INTERNSHIP REPORT

ON

MYMENSINGH POWER STATION

[RURAL POWER COMPANY LIMITED]

Prepared By

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[Md. Ashik Mahmud: (2008-1-80-064)]

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
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Approved By

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Approval Letter

Rural Power Company Ltd. (RPCL)

Mymensingh Power Station (MPS)

Certificate of Training Completion

This is to certify that ***Md. Shohel Rana Chowdhury*** *Department of Power (EEE) bearing ID No. 2008-1-80-068 of East West University has successfully completed the Industrial Training Courses from Mymensingh 210MW Combined Cycle Power Plant during 20.08.2011 to 11.09.2011.*

11/9/2011

Md. Ashraf Hussain
Course Coordinator
DGM, MPS, RPCL

11-09-2011

Engr. Satya Ranjan Debnath PEng
General Manager
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11-09-11

11th September 2011

Rural Power Company Ltd. (RPCL)

Mymensingh Power Station (MPS)

Certificate of Training Completion

This is to certify that ***Md. Nafiz Hossain*** *Department of Power (EEE) bearing ID No. 2007-2-80-014 of East West University has successfully completed the Industrial Training Courses from Mymensingh 210MW Combined Cycle Power Plant during 20.08.2011 to 11.09.2011.*

11/9/2011
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Rural Power Company Ltd. (RPCL)

Mymensingh Power Station (MPS)

Certificate of Training Completion

*This is to certify that **Md. Ashik Mahmud** Department of Electronics (EEE) bearing ID No. 2008-1-80-064 of East West University has successfully completed the Industrial Training Courses from Mymensingh 210MW Combined Cycle Power Plant during 20.08.2011 to 11.09.2011.*

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Md. Ashraf Hossain
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11th September 2011

Schedule

We started our internship training program at Mymensingh power station (MPS) of Rural Power Company Limited, Shamvugonj, Mymensingh. The concerned head of MPS, Engr. Satya Ranjan Debnath, PEng. General Manager (Technical) was the coordinator of training. The details of the training schedule (20th August to 11th September, 2011) are provided below:

Date	Program	Department	Mentor
20.08.11	Overview of plant operation and security system	Safety, security and Intelligence	Md. Ashraf Hossain Deputy General Manager
21.08.11 to 29.08.11	Brief idea of different Electrical maintenance work	Electrical Maintenance	Md. Monowar Hossain Assistant Manager
03.09.11	Overview of Mechanical system	Mechanical Maintenance	S.M.Abdul Mannaf Assistant Manager
04.09.11 to 06.09.11	Brief idea of I &C Maintenance work	Instrumentation & Control	Soumen Kumar Mondal Assistant Manager
07.09.11 to 11.09.11	Familiarization of Plant operation	Operation	Khokan Mia Assistant Manager & Md.Rabiul Islam Assistant Manager

Acknowledgement

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

We would also like to thank our advisor Ms. Sharmin Rowshan Ara, Senior Lecturer and Ms. Sohana Tanzeem, Lecturer, Department of Electrical & Electronic Engineering, East West University, Bangladesh for being with us with constant help, encouragement and valuable suggestions during the period of our internship.

We would also like to mention the name of Dr. Anisul Haque, Honorable Chairperson & Professor of the Department of Electrical & Electronic Engineering and Dr. Khairul Alam, Associate Professor, Department of Electrical & Electronic Engineering of East West University, Bangladesh for their constant guidance, enlightening discussion and inspection during the course of this project work.

We are also grateful to Engr. Md. Abdus Sabur, Director RPCL Board & Managing Director RPCL, Engr. Satya Ranjan Debnath, PEng, General Manager (Technical) MPS, RPCL and Engr. Md. Ashraf Hossain our Course Coordinator, DGM, MPS of RPCL for allowing us to do the internship, observe and work with them.

We would also like to thank Engr. Md. Monowar Hossain, Assistant Manager (Electrical Maintenance Department); Engr. Md. S.M.Abdul Mannaf, Assistant Manager (Mechanical Maintenance Department); Engr. Soumen Kumar Mondal, Assistant Manager (Instrumentation & Control Department); Engr. Khokan Mia, Assistant Manager & Engr. Md.Rabiul Islam, Assistant Manager (Operation Department); who had given their precious time to collect related data for our report and to make us understand many related matters about MPS of RPCL.

At last we want to thank all of our faculty members and friends for their inspiration and co-operation throughout our whole academic life in EWU.

Executive Summary

Power is one of the most vital sectors for the growth of country's economy. As a developing country, the significance of power is enormous. Rural development is directly correlated to rural electrification in Bangladesh. Socioeconomic development in rural areas causing the increasing demands of electricity day by day. With the growing use of power based industries in agriculture, small & cottage industries, the stable supply of power both in urban and rural areas in the country has become the demand of the time. With the appearance of market economy, the demand of stable supply of power has become more and more important for trade, commerce, industry and agriculture for success of overall development of the country and alleviation of poverty.

Government of Bangladesh has been implementing the concept of privatization in power sector since last decade. Mymensingh Power Station (MPS) is one of these pilot projects launched in private power generation project. Accordingly a public limited company named Rural Power Company Limited was formed and registered on 1994 by active participation of Rural Electrification Board (REB). Our internship in Mymensingh Power Station, Rural power Company Limited (RPCL), helped us to learn the generation and distribution power practically.

During this internship we got the opportunity work as a member of a team in combine cycle power plant. The generation of electricity is one of the most multifunctional processes in the world. During the internship period we gathered practical experience in substation, switchgear, transmission and protection of the electricity and the overall control of the power generation system.

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Chapter: 01

Introduction to RPCL

1.1 Introduction:

Bangladesh is currently experiencing severe power crisis. Load shading is a burning issue in this country. This has an enormous impact on the agriculture, industry, commerce, economy. Rural Power Company Limited is dedicated to generate power for rural development and also to take part in social & economical development for rural people of the country. Rural Power Company Limited was the first Independent Power Producer (IPP) of Bangladesh and non government entity to be licensed to generate power.

In this context, Rural Power Company Limited (RPCL) is playing a significant role in power sector of Bangladesh. RPCL started supplying power to the national grid from 1994. To satisfy the increasing demand for electricity, RPCL has launched several programs to increase its production. RPCL is rewarded for Mymensingh Power Station as the best Power Plant in National Electricity week, 2010 for continuous power supply in national grid. Thus RPCL is contributing in the rural development of Bangladesh. Rural Power Company Limited has 100% equity investment which is mobilized locally. This is a pioneer non government entity in Power Sector of Bangladesh.

Figure 1.1: Mymensingh Power Station (MPS)

Capacity: 210 MW
(4×35MW Open Cycle Gas Turbine & 1×70 MW Combined Cycle Steam Turbine)

1.2 Company Profile:

Mymensingh Power Station is one of the modern Combined Cycle power plants in Bangladesh. At present the total capacity of its 5 units is 210 MW.

Vision:

"Electricity for all by 2020".

Mission:

"Committed to reliable power generation for rural development". [1]

1.2.1 Background of Rural Power Company Limited:

As a part of reform in the power sector of the country, RPCL was registered as a public Limited Company in 1994 and to create a private culture in the power generation sector. The company was financed by REB and five Palli Bidyut Samitys (PBSs).One of the project initiated by RPCL was Mymensingh Power Station which was situated at Shombhuganj, Mymensingh. Initial capacity of MPS was estimated as 70MW which was implemented phase by phase. In order to implement Phase-I of the project, Engineering, Procurement and Construction (EPC) contract was signed between RPCL and REB in October, 1997 to set up 70 MW (2×35) gas turbine power plants.

RPCL started supply of electricity to the national grid by phase-I February,1999.The phase –II was started in November,1999.In phase –III,RPCL signed EPC contract in 2002 to install a 70MW Steam Turbine Generation(STG) plant by converting simple cycle power plant to combined cycle power plant. This new power plant was designed to utilize Exhaust fuel Gas from the existing gas turbine units for producing electricity without any additional fuel cost. Meanwhile, Phase-III has been completed and from July, 2007 the Mymensingh Combined Cycle Power plant has been supplying 210 MW of electricity to the national grid.

RPCL Management has taken over all property & liabilities of Mymensingh Power Station Complex consisting of the following assets and liabilities. [2]

1.2.2 Project Cost of Mymensingh Power Station (MPS)

Capacity: 210 MW

(4X35MW Open Cycle Gas Turbine & 1X70 MW Steam Turbines)

Phase - I	2×35 MW Gas Turbine
Phase - II	2×35 MW Gas Turbine
Phase - III	1×70 MW Steam Turbine

Table 1.1: Power Generation Capacity of Mymensingh Power Station

Phase-I:	
a) Total Project Cost	BDT2, 359,150,203
b) **Financing:**	
i) Equity	BDT 667,939,035 Equity raised from REB and Five PBSs
ii) Debt	BDT 1,691,211,168 Debt raised from ADB long term loan of $36.386 million.
Phase-II:	
a) Total Project Cost	BDT 1,673,588,679
b) **Financing:**	
i) Equity	BDT 840,708,965 Equity raised from Eight PBSs
ii) Debt	BDT 520,000,000 Debt raised from REB
iii) RPCL own source	BDT 312,879,714
Phase-III:	
a) Total Project Cost	BDT 11,046,000,000
b) Cost incurred so far	BDT 9,197,523,020
c) **Financing:**	
i) Equity	BDT 909,465,000 Equity raised from 9 PBSs
ii) Debt	BDT 3,840,000,000 Debt raised from REB &11 PBSs
iii) RPCL own fund	BDT 6,296,535,000
Total Project Cost:	BDT2, 359,150,203

Table 1.2: Overview of Total Project Cost for 3 Phases of Mymensingh Power Station

