steam power plant of APSCL.

Characteristics	Steam power plant section	
	Unit 1, 2	Unit 3, 4, 5
Maximum capacity	270 ton/hr	450 ton/hr
Efficiency	90%	86.8%

4.2 Different Components of a Boiler

4.2.1 Water Tube Boiler

Water tube boiler is used as a high pressure boiler. Water tube boiler is a type of boiler in which water circulates through tubes which is heated externally by fire. The fuel is burned inside the furnace, creating hot gas which heats water in the steam generating tubes. The water tube boilers are easy to install, can be taken apart for maintenance and are highly efficient. In every steam power plant there are three stage water tube boilers.

4.2.2 Furnace

Furnace is the chamber inside the boiler where natural gas or coal is burned with the presence of air for producing heated gas or flue gas. The ratio of gas and air is 1:10. In steam turbine power plant of APSCL each furnace chamber has nine furnaces. The temperature inside the furnace chamber is 1200-1500° C. The treated water from the feed water tank through economizer enters into the furnace through tubes and the flue gas produced inside the furnace passes around the tubes. By this way flue gas releases heat to the water and water becomes saturated steam. Temperature of this saturated steam is about 260° C. At the beginning of the firing of the burner small amount of natural gas and air is needed. This small amount of gas is known as ignition gas which is supplied into the burner by ignition pipe or line. When the ignition line of the burner is turned off, the main line for fuel and air supply is turned on. The draft fan forcefully supplies air to the furnace and then the saturated steam from the furnace goes to the boiler drum.

4.2.3 Pressure Gauge

In APSCL, the pressure rating of flue gas and steam are measured by pressure gauges. Typically, pressure gauges are devices which are used for measuring the pressure of any gas or liquid. The following pressure gauges are used in APSCL.

- Steam pressure,
- Feed water pressure,
- Gas pressure.

Each boiler has to be provided with a pressure transmitter which measures the pressure at which the steam is being generated in the boiler. The transmitter is usually mounted at the front top of the

boiler shell or drum. The gauge has to be clearly visible to the attendant so that he can easily record the pressure reading. These gauges are used to measure gas and air pressures.

4.2.4 Feed Water Pump

Feed water pump is used for pumping feed water from feed water tank to high pressure heater. In steam power plant of APSCL there are two feed pumps in each boiler. One is standby and another is active. In unit 5 of steam power plant we have seen that the feed water pump transfers feed water to the economizer through a by-pass line because the high pressure heater is out of work. The feed water tank and the feed water pump are shown in figures 24 and 25 respectively.

Figure 24: Feed water tank.

Figure 25: Feed water pump.

4.2.5 Condenser

Condenser recovers the waste heat which is normally rejected to the atmosphere from the flue gas to a conventional boiler. This is accomplished by using an extra-large heat exchanger or sometimes two heat exchangers within the boiler which maximize heat transfer from the burner as well as recover useful heat which would normally be lost with the flue gas. Condenser creates a very low pressure at the exhaust of turbine, which in turn permits expansion of the steam in the prime mover to a very low pressure. This helps in the conversion of heat energy of steam into mechanical energy

in the prime mover and the condensed steam can also be used as feed water to the boiler. Condenser is shown in figure 26.

Figure 26: Condenser.

4.2.6 Boiler Drum

Water is reserved in the boiler drum which comes from the economizer. Inside the boiler drum the level of water is measured by a level transmitter. If the water level crosses the limit then the plant will trip. So it is very important to control the level of the water. This is done by an automatic system. From the boiler drum the saturated steam is transferred into super heater.

4.2.7 Super Heater

Super heater is a part inside the furnace where saturated steam is converted into a super heated steam. There will be no water content in the super heated steam. So the super heater converts the wet saturated steam into dry high temperature steam. In each steam power plant of APSCL, the temperature of the super heated steam inside the super heater is about 523° C. This super heated steam is then supplied to the high pressure turbine at a pressure of 135 bar. There are three super heaters inside the boiler section of every steam power plant of APSCL. There are bundle of tubes inside the super heater which carries the saturated steam and the flue gas passes around these tubes. While passing around the tubes the flue gas releases heat and the saturated steam receive the heat and become dry and super heated.

4.2.8 Economizer

The economizer is a device which recovers some of the heat carried by exhaust flue gas. The recovered heat is utilized to raise the temperature of feed water. Then the feed water at raised temperature is supplied to the boiler. If the feed water at raised temperature is supplied to the boiler, it needs less heat to convert the water into steam. As a result consumption of fuel decreases.

CHAPTER 5: Sub-Station

5.1 Introduction

A sub-station is the assembly of apparatus used to change electric supply. Incoming power comes from generator to sub-station and transmission and distribution lines are outgoing from sub-station. In a sub-station there are measuring and protecting equipments for operating sub-station. Transformers are used to change the voltage level and also for measurement and protection purpose. On September 07, 2012 we observed the transformer section. In this section we were briefed about the transformer, circuit breaker, relay, lighting arrester and bus bar. We discussed how these equipments work and their working principles.