1.2.3 Number of Generator and their Production Capacity:

SL No.	PARTICULARS	UNIT#1 (GT)	UNIT#2 (GT)	UNIT#3 (GT)	UNIT#4 (GT)	UNIT#5 (ST)
1	Installed Capacity (MW)	35	35	35	35	70
2	Present Contracted Capacity (MW)	33	33	33	33	62
3	Commissioned in	November 1999	November 1999	December 2000	December 2000	July 2007

Table 1.3: Number of Generators and their Production Capacity in MPS [3]

1.2.4 Company at a Glance:

Name of the Company : Rural Power Company Limited
Status of the Company : A public Limited Company incorporated on 31st December, 1994.
Promter of the Company : Rural Electrification Board (REB) and five Palli Bidyut Samitys (PBS) (Dhaka PBS-1, Moulvibazar PBS, Narsingdi PBS-1, Comilla PBS-1 and Tangail PBS)
Present Shareholdes & Compositions: Rural Electrification Board (REB)-21.05% & Nine Palli Bidyut Samity (PBS) s-78.95%

Dhaka PBS-1(41.09%)	Narsingdi PBS-1(7.50%)	Sirajganj PBS (2.89%)
Moulvibazar PBS (11.40%)	Tangail PBS (1.45%)	Natore PBS-1(0.71%)
Comilla PBS-1	Hobiganj PBS (4.22%)	Natore PBS-2(0.71%)

Table 1.4: Number of PBSs and their shareholders and compositions in RPCL

Schedule Maintenance Inspections: RPCL has a long Term Service Agreement (LTSA- 2nd Cycle) with M/S. Ansaldo Thomassen B.V. Netherlands (Former Babcock Borsing PowerInc.) For Major Schedule Inspections and maintenance of the power Station.

Power Purchase Agreement (PPA) : RPCL has an extended Term Service Agreement with Bangladesh Power Development Board (BPDB).
Gas (Fuel) Sales Agreement (GSA) : RPCL has an extensive Term Service Agreement with Titas Gas Transmission and Distribution Company Ltd. (TGTDCL)

Projects under RPCL:

Power station in Operation at Present: Mymensingh Power Station, Shambhuganj, Mymensingh.

Present Capacity of the power Station: 210MW (4×35MW Gas Turbine &1×70MW Steam Turbine).

Gas Turbines	Heavy Duty Gas Turbine
Type	PG6551 B(Ph-I) and PG 6561 B (Ph-II)
Manufacture	GEEPE, France
Generators	Type T600C
Rated Speed	3000rpm
Power Factor	0.8
Rated apparent power	44.462 MVA
Manufacture	GEEPE, France
Units step-up Transformer	11/132KV, 35/50MVA (ONAN/ONAF)
Manufacture	Hyundai, Korea
Substation & Switchgear Manufacture	ABB, Sweden
Control and Supervisory system	Mark V, DCS & PCS-7.
Exhaust Gas Emission Control	Dry Low NOx(DLN) Combustion System (NOx below 15 ppm)
Noise Pollution Control	Gas Turbines are enclosed by Acoustic Walls.

Table 1.5: Feature of Plant Machinery (Phase-I-II)

Steam turbine	Model –NK 90/3.2
Manufacture	Siemens, Germany
Generator	Model TLRI 100/36
Capacity	77.3 MW RPM -3000, Brush less Excitation
Manufacture	Siemens, Germany
Units step-up Transformer	10.5/132KV,70/100 MVA (ONAN/ONAF) Siemens, Germany
Substation & Switchgear Manufacture	Siemens, Germany

Boiler (HRSG)	HP Steam flow capacity-61.02 tons/hr HP Steam temperature-520°C HP Steam Pressure-82.5 bars LP Steam flow capacity -13.248 tons /hr
Manufacture	Standard Fasel, Netherlands
Condenser (ACC)	Air flow capacity-82.5 kg/s No. fans 15.Motor rating -30/132KW,900/1420 rpm
Manufacture	Balcke Dour GmbH.
Water Treatment Plant	Capacity-11.5 m3/hr Chirst, Netherlands

Table 1.6: Feature of Plant Machinery (Phase-III)

Installed Generation capacity	1839.60 million kwh
Available Generation capacity	1530.925 million kwh
Energy Dispatch	895.431 million kwh
Fuel Gas Consumption	257.34 SM cube
Guaranteed plant Available	79.86%
Actual plant Available	83.22%
Plant Factor	53.10%

Table 1.7: Energy Generation Data-2009 [3]

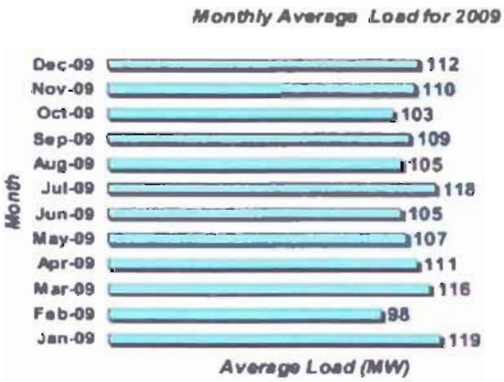


Figure 1.2: Statistics of Monthly Average load for 2009 in MPS [3]

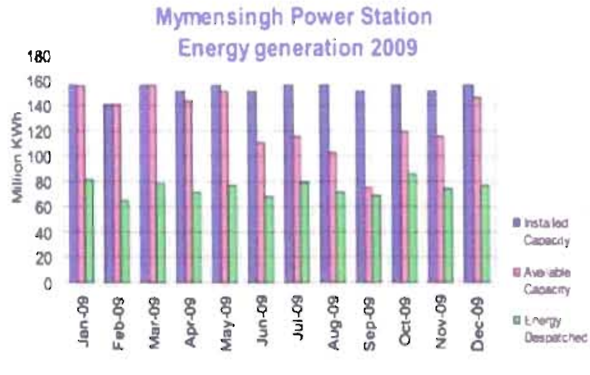


Figure 1.3: Statistics of Energy Generation in Million KWh in MPS for 2009 [3]

1.3 Purpose of the Internship:

The objective of this internship is to acquire practical knowledge and hand on experience in Power Station. Following the guideline provided by the EEE Department of East West University, the internship can be viewed as a two part project. At first we spent fifteen days in Mymensingh Power Station (MPS) to learn practically the process of power generation and distribution. On completion of this rigorous training we are going to submit this report, which reflects our valuable experience regarding the function of Steam, Gas, Combine Cycle and Substation of Mymensingh Power Station, RPCL.

1.4 Methodology:

This internship report describes power generation system of Mymensingh Power Station, RPCL. Significant part of the report consists of detailed description of generation of power from combined cycle power plant, protection, maintenance and substation. Major source of information delivered by the respected officials of MPS and other mentionable sources include documents provided by MPS.

Chapter: 02

Overview of Electrical System

2.1 Introduction:

Mymensingh power station is one of the greatest power stations in Bangladesh. This power station produces a huge amount of power which meets up a big demand of power. In this power station there are four departments. Among the four departments electrical department is the most important one. The electrical department mainly does two jobs. The first job is maintenance of generator, transformer, and different motors like 3 phase induction motor, ACC fan motor, and condensate pump motor. The second job is preventing maintenance. Example of the second job is giving grease in motor after certain period. These departments also take care of every electrical equipment in the power station.

2.2 Motor:

Motor is a device that creates motion. When a current carrying conductor is perpendicular to the external magnetic field, the conductor experiences a force perpendicular to itself and to the external magnetic field.

An electric motor consists of a permanent external field magnet (stator) and a coiled conducting ammeter (rotor) which is free to rotate within the field magnet. Brushes and a commutator (designed differently if A.C. or D.C. current is supplied to the armature) connect the armature to an external voltage source. The speed of rotation of a motor depends on the amount of current flowing through it, the number of coils on the armature, the strength of the field magnet, the permeability of the armature, and the mechanical load connected to the shaft. [4]

2.2.1 Types of Motor:

i. Electric motor
ii. DC Motor
iii. AC Motor

i. Electric Motor:

An electric motor is an electromechanical device that converts electrical energy into mechanical energy. Most electric motors operate through the interaction of magnetic fields and current-carrying conductors to generate force.

DC Motor:

A DC motor is an electric motor that runs on direct current (DC) electricity. DC motors were used to run machinery. DC motors can operate directly from rechargeable batteries, providing the motive power for the first electric vehicles.

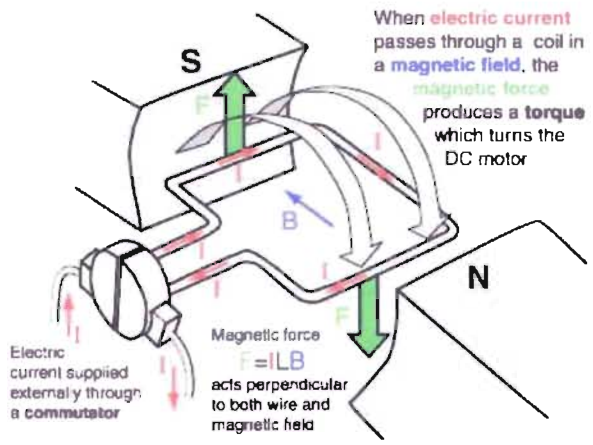


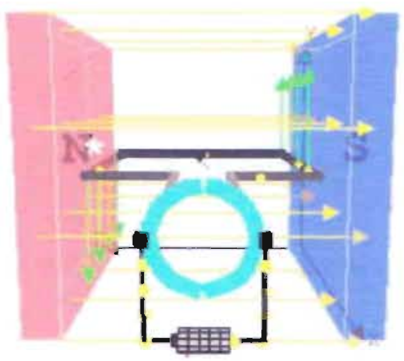
Figure 2.1: DC Motor

Types of DC Motor:

a. Brushed dc motor and
b. Brushless dc motor

a. Brushed dc motor:

The brushed DC electric motor generates torque directly from DC power supplied to the motor by using internal commutation, stationary magnets (permanent or electromagnets), and rotating electrical magnets.



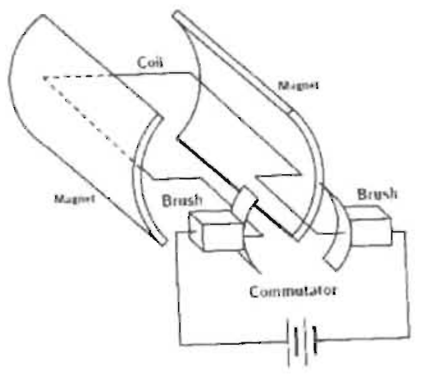


Figure 2.2: Brushed dc motor

This is a brushed DC electric motor generating torque directly from DC power supplied to the motor by using internal commutation, stationary permanent magnets. Torque is produced by the principle of Lorentz force, which states that any current-carrying conductor placed within an external magnetic field experiences a force known as Lorentz force. The commutator consists of a split ring 80 degree shows the effects of having a split ring.

b. Brushless dc motor:

Brushless DC motors use a rotating permanent magnet or soft magnetic core in the rotor, and stationary electrical magnets on the motor housing. A motor controller converts DC to AC.

AC Motor:

An AC motor is an electric motor that runs by an alternating current. It commonly consists of two basic parts, an outside stationary stator having coils supplied with alternating current to produce a rotating magnetic field, and an inside rotor attached to the output shaft that is given a torque by the rotating field.

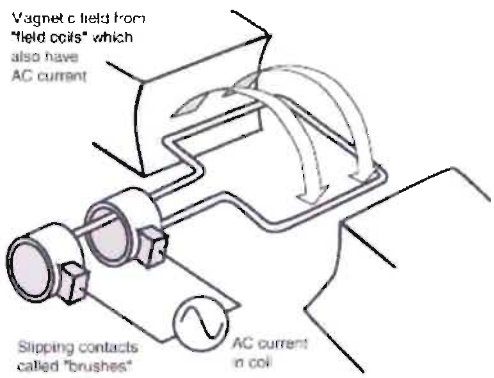


Figure 2.3: AC Motor

There are two main types of AC motors, depending on the type of rotor used:

The first type is the **induction motor**, which runs slightly slower than the supply frequency. The magnetic field on the rotor of this motor is created by an induced current.

The second type is the **synchronous motor**, which does not depend on induction and as a result it can rotate exactly at the supply frequency or a sub-multiple of the supply frequency. The magnetic field on the rotor is either generated by current delivered through slip rings or by a permanent magnet.

2.2.2 Three phase (3φ) Induction Motor:

An **induction** or **asynchronous motor** is a type of AC motor where power is supplied to the rotor by means of electromagnetic induction. The induction motor is made up of the **stator** and the **rotor**.

The stator or stationary windings consist of a series of wire windings of very low resistance permanently attached to the motor frame. As a voltage and a current are applied to the stator winding terminals, a magnetic field is developed in the windings.

The rotor is comprised of a number of thin bars, usually aluminum, mounted in a laminated cylinder. The bars are arranged horizontally and almost parallel to the rotor shaft. At the ends of the rotor, the bars are connected together with a "shorting ring." The rotor and stator are separated by an air gap which allows free rotation of the rotor.

The magnetic field generated in the stator induces an EMF in the rotor bars. In turn, a current is produced in the rotor bars and shorting ring and another magnetic field is induced in the rotor with an opposite polarity of that in the stator. The magnetic field, revolving in the stator, will then produce the torque which will "pull" on the field in the rotor and establish rotor rotation.

The AC induction motor is a rotating electric machine designed to operate from a three-phase source of alternating voltage.

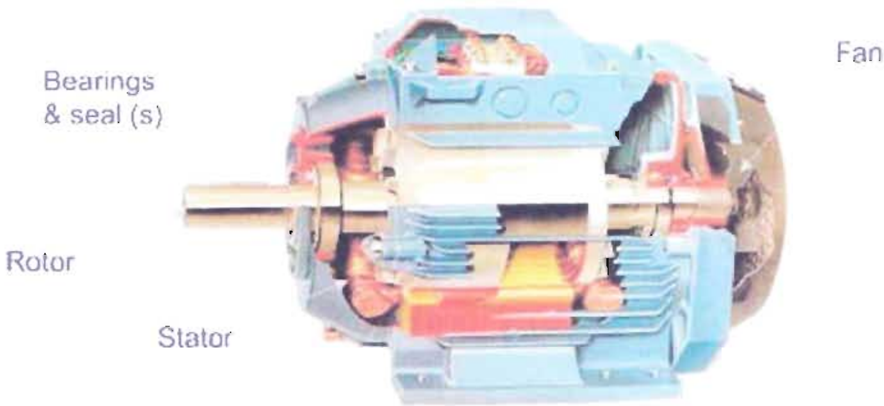


Figure 2.4: Construction of Induction Motor

Two types of rotors are used in Induction motors:

a. Squirrel-cage rotor and
b. Wound rotor

Figure 2.5: Induction Motor of MPS

2.2.3 Synchronous Motor:

Synchronous motors are like induction motors in that they both have stator windings that produce a rotating magnetic field. Unlike an induction motor, the synchronous motor is excited by an external DC source and, therefore, requires slip rings and brushes to provide current to the rotor.

A synchronous motor is not a self-starting motor because torque is only developed when running at synchronous speed; therefore, the motor needs some type of device to bring the rotor to synchronous speed. Synchronous motors use a wound rotor. This type of rotor contains coils of wire placed in the rotor slots. Slip rings and brushes are used to supply current to the rotor.

2.2.4 Synchronous Speed:

The speed of the rotating flux called synchronous speed which is directly proportional to the frequency of the supply voltage and inversely proportional to the number of pairs of poles. Poles only occur in pairs. Expressed mathematically:

$$n_s = \frac{120 \times fs}{P} \quad r/min$$

Here, n_s = synchronous speed

f_s = frequency of the supply voltage

2.2.5 Power factor:

AC power flow has three components: Active power (P), measured in watts (W), Apparent power (S), measured in volt-amperes (VA), and Reactive power (Q), measured in reactive volt-amperes (var). [5]

We know,

$$\text{Power factor} = \frac{\text{Active power(P)}}{\text{Apparent Power(s)}} = \cos\theta$$

$$\text{Active power, } P=VI\cos\theta$$
$$\text{Reactive power, } Q=VI\sin\theta$$
$$\text{Apparent power, } S=VI$$

There are several power equations relating the three types of power to resistance (R), reactance(X), and impedance (Z).

$$P = \text{Active Power} = I^2R = \frac{E^2}{R}\ (w)$$
$$Q = \text{Reactive power} = I^2X = \frac{E^2}{X}\ (Var)$$
$$S = \text{Apparent power} = I^2Z = \frac{E^2}{Z}\ (VA)$$

P, Q and S can be expressed as vectors that form a vector triangle such that:

$$S^2 = P^2 + Q^2$$

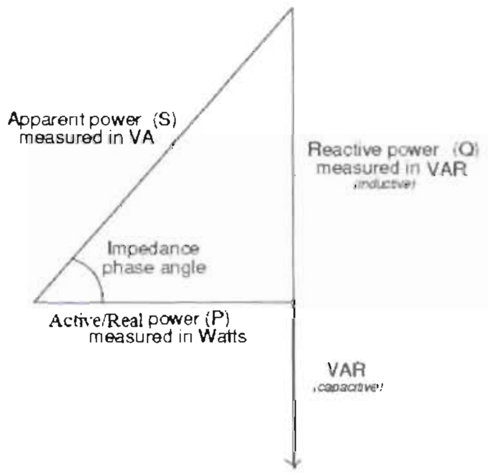


Figure 2.6: Vector Triangle

2.2.6 Motor Rating (KW):

Motors are rated in KW, because for motor the load is mechanical load. Motor is machines which coverts electrical Energy to Mechanical energy. Only active power which is converted to mechanical power is significant. The power factor of the motor is independent of the load and at whatever power-factor it works it is due to its design. Different types of losses of motor like rotational losses, frictional and windage losses can be expressed in KW, not in VA. Hence the motor rating is KW.

$$\text{Power} = \text{Voltage} \times \text{Current} \times \text{Power Factor}$$

1 HP = 746 Watts; HP is non-SI units of power. [6]

2.3 Generator:

A generator is a device which converts mechanical energy of turbine into electrical energy for transmission and distribution over power lines to domestic, commercial, and industrial customers. The mechanical power may come from a number of sources: Gas turbines, Steam turbines, Wind turbines, Hydro-electric turbines, and Diesel engines. The construction and the speed of the generator may vary considerably depending on the characteristics of the mechanical prime mover. It operates on the principle of electromagnetic induction law.

Figure 2.7: Steam Generator

2.3.1 Generator classification:

i. DC generator and
ii. AC generator

2.3.2 Generator Structure:

Generator is normally composed of the stator, rotor, coil, field electromagnet, and brushes. Stator is composited by the stator core, winding line package, these fixed-Block and other parts of the structure. Rotor is composited by the rotor core (or magnetic pole, magnetic escapped) winding, retaining ring, the center ring, slip ring, the fans and shaft and others. Coil usually consists of many turns of copper wire wound on the armature. The two ends of each coil are connected with either two slip rings (AC) or two opposite bars of a split-ring commutator (DC).