5.2 Transformer

Transformer is an important and expensive part in sub-station. Generally there are two types of transformers. These are

1. Power transformer,
2. Instrument transformer.

5.2.1 Power Transformer

The power transformer is used in the sub-station to step up the voltage. To supply the power to the grid, the generated voltage at the generator is stepped up at the sub-station through the power transformers. Most of the power transformers at the sub-station of APSCL are rated up to 100 MVA. Total twenty power transformers are used at APSCL. APSCL has five units in steam generation section and for every unit there are three power transformers and one auxiliary transformer. At APSCL both single phase and 3 phase power transformers are used. Unit 1 and 2 are connected to the 132 KV bus bar and the generator output is 15 KV. So its primary winding output is 15 KV and secondary winding output is 132 KV. Unit 3, 4, 5 are connected with 230 KV bus bar. Step up transformer is shown in figure 27. The transformer includes radiator, bushing, transformer tank and relay.

Figure 27: Step-up transformer.

5.2.2 Instrument Transformer

Instrument transformer is used to step down the voltage or current. Instrument transformer is mostly used for measuring and protection purpose.

There are two types of instrument transformers.

- Potential transformer,
- Current transformer.

Potential Transformer

APSCL uses outdoor type 132 KV rated voltage potential transformer. Potential transformers are mainly used for protective relaying purpose and operation. The rating of a potential transformer at APSCL has been given below in table 8. And the potential transformer is shown in figure 28.

Table 8: Potential transformer's rating.

Rated voltage	132 KV
Secondary voltage	110 V
Burden	60 VA
Highest system voltage	145 KV
Insulation level	275/650 KV
Rated frequency	50 Hz
Class of accuracy	0.2
Ratio	132000/110

Figure 28: Potential transformer (PT).

Current Transformer

Current transformer is used to step down the current. It is a voltage step up transformer. The current transformer that is used in APSCL 132 KV sub-station is made by Crompton Greavas. We saw a current transformer used in 132 KV bus system. Table 9 shows the nameplate data of the current transformer which is shown in figure 29.

Table 9: Rating of current transformer.

Rated current	1920 A
No. of phase	Single phase
Ratio	800/1
Burden	30 VA
Rated frequency	50 Hz
Class of accuracy	0.2

Figure 29: Current transformer (CT).

5.3 Circuit Breaker

A circuit breaker is a protective device which protects electric load devices and electric power cables from a large fault current caused by an electrical short circuit or a ground fault that can be generated on an electrical circuit. It also performs the breaking operation automatically when such fault current is generated. When the fault occurs, electric circuits detect the fault current and give a trip signal. SF6 circuit breaker is shown in figure 30. The following types of circuit breakers are used in APSCL.

1. SF6 circuit breaker,
2. Air blast circuit breaker,
3. Oil circuit breaker.

Figure 30: Oil circuit breaker.

At APSCL the oil circuit breakers are used in 132 KV and 33 KV bus bars. SF6 circuit breakers are used in 132 KV and 230 KV bus bars. We saw the number plates of oil circuit breaker and SF6 circuit breaker. The rating of oil circuit breaker and SF6 circuit breakers are given in the table 10 and 11 respectively.

Table 10: Rating of oil circuit breaker.

Type	3AP1DT
Rated voltage	145 KV
Rated lightning impulse withstand voltage	650 KV
Rated power frequency withstand voltage	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
Rated line-charging breaking current	50 A
Temperature class	-25 to +55° C

Table 11: Rating of SF6 circuit breaker.

Type	H 801-132/1250-5000E
Rated voltage	132 KV
Max. service voltage	170 KV
Rated current	1250 A
Breaking capacity	5000 MVA
Frequency	50 Hz
Natural frequency	1.5 KHz
Making current	55/43 KA
Short time current	32 KA

5.4 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 sides of the circuit breaker. We observed relay panel and how to operate it. Relay panel operates by DC power supply. There are two different sources of DC power supply which are connected in parallel with relay panel. The DC power sources are DC batteries and grid. Grid provides DC power to the relay by using rectifier which converts AC into DC power. Because of safety reasons, we could not test and operate relay [8].

The following types of relays are used in APSCL.

1. Induction type relay,
2. Classical relay,
3. Percentage differential relay.

Induction Type Relay

Induction type relay is used for inductive load and over current protection in APSCL's sub-station. It has Inverse Definite Minimum Time (IDMT) characteristic. In this relay angular force is used for time adjustment. The relay is sensitive to direction. This type of relay is used for providing protection of generator, motor and feeder at APSCL [8].