2.3.3 AC Generator:

The main component of AC Generator is rotor and stator.

a. **Rotor:**

The rotor of an AC generator is the rotating component of the generator, as shown in Figure. The rotor is driven by the generator's prime mover, which may be a steam turbine, gas turbine, or diesel engine. Depending on the type of generator, this component may be the armature or the field. The rotor will be the armature if the voltage output is generated there; the rotor will be the field if the field excitation is applied there.

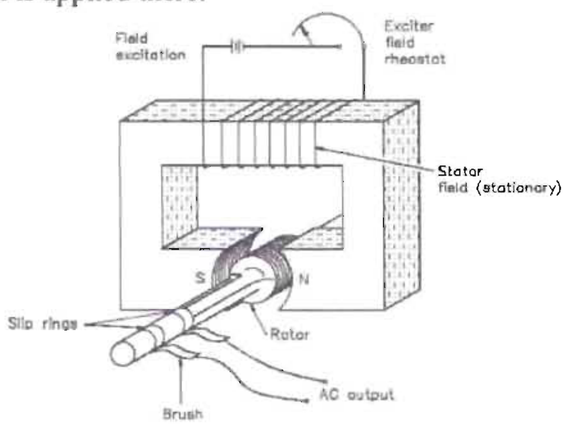


Figure 2.8: Basic AC Generator

b. **Stator:**

The stator of an AC generator is the part that is stationary (refer to above Figure). Like the rotor, this component may be the armature or the field, depending on the type of generator. The stator will be the armature if the voltage output is generated there; the stator will be the field if the field excitation is applied there.

2.3.4 Diesel Generator:

A diesel generator is the combination of a diesel engine with an electrical generator to generate electrical energy. Diesel generating sets are used in places without connection to the power grid, as emergency power-supply if the grid fails, as well as for more complex applications such as peak-lopping, Grid Support and export to the power grid.

2.3.5 Converting Generators to Supply Three-Phase Power:

In addition to ensuring that the generator frequency matches the frequency of the grid or appliances, the following conditions must also be satisfied:

a) Output voltage of the generator must match the operating voltage of the grid, or the appliances powered by the generator.

b) There should be no phase difference between the grid voltage and that of the generator.

A brief description is given below that mentions the conversion of a three-phase generator to a single-phase one and vice versa.

2.3.6 Three Phase Generator:

In a three-phase generator, three single-phase windings are spaced such that there is a phase difference of 120° among the voltages induced in each of the stator windings. The three phases are independent of each other. [7]

a) Y Configuration:

In a Y connection, one lead from each winding is connected to form the neutral. The opposite end of each winding, known as the finish end, is connected to a line terminal each. This produces a line voltage greater than the individual voltage across each winding.

b) Δ Configuration:

In a Δ configuration, the start end of one phase is connected to the finish end of the adjacent phase. This produces a line voltage equal to the phase voltage. Electrical utilities and commercial generators produce three-phase power.

2.3.7 Generator Rating (KVA):

Generator produces Voltage and Current. We can connect load as such demanding full load current or half load current, even no load. But voltage remains moreover same. So it will rate in terms of product of V × I, Secondly it gives an electrical output for any Load (Capacitor, Inductor, & Resistor). So it is considered as Product of Voltage & Current excluding power factor. This is why Generator is rated in KVA. [8]

2.4 Transformer:

Transformer is an electrical device which transforms power from one circuit to another circuit without changing frequency. A varying current in the primary winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic field through the secondary winding. This varying magnetic field induces a varying electromotive force (EMF) or voltage, in the secondary winding. This effect is called inductive coupling.

Figure 2.9: Transformer of MPS

Figure 2.10: Cut away view of three-phase oil cooled transformer

If a load is connected to the secondary, current will flow in the secondary winding, and electrical energy will be transferred from the primary circuit through the transformer to the load. In an ideal transformer, the induced voltage in the secondary winding (V_s) is in proportion to the primary voltage (V_p) and is given by the ratio of the number of turns in the secondary (N_s) to the number of turns in the primary (N_p) as follows:

$$\frac{Vp}{Vs} = \frac{Np}{Ns}$$

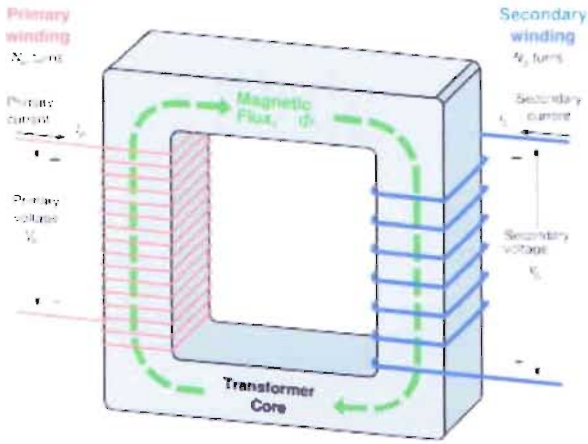


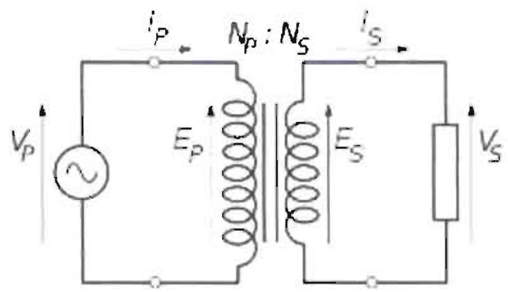
Figure 2.11: Ideal Transformer

Since the same magnetic flux passes through both the primary and secondary coils in an ideal transformer, the instantaneous voltage across the primary winding equals:

$$V_P = N_P \frac{d\Phi}{dt}.$$

Taking the ratio of the two equations for V_p and V_s gives the basic equation for stepping up or stepping down the voltage:

$$\frac{Vp}{Vs} = \frac{Np}{Ns}$$



$$\frac{V_P}{V_S} = \frac{I_S}{I_P} = \frac{N_P}{N_S}$$

Figure 2.12: The ideal transformer as a circuit element

2.4.1 Equivalent Circuit of a Practical Transformer:

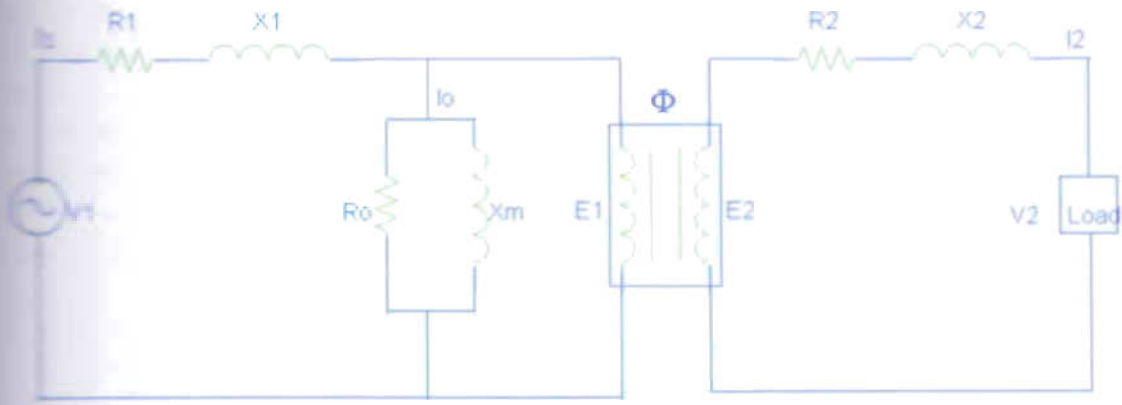


Figure 2.13: Transformer equivalent circuit

Here,

Φ = mutual flux
E_1= voltage induced in primary due to mutual flux
E_2= voltage induced in secondary due to mutual flux
V_1= applied voltage
V_2= output voltage
I_1= primary current
I_2= secondary current
R_1= resistance of primary winding
R_2= resistance of secondary winding
X_1= $2\pi L_1$ = leakage reactance of primary
X_2= $2\pi L_2$ = leakage reactance of secondary
I_o= Exciting current
R_o= fictitious resistance
X_m= fictitious magnetizing reactance

2.4.2 Three Phase Transformers:

Most power is distributed in the form of three-phase AC. Therefore, before proceeding any further we should understand what is meant by 3 phase power. Basically, the power company generators produce electricity by rotating (3) coils or windings through a magnetic field within the generator. These coils or windings are spaced 120 degrees apart. As they rotate through the magnetic field they generate power which is then sent out on three (3) lines as in three-phase power. [9]

2.4.3 Three Phase Transformers Construction:

A three phase transformer is constructed by winding three single phase transformers on a single core. These transformers are put into an enclosure which is then filled with dielectric oil. The dielectric oil performs several functions. Since it is a dielectric, a nonconductor of electricity, it provides electrical insulation between the windings and the case. It is also used to help provide cooling and to prevent the formation of moisture, which can deteriorate the winding insulation.

2.4.4 Types of Transformer Connection:

a. Y Connection &
b. Δ Connection

a. Y-Connection:

In a Y system the voltage between any two wires will always give the same amount of voltage on a three phase system. For example, if the voltage between the power conductors of any two phases of a three wire system is 208v, then the voltage from any phase conductor to ground will be 120v. This is due to the square root of three phase power.

Here, Line to Line Voltage = 208 V

Line to Neutral Voltage = $\frac{208}{\sqrt{3}}$ =120V

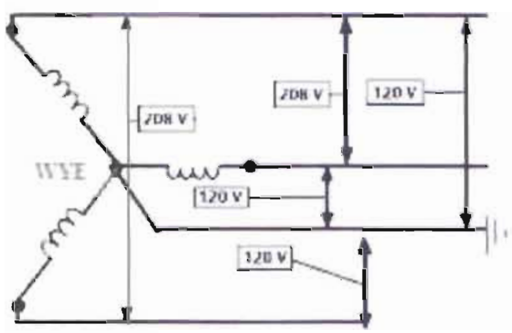


Figure 2.14: Y Connection

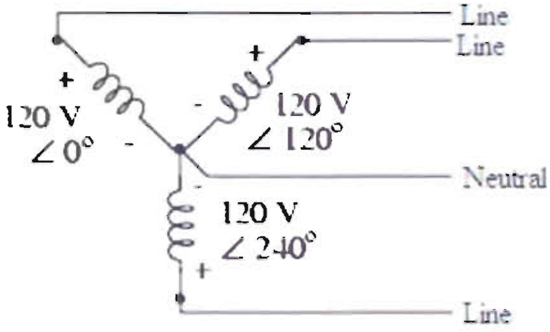


Figure 2.15: Y Connection with phase angle

b. **Δ-Connection:**

A delta system is a good short-distance distribution system. The voltage would be the same between any two wires

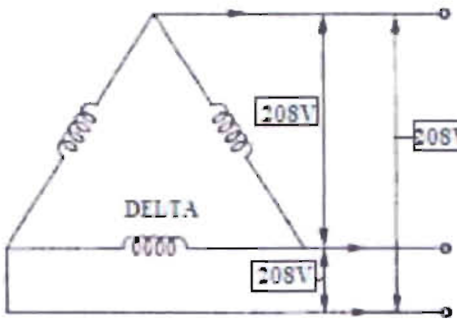


Figure 2.16: Δ Connection

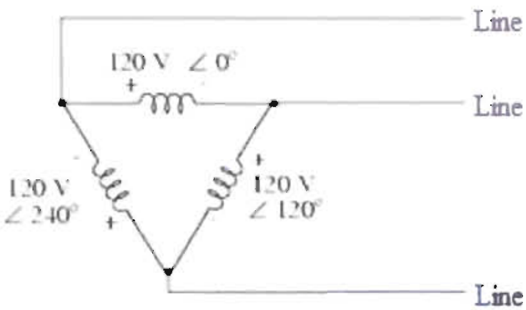


Figure 2.17: Δ Connection with phase angle

2.4.5 Three Phase Transformer Connections:

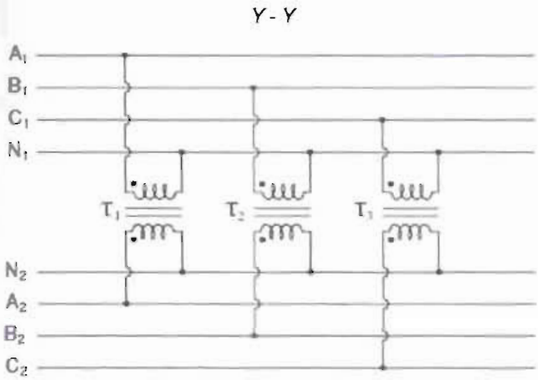
There are only 4 possible transformer combinations:

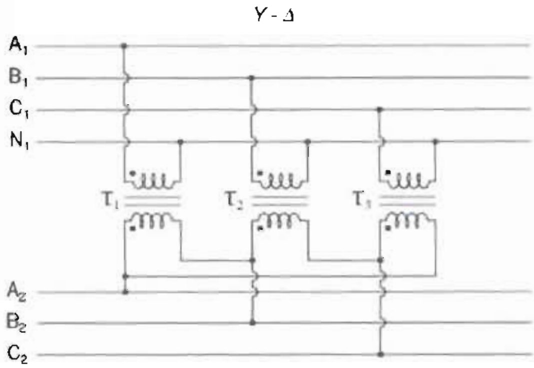
a. Delta to Delta - use: industrial applications
b. Delta to Wye - use: most common; commercial and industrial
c. Wye to Delta - use: high voltage transmissions
d. Wye to Wye - use: rare, don't use causes harmonics and balancing problems.

2.4.6 Three phase Transformer Configuration:

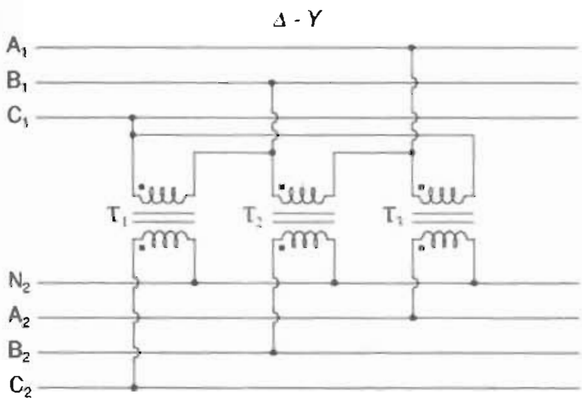
Three individual transformers (T_1, T_2, T_3) are to be connected together to transform power from one three-phase system to another. Here, Inputs A_1, A_2, A_3 and outputs B_1, B_2, B_3.[10]

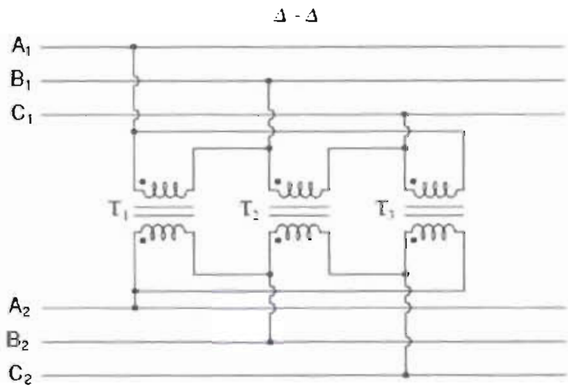
a. Y-Y configuration & Y-Δ configuration:





b. Δ-Y configuration & Δ-Δ configuration:





2.4.7 Y-Δ Transformer:

A Y-Δ transformer has its primary winding connected in a **Y** and its secondary winding connected in a Δ.

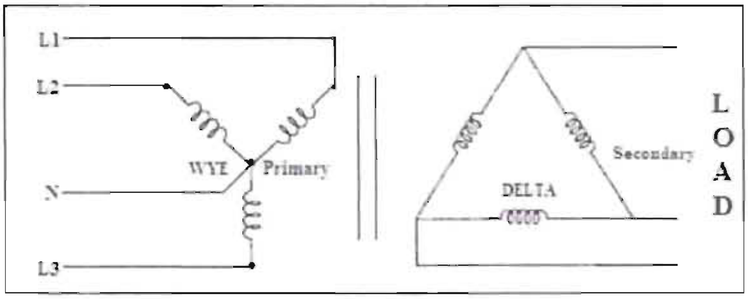


Figure 2.18: Y-Δ Transformer

2.4.8 Δ-Y Transformer:

A Δ-Y transformer has its primary winding connected in Δ and its secondary winding connected in a Y.

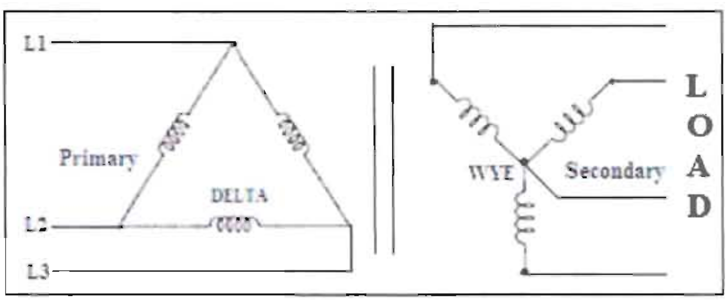


Figure 2.19: Δ-Y Transformer

2.4.9 Transformer Protection:

There are some transformer protections:

1. Over current Protection
2. Percentage differential Protection
3. Buchholz Relay Protection

2.4.10 Transformer Rating (KVA):

KVA is the unit for apparent power. Apparent power consists of active and reactive power.

There are 2 losses in a transformer:

1. One is core loss. Also known as excitation loss, iron loss. Core loss may be subdivided into two principal components: hysteresis loss and eddy-current loss. Core losses in a transformer depend on voltage and the unit of voltage is volt.
2. Other is copper loss, which occurs in the transformer winding. Copper Loss = I^2R. When an electric current flows through the resistance of the copper conductor, some energy is converted to heat. The heat, in turn, causes the operating temperature of the device to rise. Copper losses in a transformer depend on current and the unit of current is Amps.

These two factors are not affected by the power factor. This is why transformers are rated in KVA and not KW. Power = Voltage × Current × Power Factor

2.5 Pump:

A pump is a device used to move fluids, such as liquids, gases or slurries. A pump displaces a volume by physical or mechanical action.

Figure 2.20: Pump

Chapter: 03

Substation and Switchgear

3.1 Introduction:

Here, we learned different parts of substation including their maintenance and operation. Transmission of electricity at higher voltage is more efficient compared to lower voltage. That's why the substation is required. Incoming voltage to substation is 11KV. The outgoing voltage is 132KV, which is directly connected to the grid. This substation is required to step up the generated voltage suitable for transmission. In Rural Power Company Limited (RPCL), Mymensingh power Station (MPS) generated electricity is transformed from 11 KV to 132 KV transmission line. For transmitting the power to Kishorganj 1, 2 from MPS medium distance transmission 132 KV line is used. So it is required to have step up as well as step down Transformer.

In substation, transformers are one of the most significant parts. Beside this, the functioning area of substation is not only converting voltage level but ensuring the security of bus bar as well as used for communicate with other substations. Mymensing Power Station (MPS) has an outdoor, step up, double bus bar type substation. From functioning generators it gives power through bus bar one to the grid.