Classical Relay

Classical relay is the first protection device. At APSCL electromagnetic attraction type double quantity classical relay is used. The operation time of this relay is constant. The construction of this relay is very simple. Operating current of this relay can be adjusted easily [8].

Percentage Differential Relay

At APSCL percentage differential relay is used to give protection of power transformer. This type of relay identifies internal fault only. There are two current transformers connected to the two end point of the protection part in percentage differential relay. The current difference between the two current transformers passes through the operating coil of the differential relay. If the current difference is greater than zero then the relay will operate [8].

5.5 Lightning Arrester

Lightning Arrester is used to protect the sub-station equipments from lightning surge at APSCL. Lightning arrester is also known as surge arrester. It has a high voltage terminal and a ground terminal. When thunder strikes then arc is formed to provide a low resistance path for surge to the ground. In this way the excess charge is grounded. Figure 31 shows the lightning arrester.

The following types of lighting arresters are used in APSCL.

1. Zinc oxide arrester,
2. Over head lightning arrester,
3. Metal oxide arrester,
4. Rod gap lightning arrester.

Over head lightning arrester is used at the top of the sub-station. Rod gap lightning arrester is used to protect transformer against lightning surge. Over head lightning arrester and metal oxide arrester are used in different sections of the sub-station.

Figure 31: Zinc oxide lighting arrester.

5.6 Transmission Line

Transmission line is a material medium or structure that forms a path for directing the transmission of energy from one place to another. Overhead lines are used for transmission lines. In APSCL after producing the electric power it is supplied to the transmission line for distribution.

5.7 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 uses double bus bar because if repair or maintenance is needed and also if fault occurs then the continuity of supply to the circuit can be maintained by transferring it to the other bus bar. Because, APSCL is a generation company, it generates power and supplies to the grid. If any generator needs power for starting then it collects the power from the grid by bus bar. Bus bar is shown in figure 32.

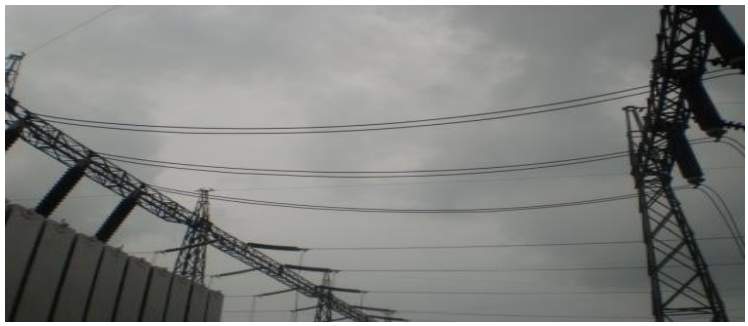

Figure 32: Bus Bar.

Chapter 6: Water Treatment Plant

6.1 Introduction

On September 06, 2012 we observed the water treatment plant. It is an important plant in APSCL because boiler requires clean and soft water for longer life and better efficiency. The source of boiler feed water is generally the river Meghna which may contain suspended particles and dissolved gases. Therefore, it is very important that water is first purified and softened by chemical treatment and then delivered to the boiler. In this chapter we discuss about the screening, clarification, filtration and demineralization process. The water treatment process is shown in figure 33. We see that the water comes from Meghna which goes to water filter house then the water goes to water treatment tank. After the water treatment plant the water is demineralized then it goes to boiler through the feed water pump. Inside the boiler the steam is produced which rotate the turbine. From the turbine the low pressure steam goes to boiler and feed water pump through condenser.

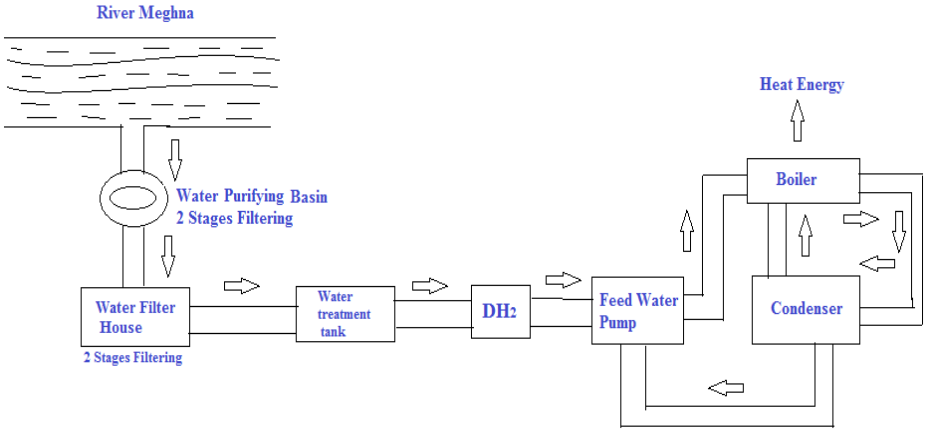

Figure 33: Water treatment steps.