A 11/132kV substation is shown in Figure 3.1:

Figure 3.1: A 11/132kV substation in Mymensingh power station (MPS)

3.2 Single line diagram:

Single line diagram is useful to recognize the entire system. It is a diagram of a substation that outlines the connection of equipments in the substation. Inside the substation of MPS, the equipments are Power Transformer, Lighting Arrester, Potential Transformer, Current Transformer, Circuit Breaker, Bus bar, wave Trap and subsequently it goes to the transmission lines. The single line diagram of MPS substation is given below:

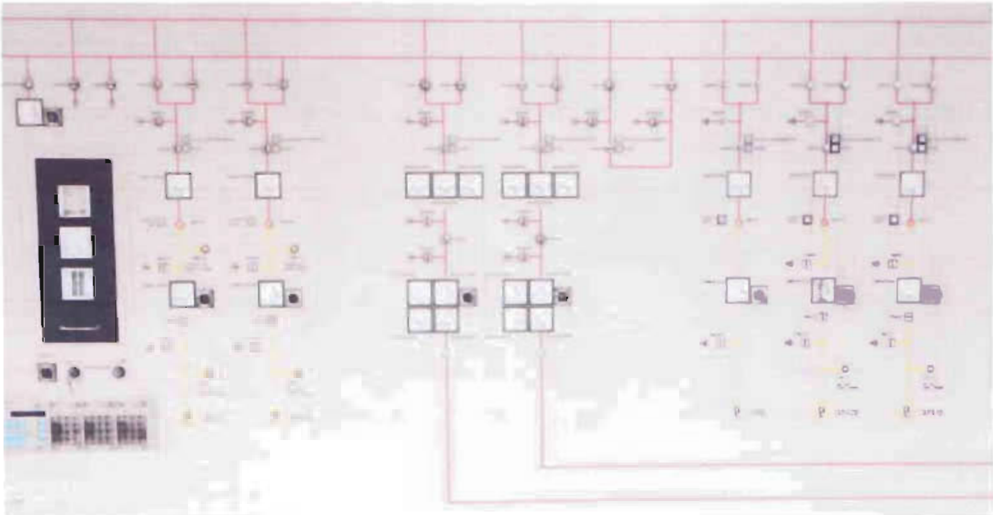


Figure 3.2: Single line diagram of MPS substation

3.3 Equipments of Substation:

The major components of substation are provided below. These are described sequentially in the next segment.

A list of equipments in MPS substations:

1) Transformer
2) Relay
3) Circuit Breaker
4) Lightning Arrester
5) Bus bar
6) Transmission Line
7) Central Control Room

3.3.1 Transformer:

There are different kinds of transformer used in substation. Power transformer, Current transformer, and voltage transformer are described sequentially in the next segment.

a) Power Transformer
b) Current Transformer
c) Potential Transformer

a) Power Transformer:

Power transformer that is used to transform AC power in power system and operates at a constant effective voltage. The frequency of power-transformer in our country is 50 hertz (Hz). To perform this operation, tap-changing transformer is used in MPS.

In table 3.1, name plate data of a three phase outdoor types Power Transformer is given. [11]

HYUNDAI step- up transformer	Model No.RP-8283
Transformer type	TL-585
Number of Phase	3
Rated Power	35/50 MVA
Type of cooling	ONAN/ONAF
Standard	IEC-76
Rated frequency	50 Hz
Vector group	YNDI
BIL(HV/HVN/LV)	650/650/95 KV
Altitude	Max.1000m Above sea level
Ambient temperature	Max.45°C Min 5°C
Type of insulating oil	IEC-296
Mass of insulating oil	24120Kg
Untanking Mass	39500kg
Temperature rise (wind/oil)	65/60°C
Temperature rise(Hot spot)	75°C
Conductor Material	Copper

Total mass	92620kg
Transportation mass	54000kg
Year of manufacture	1998

Table 3.1 Name plate data of 35/50MVA three phase outdoor types Power Transformer

Name plate data is given in below figure:

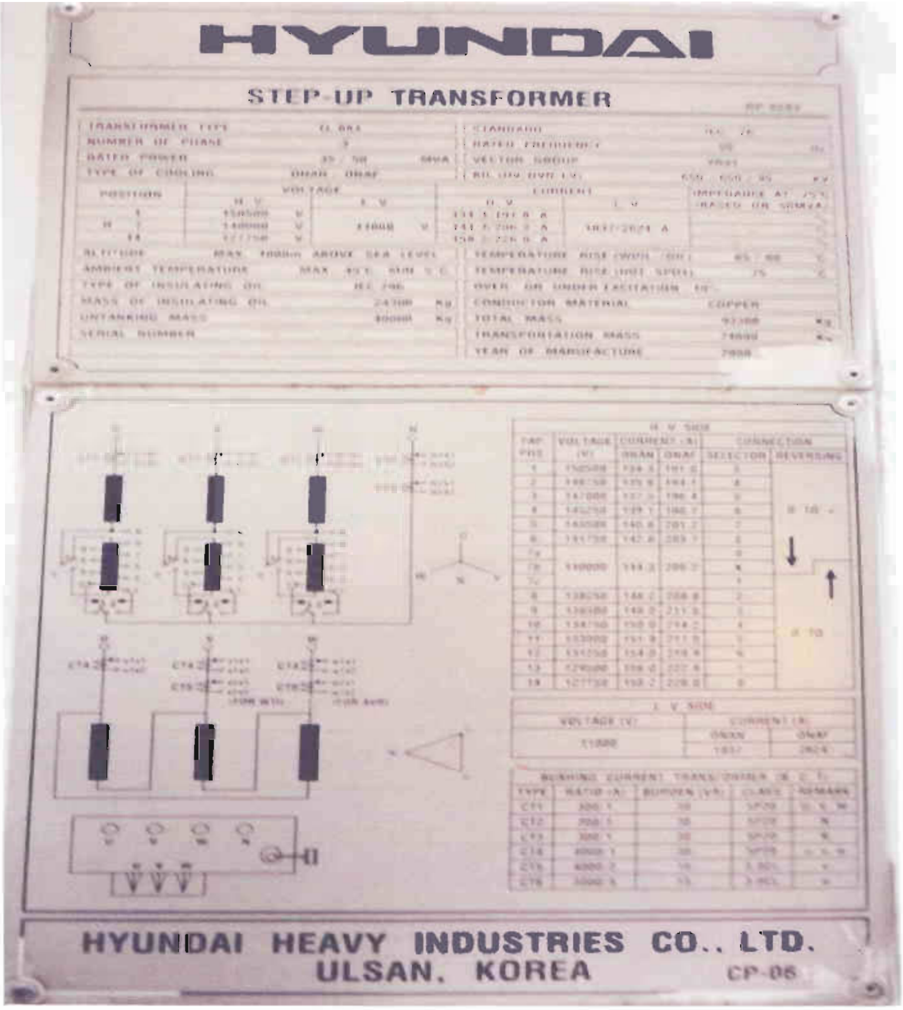


Figure 3.3: Name plate data of a power transformer used in MPS

A power transformer used in MPS is shown:

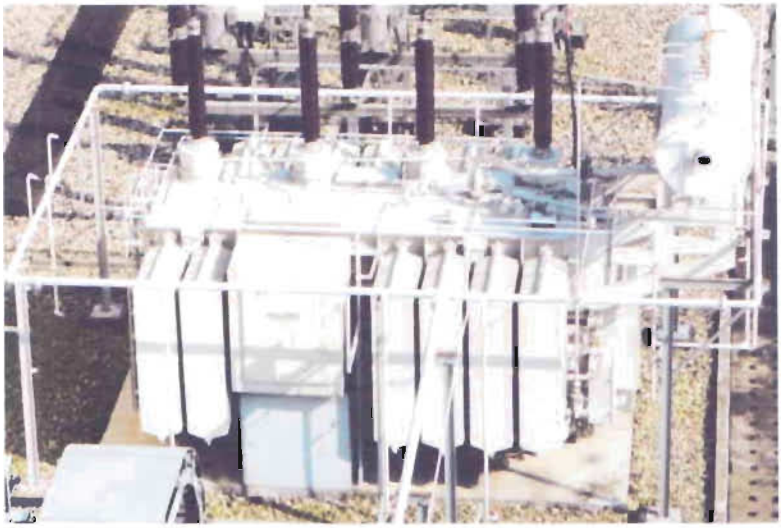


Figure 3.4: A power transformer 11 kV to 132 kV

b) Current Transformer (CT):

Current Transformer is used for the measurement and monitoring of large currents. It serves to insulate apparatus from the potential of the circuit that is being measured or monitored. Current transformer is connected in series with circuit breaker for the protection as we observed in substation. Ensuring the safety of the system, current transformer's secondary winding checked on regular schedule. To avoid accidental arc or any other kind of accident, proper safety measures are ensured when it gets unloaded or open. [12]

In table 3.2 name plate data of a single phase outdoor types Current Transformer is given:

Current Transformer	Type IMB 145
Standard	IEC 44-1
Highest System voltage	145kV
Ratio	300/1/1/1-1000/1
No.	8372 683-688
Insulation level	275-650kV
Frequency	50Hz
Total mass	600kg
Max cont. thermal current	300A
Ith	25kA/3s
Idyn	63kA
Creepage distance	4568m
Max elevation	1000m

Temp Range	-40° to+40°C
Manufacturing Year	1998

Table 3.2 Name plate data of 145 KV single phase outdoor types Current Transformer

A typical current transformer is shown:

Figure 3.5: Current Transformer by ABB (Sweden) used in MPS's substation

c) Potential Transformer (PT):

Voltage transformers are used to transform high voltages to standardized values for controlling equipments such as relays and meters. Outdoor voltage transformers are single-phase design and intended for connection between phases and ground in networks with insulated or direct grounded neutral points. Potential transformer used in MPS is 145 KV and outdoor type.[13]

In table 3.3 name plate data of 145 kV single phase outdoor types Potential Transformer is given:

Potential Transformer	Type EMFC 145	
No.	8372695-706	
Insulation level	275-650kV	
Highest system voltage	145kV	
Frequency	50Hz	
Standard	IEC 60044-2	
Voltage factor	1.5/30s	
Total mass	620kg	
Max simultaneously	20VA 3P	
Class	0.2	3P

Burden	10VA	10VA	
Ratio	A-N	a-n	da-dn
	132000/V3	110/V3	110
Manufacturing year	1998		

Table 3.3: 145 kV single phase outdoor type Potential Transformer made by ABB(Sweden)

In Figure 3.6, potential transformers used by MPS are shown:

Figure 3.6: 145 kV single phase outdoor types Potential Transformer by ABB (Sweden)

Protection and Maintenance of Transformer:

To ensure reliability of operation regular maintenance of transformer needs to be monitored. As a part of this maintenance some tests are performed according to the schedule .In MPS the protection and maintenance schedule is given below:

Protection schedule:

a) Observe Thermal over heating protection.
b) Observe Directional over current.
c) Observe Differential relay.
d) Observe Buchholz relay.
e) Observe Over fluctuation protection.
f) Observe Earth fault protection.

Maintenance schedule:

a) Observe the tightness of primary side & secondary terminals of transformers.
b) Observation of physical condition and the insulation resistance of transformer.
c) Observe the ratio and justify the accuracy of transformers.
d) Observe the dielectric strength of oil of transformers.
e) Observe oil leakage for oil immerged current and potential transformers.

3.3.2 Relay:

Relay is a switch which offers zero impedance to a current when it is closed and infinite impedance when open. It consists basically of an electromagnet with a soft iron bar, called an armature, held close to it. A movable contact is connected to the armature in such a way that the contact is held in its normal position by a spring. Relays are operated at the both side of the circuit breaker. Different types of relays used in MPS substation are described below.

Types of Relays used in MPS:

There are different types of protective relays. At MPS they use following types of relay:

a) Generators and Transformers protection relay

b) Percentage differential relay

c) Classical relay

d) Impedance distance relay

e) Induction relay

f) Pilot relay

a) Generators and Transformers protection relay:

In Mymensingh power station the particular unit generator is protected against external and internal faults by digital protection relays LGPG111 (-F60).

The Relay LGPG111 (-F60) integrates the following function:

i) F60.1: Generator differential protection (87G)

ii) F60.2: Stator Current (51V)

iii) F60.3: Reverse power fault (32) and its protection is used for the detection of prime mover loss

iv) F60.4: Negative phase sequence (1'st and 2'nd step) protection

v) F60.5: MV cable earth fault (64B)

vi) F60.6: Stator earth fault (64G1)

vii) F60.13: Field failure (excitation loss) (40)

viii) F60.W: Watchdog

In Mymensingh power Station the particular unit Transformer is protected from faults by transformer protection relay KBCH130 (-F61).

The relay KBCH130 (-F61) has the following function:

i) F61.0: Block differential protection (87B)

The differential protection compares, phase by phase, the currents in three different places: generator neutral side, downstream of the auxiliary transformer and unit transformer HV side. The minimum differential current required for operation is adjustable between 10% and 50% of rated current .The differential protection has been designed to restrain when the transformer is over fluxed so that an instantaneous trip is not used for transient over fluxing.

ii) F61.1: Over –fluxing protection (59/81)

iii) F61.W: Watchdog

Continuous self monitoring, in the form of a watchdog circuitry, memory checks and analog input module tests, is performed .In the event of a failure ,the relay will either lockout or attempt a recovery ,depending on the type of failure detected. [14]

b) Percentage differential relay:

In Percentage differential relay, the two end point of the its protection parts are connected with two current transformers .Through the operating coil of the percentage differential relay, it senses the difference of current flows between two current transformers. If difference is greater than zero then relay will operate. To ensure protection of power transformer at MPS, Percentage differential relay is operated. This type of relay is useful to detect internal fault only.

c) Classical relay:

This relay has instantaneous operation, means operation time is constant. At MPS electromagnetic attraction type double quantity classical relay is used. There are various types of classical relays in power system; this is the most common kind of relay. The construction of this relay is very simple and operating current can be adjusted significantly.

d) Impedance distance relay:

Impedance distance relay type is considered as a voltage restrain over current relay. Basically it is used for transmission grid line protection. If abnormal condition results in transmission line, relay should trip the coil timely and detect the point of fault part of the transmission line. This type of relay is the most valuable. Impedance type distance relay is operated for ensuring protection of transmission line in MPS.

e) Pilot relay:

Pilot relay is operated in MPS to send signal to the fault part .Ensuring the protection of the transmission line, power line carrier type pilot relay and microwave type pilot relay are usually used in Mymensingh power station. If a fault occurs in any zone of transmission line, instantaneously the fault should be noticed by sending a signal. Pilot relay will operate this signal.

f) Induction relay:

For controlling the characteristic curve of this relay there are a 'Time Setting Multiplier' and 'Plug Setting Multiplier'. These parts are positioned at the upper part of the relay. There is an angular force used for time adjustment. It has Inverse Definite Minimum Time (IDMT) characteristic. This type of relay is significantly operated for ensuring protection of motor and generator. This type of relay is basically operated for over current protection and inductive load in MPS's substation. [15]

3.3.3 Circuit Breaker:

It is a protective device to protect electric power cables and electric load devices from a large fault current. This fault may be caused by a ground fault and an electrical shortage. It interrupts the power system. In MPS, Circuit Breakers are significantly operated.

There is a special type of Circuit Breaker used in MPS described below.

3.3.3.1 SF6 Circuit Breaker:

SF6 Circuit Breakers are used in power distribution to control and protect transmission lines, transformer and distribution substations, motors, transformers, capacitor banks, etc. They are highly suitable for insulating materials of circuits. It may be sensitive to dielectric stresses. SF6 (145 kV), circuit breaker is used in MPS. ABB (Sweden), Switchgear is the main suppliers of these type circuit breakers. The name-plate data of a 145 KV, SF6 circuit breaker is given below:

SF6 Circuit Breaker	Type LTB 145kV
Manufacturing Year	1998
Rated voltage	145 kV
Frequency, f	50 Hz
Rated normal current, Ir	3150 A
Rated short circuit breaking current, Isc	40 KA
Out-of-phase breaking current, Id	10 KA
Line-charging breaking current	50 A
Duration of short-circuit, t	3 s
Lightning impulse withstand voltage	650 kV
Power frequency withstand voltage	275 kV
Weight of SF6	26.0 kg
Operated sequence	0-0.3s-CO-3min-CO
Weight including sf6	3530 kg
Pressure of SF6	6.0 bar

Table 3.4: 145 kV rated voltage SF6 circuit breaker made by ABB (Sweden)

In Figure, we have shown a SF6 circuit breaker:

Figure 3.7: SF6 Circuit Breaker, 6.0 bar pressure by ABB (Sweden)

Schedule Maintenance of Breakers:

Maintenance of Breakers is performed according to the schedule. This maintenance schedule is given below:

a) Observe the performance of temperature & winding temperature meter.
b) Observe the insulation resistance of bushing.
c) Observe the control system and driving mechanism.
d) Observe that silica gel crystals are blue.
e) Observe for leakage & integrity of gasket joints.
f) Observe the tightness of nuts & bolts.
g) Observation of insulation resistance between each winding and ground.
h) Observe the condition of gas level.

3.3.4 Wave Trap:

Wave trap is also well known as line trap. The major purposes of the wave trap are designed for communication among two substations. It utilizes the similar transmission line between individual's substations. It is an electronic filtering device. Besides it is used to communicate with SCADA of MPS control room. In MPS, wave trap is mainly used for communication with additional substation from MPS substation. If there is no high impedance in the wave trap, data could get missing and then communication among individuals substations would be unsuccessful or can be unworkable. Inside wave trap, there is high impedance to block high frequency signal. Using coupling capacitor and line matching unit, this device traps the high frequency signal which is sent from the distant substation and diverts that signals to telecom section in the substation control room. These signals are generally teleportation signals and in addition there are voice and data communication signals. In MPS, we observed the lightning arrester surrounding the wave trap for generous protection from lighting surge.

3.3.5 Lightning Arrester:

Lightning arrester is also recognized as surge arrester. During the normal condition lightning arrester does not operate but when the high voltage or thunder strike happens it works. Then air insulation of the gap breaks and arc is formed. After that it forms a low resistance path for surge to the ground. Lightning arrester is necessary for providing protection of the equipments of substations from lighting surge. Through the low resistance path the surplus charge is grounded. Thus Lightning is a huge flash and takes position when clouds are stimulating to a high potential with respect to ground or earth. Lightning arrester has a ground terminal and a high voltage terminal.

In Figure, we have shown a Lightning Arrester:

Figure 3.8: Lightning Arrester in the substation of MPS

Types of Lightning Arrester used in MPS:

MPS have two types of lightning arresters. These are:

a) Rod gap arrester
b) Horn gap arrester

a) Rod gap arrester:

This kind of arrester is positioned around transformers. It consists of two rods. One rod is connected to the line and other is connected to the ground. It is awfully easy type of lightning arrester which consists of two rods and is bowed at right angle with a very small gap to protect power transformers, tap changing transformers in MPS.

b) Horn gap arrester:

In support of protection of bus bar, breakers, wave traps Horn gap arrester is used in MPS primarily. The space between the horns is adjusted so that regular supply voltage is not sufficient to reason an arc across the gap. Thus one end of the horn is associated with line and other end is connected to the ground. The horn gap arrester is a different type of arrester which consists of two horns of metal rods divided by a little gap.

3.3.6 Bus bar:

There is a type of bus bar like double bus bar with reserve bus bar. MPS used double bus bar. It is used to carry huge amount of current at highest system voltage (145kV) and distribute current to several destinations. If in the least, generator requires power for starting then it takes the power from the grid through bus bar. Since, MPS is a power generation company, it generates power and distributes to the grid system through double bus bar.