6.2 Screening

Water is the most important element in a steam power plant. At APSCL, water is collected from the river Meghna. This water comes through 3 channels. One channel is for CCPP, ST-1 and ST-2 and one channel is for ST-3, ST-4 and ST-5 and the other channel is for demi water. Demi water means de-mineralized water where mineral content is being removed. This water is used mainly for generation of steam, for condenser, cooling of overall system, cooling of lubricating oil etc. For using water efficiently water screening system is essential. There are three steps of water screening system.

1. Heavy duty bar,

2. Rotating bar,
3. Band screening bar.

6.2.1 Heavy Duty Bar

The first stage of the screening system is heavy duty bar. In this stage water is screened by trust rack. Heavy wastes like wooden pieces, dead animals, water hyacinth are removed from the water in this stage.

6.2.2 Rotating Bar

In this stage scrapers are used to screen water. Smaller wastes than heavy-duty bar wastes are removed from the water in this stage.

6.2.3 Band Screening Bar

Small wastes like small pieces of stone, sands etc are removed from water in this stage. Here 57 baskets are arranged in such a way that screens the water by passing water through net. It is the most effective and modern screening process. The wastes are separated from nets by spraying water. A tray is placed below the baskets to collect separated wastes.

6.3 Clarification and Sedimentation

After the screening process water is used for clarification. In clarification process the raw water is blended with $Al_2(SO_4)_3$ and polyelectrolyte to remove sludge. In sediment basin the sludge's are deposited below the basin. Then the clean water is collected in other basin and the sludge is removed from basin by a pump.

Figure 34: Pond of sedimentation process.

6.4 Filtration

After the clarification water is used for filtration. In this process the clean water is pumped to the gravel filter. The “Anthracite coal” of the filter removes any solid particles like sand, silt etc.

6.5 Demineralization

In demineralization ions are removed from the water. In this process the water passes through the scavenger, cation, anion and mixed bed filter.

Figure 35: Demineralization filter tanks.

Chapter 7: Conclusion

APSCL is playing an important role in producing power for the nation and thus contributing to the country's economy. APSCL produces and supplies 777 MW of electric power to the national grid. Its contribution to the country is 15% of the total national power generation sector. It has total 9 units. Although production of power is insufficient compared to the demand of our country but the good thing is that the supply of power in national grid is rapidly increasing now-a-days. In the near future to contribute more to the national power system APSCL has plans to setup more units in the power station. It is expected that the power generation in APSCL will be increased by its own property. The mission of this company is to ensure long-term uninterrupted supply of quality power to the consumers in future. No doubt that the power sector of Bangladesh has to go for a long way in future. We are glad that we got an opportunity to complete 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.

We completed our internship at APSCL. Through the internship we have known the practical field of power generation, distribution and transmission. The fuel input of APSCL is gas supplied by Titas Gas. We have seen how water is collected, purified and then boiled in boilers to produce steam. Steam is used to rotate the turbine for power generation. We have observed various protection schemes which are used to protect the equipments. Control units 1, 2, 3, 4 and 5 control the steam power plant. We also visited gas turbine plant, water treatment plant and sub-station. In gas turbine plant gas is used as fuel to produce hot flue gas which rotates the turbine for power generation.

7.1 Problems

During our internship we faced some problems. Such as:

i) Practical participation in different works of APSCL would have given us more experience but unfortunately it was not within the policy of APSCL. We just observed the systems.
ii) We could not see the internal configuration of machines as well because machines were running.
iii) We could not take enough pictures and information in sub-station section because it is a high voltage area and also one day observation was not enough.

iv) Because of high temperature in generator section we faced some difficulties to observe the machines closely.

7.2 Recommendations

From the experience having from our internship, we have some recommendations of our own.

i) Before going to the internship, our major subjects should be completed for understanding the equipments and the system.

ii) The tenure of our internship program with APSCL was only for 15 days. This is not enough to be able to understand the total functions of a power plant efficiently. So the duration of internship should be increased.

Reference

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[6] NUS Training Corporation, Power Plant Practice Series (Combine Cycle). United States of America, 1983.

[7] NUS Training Corporation, Power Plant Practice Series (Turbine). United States of America, 1983.

[8] Sunil S. Rao, "Switchgear protection and power system," Khanna Publishers, 2008.

Appendix

Department of Electrical and Electronic Engineering
East West University
EEE 499
Industrial Training
Daily Activity Report

Separate Daily Activity Report should be completed by each intern for every day of work and should be signed by the mentor from the company and the academic advisor. Copy of all the reports should be attached to the final internship report.

Name of the company:	APSCL
Name of the student:	Md. Nuruddin Al-Mamud
ID:	2008-1-80-013

Date:	24/08/2012
Start time/End time	8.00AM-4.00 AM
Location:	APSCL
Mentor:	Rokon-Uz-Zaman

General Instructions:

a. It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
b. The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
c. The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
d. In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.

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East West University

Address the following points briefly (Use additional page if necessary)

1 What was the objective of the day's activities? (If applicable. list multiple objectives)

Our objective was to introduce with the whole power station and the different sections.

We have also known the future plan of this power station.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

There are 3 types of generation system. Gas turbine, steam turbine and combined cycle. There are total Nine units. The generation capacities of these sections are given below.

i) Unit 1 : 64 mw
ii) Unit 2 : 64 mw
iii) Unit 3 : 150 mw
iv) Unit 4 : 150 mw
v) Unit 5 : 150 mw
vi) ~~Unit~~ Gas turbine 1 : 56 mw
vii) Gas turbine 2 : 56 mw
viii) Steam turbine : 34 mw
ix) Gas Engine : 50 mw

620 mw is supplied in the National Grid.

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

This was just an introductory part of our internship and we have known about the basic things about this power station.

22/08/12
Signature of the mentor with date
Name: Rokon Uz Zaman
Designation:
Contact Phone #: 01736247593

10.09.2012
Signature of academic supervisor with date
Name:
Designation: Dr. Anisul Haque
Professor
EEE Department
East West University
Dhaka, Bangladesh.

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East West University
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Industrial Training
Daily Activity Report

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Name of the company:	APSCL
Name of the student:.	Md. Nuruddin Al-Mamud
ID:	2008-1-80-013

Date:	25/08/2012
Start time/End time	8.00 AM - 4.00 PM
Location:	Generator section
Mentor:	Rokon Uz Zaman

General Instructions:

a. It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
b. The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
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Address the following points briefly (Use additional page if necessary)

1 What was the objective of the day's activities? (If applicable. list multiple objectives)

The objective was to know about the generator principle and construction.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

We have seen the construction equipments of the generator.

i) Shaft
ii) stator
iii) rotor
iv) slip ring
v) carbon brush
vi) Exciter
vii) turbine
viii) coolers

We have also seen the dummy model of the generator section.

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

We have seen these things theoretically in the machine courses.

25/08/12

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Contact Phone #: 01736247593

10.09.2012

Signature of academic supervisor with date
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Name of the company:	APSCL
Name of the student:	Md. Nuruddin Al-Mamud
ID:	2008-1-80-013

Date:	26/08/2012
Start time/End time	8.00 AM – 4.00 PM
Location:	Generator section
Mentor:	Rokon Uz Zaman

General Instructions:

a. It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
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Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable. list multiple objectives)

The objective of the day was to know about the different types of generator protection and generation system.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

Generator Protections:

i) Overcurrent protection
ii) Over voltage protection
iii) Undercurrent protection
iv) Under voltage protection
v) Under frequency protection
vi) Stator earth fault
vii) Loss of excitation
viii) Rotor earth fault
ix) Gaial protection
x) Unit Transformer protection
xi) Reverse power relay
xii) Unit Auxiliary Transformer Protection

(*) We have also differents type of exciters.
i) Ac exciter ii) Dc exciter
iii) Brushless exciter iv) Static exciter.

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

We have seen these things theoretically in Switchgear Protection System course.

26/08/12

Signature of the mentor with date
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Name of the company:	APSCL
Name of the student:	Md. Nowaldin Al-Masud
ID:	2008-1-80-013

Date:	27/08/2012
Start time/End time	8.00 AM – 4.00 PM
Location:	Winding Shop
Mentor:	Rokon Uz Zaman

General Instructions:

a. It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
b. The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
c. The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
d. In case of any confusion, interns are strongly recommended to consult their r ctive academic supervisors.

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Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable. list multiple objectives)

The objective of the day was to see how the faulty motor is checked and repaired in motor repairing room or winding shop.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

We have seen how different types of motor which were being repaired there —

i) Vaccum Pump motor
ii) Diode cooling fan motor
iii) fire fighting motor pump water
iv) Turbine cooling fan motor

we have also seen, ~~the how~~ different types of motor winding wire, megger test, panel board test, winding test.

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

We have seen these things in Electrical measurement course..

07/08/12
Signature of the mentor with date
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Designation:
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Alaque 10.09.2012
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Designation: Professor
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Daily Activity Report

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Name of the company:	APSCL
Name of the student:	Md. Nuruddin Al-Masud
ID:	2008-1-80-013

Date:	28/08/2012
Start time/End time	8.00 AM – 4.00 PM
Location:	Control Unit Room – 1, 2
Mentor:	Rokon Uz Zaman

General Instructions:

a. It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
b. The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
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d. In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.

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East West University

Address the following points briefly (Use additional page if necessary)

1 What was the objective of the day's activities? (If applicable. list multiple objectives)

The objective of the day was to visit and familiare with the control unit room 1 and 2.

Rated generating capacity - 64 mw each.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives. Generating voltage 11 KV

We have seen the following things:

i) Control unit design diagram
ii) Boiler system
iii) temp and presswre maintainance
iv) condenser
v) feed water pump
vi) Generator
vii) Economizer
viii) Burners
ix) Fan
x) Deaerator
xi) HP, LP heater
xii) vaccum pump
xiii) down comer header
xiv) Air pre heater

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

This topic is related to power Station Course.

20/08/12

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Name of the company:	APSCL
Name of the student:	Md. Nuruddin Al-Masud
ID:	2008-1-80-013

Date:	29/08/2012
Start time/End time	8.00AM – 4.00PM
Location:	Control Unit Room-3,4
Mentor:	Rokon Uz Zaman

General Instructions:

a. It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
b. The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
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East West University

Address the following points briefly (Use additional page if necessary)

1 What was the objective of the day's activities? (If applicable. list multiple objectives)

The objective of the day was to visit and familiare with the control unit room 3 and 4. We also saw the generations.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

Each control unit have one generator and each generator generate 150 MW.
We have seen the following equipments:
i) whole control design board ii) Different parameter indications.
iii) 3 types of turbine - LP, HP, IP turbine iv) generator rating 15.75 KVA
v) Air flow transmitter (range : 0-8.1 m bar)
vi) Pressure switch (binary) vii) Boiler control system
viii) Line steam flow transmitter (operates at 220V ac)
ix) Automatic tripping system x) feed water flow transmitter
xi) Photo receiver xi) Ignitor xii) range value
xiii) feedwater bypass control valve.

Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

We have seen these things theoritically in machines, switchgear and protection and power station courses.

29/08/12

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10.09.2012

Signature of academic supervisor with date
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Name of the company:	APSCL
Name of the student:	Md. Mowuddin Al-Masud
ID:	2008-1-80-013

Date:	30/08/2012
Start time/End time	8.00 AM – 4.00PM
Location:	Control Unit Room-5
Mentor:	Rokor Uz Zaman

General Instructions:

a. It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
b. The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
c. The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
d. In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.

Department of Electrical and Electronic Engineering
East West University

Address the following points briefly (Use additional page if necessary)

1 What was the objective of the day's activities? (If applicable, list multiple objectives)

The objective of the day was to visit and familiare with the control unit room - 5.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

Unit - 5 control room is fully computer operated. The system is POS operated which is linux based operating system.
We have seen the following systems -
i) Water and steam cycle ii) Super heater system iii) Burner overview iv) Boiler & flue gas system v) feed water system vi) Lube oil system vii) Temparature & vibration monitoring viii) Synchronization ix) Bearing temp. x) shaft turning gear xi) Gland steam system xii) Vibrations/Expansions xiii) sequence of events.
The generator generates 150 mw power.

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

We have seen these things theoretically in switchgear and protection, machine, and power stations and Electrical measurement courses.

30/08/12

Signature of the mentor with date
Name: Rokon Uz Zaman
Designation:
Contact Phone #: 01736247593

10.09.2012

Signature of academic supervisor with date
Name:
Designation:

Dr. Anisul Haque
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Dhaka, Bangladesh

Department of Electrical and Electronic Engineering
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Name of the company:	APSCL
Name of the student:	Md. Nuruddin Al-Mamun
ID:	2008-1-80-013

	31/08/2012
Start time/End time	8.00 AM – 4.00PM
Location:	Combined Cycle Power Plant (CCPP)
Mentor:	Rokon Uz-Zaman

General Instructions:

a. It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
b. The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
c. The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
d. In case of any confusion, interns are strongly recommended to consult their respective academic supervisors.

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East West University

Address the following points briefly (Use additional page if necessary)

1 What was the objective of the day's activities? (If applicable. list multiple objectives)

The objective of the day was to visit and learn about the combined cycle section of the power station.
2 Gas turbine, 1 steam turbine.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

We have seen the followings:

i) CCPP (Combined Cycle Power Plant) control unit
ii) Generator rating (13.75 KVA)
iii) Burners and WHRU (Waste Heat Recovery Unit)
iv) Gas turbine v) Steam turbine
vi) Boiler temperature & pressure reading
vii) 10 burner configuration through the ~~turbine~~ turbine shaft.

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

We have seen these things theoretically in Electrical Machines courses.

01/09/12

Signature of the mentor with date
Name: Rokon Uz Zaman
Designation:
Contact Phone #: 01736247593

10.09.2012

Signature of academic supervisor with date
Name:
Designation: Dr. Anisul Haque
Professor
EEE Department
East West University
Dhaka, Bangladesh.

Department of Electrical and Electronic Engineering
East West University
EEE 499
Industrial Training
Daily Activity Report

Separate Daily Activity Report should be completed by each intern for every day of work and should be signed by the mentor from the company and the academic advisor. Copy of all the reports should be attached to the final internship report.

Name of the company:	APSCL
Name of the student:	Md. Nuruddin Al-Masud
ID:	2008-1-80-013

Date:	01/09/2012
Start time/End time	8.00 AM – 4.00 PM
Location:	Battery Room
Mentor:	Rokon Uz Zaman

General Instructions:

a. It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
b. The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
c. The report should not be a compilation of lectures notes taken during the internship rather it should depict what the intern has learned on a particular day.
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East West University

Address the following points briefly (Use additional page if necessary)

1 What was the objective of the day's activities? (If applicable. list multiple objectives)

The main objective of the day was to visit the battery room of unit-3,4 and to see the arrangements of the batteries.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

i) There were total 184 batteries. Each ~~cell~~ battery cell's ~~requi~~ rated voltage is 1.5 V. The battery type is Ni-Cd. ii) We saw the Hydrometer which is used for gravity test of acid in the batteries.

iii) The backup durcation of control room is 10-12 hours.

iv) We also saw the battery amperce checking meter.

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

We have seen those things theoretically in Electrical measurement and Renewable Energy course.

01/09/12

Signature of the mentor with date
Name: Rokon Uz Zaman
Designation:
Contact Phone #: 01736247593

A Haque 10.09.2012

Signature of academic supervisor with date
Name:
Designation: Dr. Anisul Haque
Professor
EEE Department
East West University
Dhaka, Bangladesh

Department of Electrical and Electronic Engineering
East West University
EEE 499
Industrial Training
Daily Activity Report

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Name of the company:	APSCL
Name of the student:	Md. Nuruddin Al-Mamun
ID:	2008-1-80-013

Date:	02/09/2012
Start time/End time	8.00 AM — 4.00 PM
Location:	Generation Section
Mentor:	Rokon Uz-Zaman

General Instructions:

a. It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
b. The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
c. The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
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East West University

Address the following points briefly (Use additional page if necessary)

1 What was the objective of the day's activities? (If applicable, list multiple objectives)

The objective of the day was to learn about the generation maintainance Auxiliary System and factors that determine output voltage.

2 List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

We saw the following things:

i) Hydrogen cooling system operates
ii) Hydrogen seal oil system
iii) Stator cooling system that is used to by water to cool the stator windings
iv) Typical voltage control system operates

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

This is related to Electrical machines and Power Electronics courses.

02/09/12

Signature of the mentor with date
Name: Rokon Uz Zaman
Designation:
Contact Phone #: 01736247593

10.09.2012

Signature of academic supervisor with date
Name:
Designation:

Dr. Anisul Haque
Professor
EEE Department
East West University
Dhaka, Bangladesh

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Industrial Training
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Name of the company:	APSCL
Name of the student:	Md. Nuruddin Al-Mamun
ID:	2008-1-80-013

Date:	03/09/2012
Start time/End time	8.00 AM – 4.00 PM
Location:	Generator section
Mentor:	Rokon Uz Zaman

General Instructions:

a. It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
b. The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
c. The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
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East West University

Address the following points briefly (Use additional page if necessary)

1 What was the objective of the day's activities? (If applicable. list multiple objectives)

The objective of the day was to understand about generator's maintainance.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

We have understood and seen the following things:

i) Brush maintainance.
ii) Cleaning
iii) Hydrogen is removed from a typical AC generator prior to overhaul.
iv) Typical disassembly procedure
v) Meg-ohmmeter test.

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

The topic is related to Electrical measurement course.

09/09/12

Signature of the mentor with date
Name: Rokon Uz Zaman
Designation:
Contact Phone #: 01736247593

10.09.2012

Signature of academic supervisor with date
Name:
Designation:

Dr. Anisul Haque
Professor
EEE Department
East West University
Dhaka, Bangladesh.

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Name of the company:	APSCL
Name of the student:	Md. Nimuddin Al-Mamun
ID:	2005-1-80-013

Date:	04/09/2012
Start time/End time	8.00 AM – 4.00 PM
Location:	Boiler Section
Mentor:	Rokon Uz Zaman

General Instructions:

a. It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
b. The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
c. The report should not be a compilation of lectures notes taken during the internship, rather it should depict what the intern has learned on a particular day.
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East West University

Address the following points briefly (Use additional page if necessary)

1 What was the objective of the day's activities? (If applicable. list multiple objectives)

The objective of the day was to visit the boiler system and to learn about the process of boiling system.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

There are five boiler in 5 unit.
We have seen the following things:

i) boiler system design diagram and control.
ii) feed water tank iii) burners (9 burners for every boiler)
iv) water filter house v) Down heard comer vi) Condenser
vii) Furnace viii) Pressure Gauge ix) Economizer
x) water tube xi) De-hydronization xii) water treatment tank
xiii) Saldy tank

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

This topic is related to Power station course.

04/09/12

Signature of the mentor with date
Name: Rokon Uz zaman
Designation:
Contact Phone #: 01736247593

10.09.2012

Signature of academic supervisor with date
Name:
Designation: Dr. Anisul Haque
Professor
EEE Department
East West University
Dhaka, Bangladesh.

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Name of the company:	APSCL
Name of the student:	Md. Mowaddin Al-Masud
ID:	2008-1-80-013

Date:	05/09/2012
time/End time	8.00 AM - 4.00 PM
Location:	Steam Turbine section
Mentor:	Rokon Uz Zaman

General Instructions:

a. It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
b. The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
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East West University

Address the following points briefly (Use additional page if necessary)

1 What was the objective of the day's activities? (If applicable, list multiple objectives)

The objective of the day was to learn about steam turbine.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

Turbine consists the following parts:

i) Condensers
ii) Dump value
iii) Turbine blade
iv) Vaccum pump
v) Deaerator
vi) make up tank
vii) LP evaporator
viii) HP "
ix) Superheaters
x) Steam drum
xi) feed pump
xii) Turbine efficiency
xiii) Turbine steam flow
xiv) Speed changer
xv) turbine control system

There are 3 parts of turbine – LP turbine, HP turbine, IP turbine

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

This topic is related to Power Station course.

08/09/12

Signature of the mentor with date
Name: Rokon Uz Zaman
Designation:
Contact Phone #: 01736247593

10.09.2012

Signature of academic supervisor with date
Name:
Designation: Dr. Anisul Haque
Professor
EEE Department
East West University
Dhaka, Bangladesh.

Department of Electrical and Electronic Engineering
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EEE 499
Industrial Training
Daily Activity Report

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Name of the company:	APSCL
Name of the student:	Md. Nuruddin Al-Mamun
ID:	2008-1-80-013

Date:	06/09/2012
Start time/End time	8.00 AM - 4.00 PM
Location:	Water Treatment Plant (WTP)
Mentor:	Rokon Uz Zaman

General Instructions:

a. It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
b. The daily report should be a brief narration of the activities during the internship period in the eyes of the intern and should be completed and submitted by every intern irrespective of the number of partners s/he might have for the presentation and final report writing purpose.
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East West University

Address the following points briefly (Use additional page if necessary)

1 What was the objective of the day's activities? (If applicable. list multiple objectives)

The objective of the day was to visit and learn about the water treatment plant (WTP).

List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

Four steps to of water treatment:

i) Screening : remove the visible solid compound (mechanical process)
ii) Sedimentation : use Alum $(Al_2SO_4)_3$ to clearify 70% of the water.
iii) filteration : 3 steps
   * gravel filter * sand * cole
iv) clear water % using different types of salt ($CaCl_2$), $MgCl_2$, KCl etc.
   Demineralization
   4 steps - * scavenger * cation * Anion * mixed bed.
v) Demi water tank - 300 ton

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

We have learned about this things in Introduction to chemistry course.

06/09/12

Signature of the mentor with date
Name: Rokon Uz Zaman
Designation:
Contact Phone #: 01736247593

10.09.2012

Signature of academic supervisor with date
Name: Dr. Anisul Haque
Designation: Professor
EEE Department
East West University
Dhaka, Bangladesh

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Name of the company:	APSCL
Name of the student:	Md. Nuruddin Al-Mamud
ID:	2008-1-80-013

Date:	07/09/2012
Start time/End time	8.00 AM - 4.00 PM
Location:	Substation
Mentor:	Rokon Uz Zaman

General Instructions:

a. It is the intern's duty to make sure that all his/her daily activity reports are appropriately signed by both the mentor and the academic supervisor.
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East West University

Address the following points briefly (Use additional page if necessary)

1. What was the objective of the day's activities? (If applicable, list multiple objectives)

The objective of the day was to introduce and familiar with the substation of APSCL.

2. List the day's activities according to the order of objectives listed in 1. Mention the specifications of the equipments used/visited. Comment on how these activities fulfill your objectives.

The main components of substation are -

i) Bus Bar
ii) Current Transformer (CT)
iii) Potential Transformer (PT)
iv) Circuit Breaker (CB)
v) Isolators
vi) Lightening Arrester
vii) Grounding
viii) Transformers
ix) Sky-wire
x) Battery room
xi) Earth grounding

3. Relate your practical activity with the theoretical knowledge you gained in the respective academic course.

This topic is related to Power Station & Switchgear and Protection courses.

07/09/12

Signature of the mentor with date
Name: Rokon Uz-Zaman
Designation:
Contact Phone #: 01736247893

10.09.2012

Signature of academic supervisor with date
Name:
Designation:

Dr. Anisul Haque
Professor
EEE Department
East West University
Dhaka, Bangladesh