Figure 3.9: A double Bus bar is used in Substation in Mymensingh power plant

3.3.7 Transmission Line:

MPS produce the electricity and send it to the transmission line for distribution. Transmission line is mainly required for transmitting the electricity. Overhead lines are used for transmission. Transmission line is a material medium or structure that forms a path for directing the transmission of energy from one place to another. On the other hand, a double bus bar configuration consists of two independent bus bars and the main bus bar is normally energized. If it is necessary to remove a circuit breaker from service for maintenance or repairs, another reserve bus bar is used.
In the Figure, we have shown Transmission lines:

Figure 3.10: Transmission Lines in MPS

3.4 Central Control Room:

Mymensingh power station has a separate control room. It is designed for controlling the substation. The distribution of electricity to different regions is controlled from this central control room, (CCR). Each and every parameter of generated electricity e.g. frequency, voltage, current are monitored in CCR. Some faults are detected in CCR and some can be fixed directly from CCR. Those faults which cannot be cleared from CCR are taken care of following the directions of CCR. In support of every section of a power plant a control room is required. [16]

In Figure 3.11, we have shown the Control Room:

Figure 3.11: Control room of substation in MPS

In Figure 3.12, we have monitoring 136.5 MW is generated from Central Control Room:

Figure 3.12: Monitoring generation from Central Control Room in MPS

3.5 Summary:

Substation is an essential part of a power station. It is primarily responsible to distribute power to the consumers. Inside MPS, generating section generate 11kV. Initially through power transformer, the voltage is stepped up to the required voltage level for transmission. Through bus bar electricity is distributed to the transmission line. Protection of substation equipments is necessary to ensure continuous transmission of electricity to the national grid.

Chapter: 04

Overview of Mechanical System

4.1 Introduction:

Mymensingh power station is one of the modern power-stations in Bangladesh. The total power station runs on combined cycle. Gas turbines are open cycle and Steam turbines are combined cycle. In this power station there are four technical departments. Among them mechanical department is the most important one. Since most of the equipments of this power station are mechanical. Mechanical equipments such as gas turbine, HRSG unit, ACC, steam turbine, compressor, combustion chamber etc are used to produce power. Some steam generating units are also there to run the gas turbine. In one word it can be said that all the mechanical equipments are the base of the power station.

Figure 4.1: Combined Cycle (Gas and Steam) Power Station

4.2 Open Cycle Gas Power Plant:

A generating station which employs gas turbine as the prime mover for generation of electrical energy is known as a gas power plant. In the gas power plant, gas and air are used as the working fluid. The air is compressed 11-30 bar pressure by the compressor and is lead to the combustion chamber. In the combustion chamber gases are mixed up with air, rising the

temperature. The hot and high pressure burning fuel is passed to the gas turbine where it expands and does mechanical work. The gas turbine drives the generator which converts mechanical energy into electrical energy.
Mymensingh power station has four gas turbines in the gas power plant and their capacity is 70MW each. Their capacities are given below:

Phase	Gas turbine	Production
Phase-I	2	2×35MW = 70 MW
Phase-II	2	2×35MW= 70 MW

Table 4.1: Production Capacity of Gas Turbine

4.2.1 Schematic Arrangement of Gas power plant:

The schematic arrangement of gas power plant is shown:

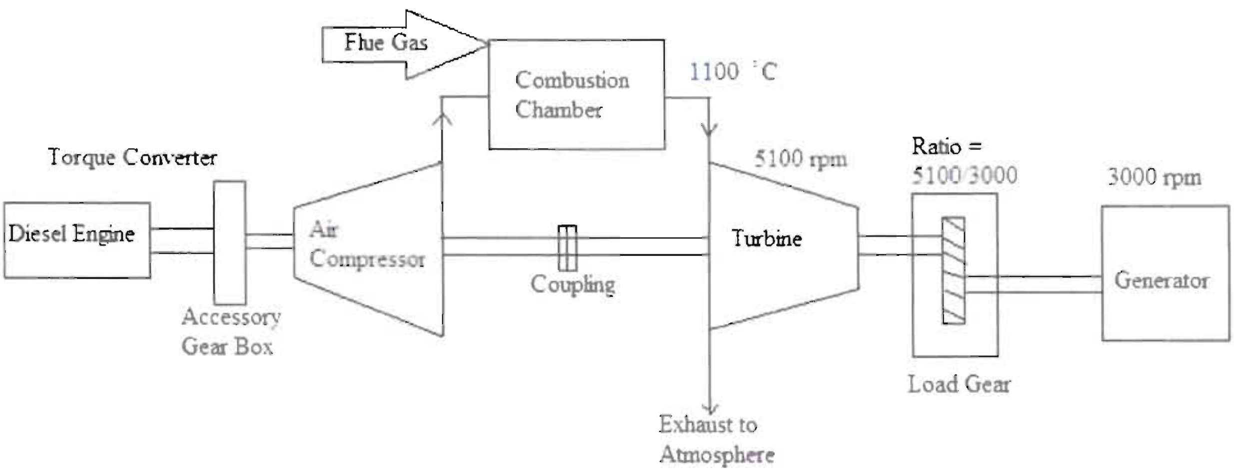


Figure 4.2 Schematic Arrangement of Gas power plants

4.2.2 The main components of the Gas power plant:

i) Diesel Engine
ii) Air intake filter
iii) Compressor
iv) Combustion chamber
v) Gas turbine
vi) Transition piece
vii) Generator

i) Diesel Engine:

Before starting the turbine, compressor has to be started. For this purpose diesel engine is used. Initially it creates rotational torque speed of turbine shaft. It creates 68-70% speed. When speed crosses over 68-70%, the diesel engine is automatically stopped.

ii) Air intake filter:

Air intake filters are modern and reliable for air intake application. They ensure high efficiency filtration of dust and other contaminants even in the most polluted environment. Normally, these are made of mixture of polyester and cellulose and sometime 100% polyester media. In MPS there are 156 pairs of conical and cylindrical shaped air inlet filters.

iii) Inlet plenum:

Inlet plenum is a casing where variable inlet guide vane (VIGV) is present. VIGV controls the amount of air sucked due to variation of load. There are 64 stages of VIGV, which is controlled by rotating.

iv) Compressor:

A gas compressor is a mechanical device that increases the pressure of a gas by reducing its volume. The compressor used in the plant is generally of rotator type. The air at the atmospheric pressure is drawn by the compressor via the filter which removes the dust from air. The rotator blades of the compressor push the air between stationary blades to raise its pressure. Thus air at high pressure is available at the output of the compressor.

In compressor there are two types of blade:

a) Stator blade
b) Rotor blade

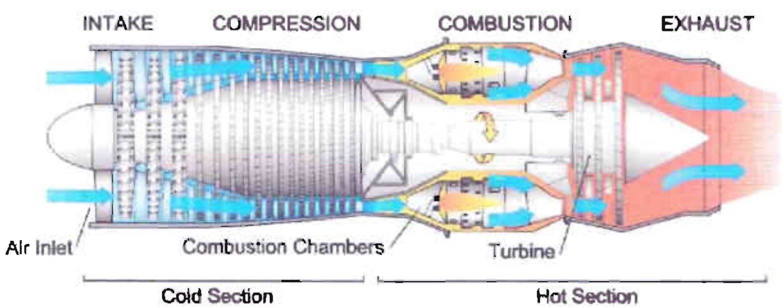


Figure 4.3: Working principle of compressor and combustion chamber

v) Combustion Chamber:

The air at the high pressure from the compressor is led to the combustion chamber. Combustion chamber is the part of a system in which fuel is burnt. The output of the chamber attains a very high temperature (about 1200°c).

Parts of combustion chamber are shown below:

a) Combustion casing
b) Linear
c) Primary fuel Nozzles
d) Secondary fuel Nozzles
e) Spark plug
f) Flame detector

vi) Gas Turbine:

Gas turbine is the main part of gas power plant. Theoretically, working principle of Gas turbine is:

a) A compressor is there to compress the incoming air to high pressure.
b) A combustion chamber is to burn the fuel and produce high pressure, high velocity gas.
c) Gas with high presser and high velocity moves through the turbine blades and mechanical work is done. The temperature of the exhaust gases from the turbine is about 550°C.

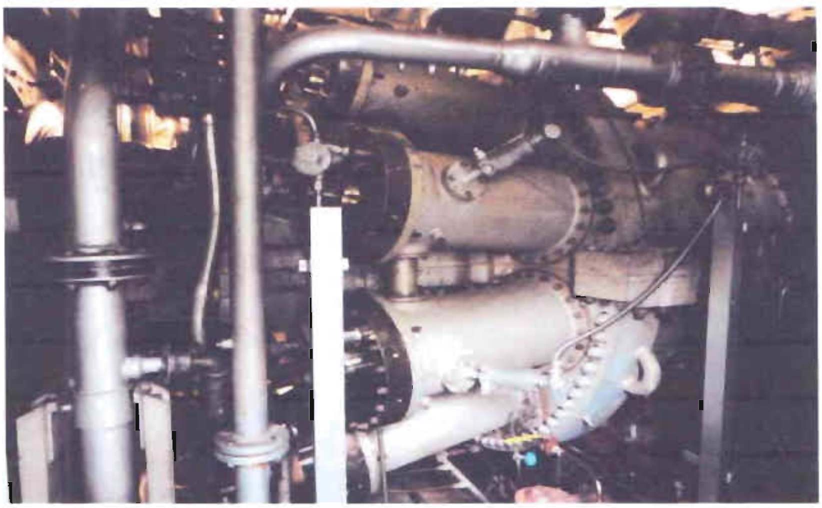


Figure 4.4: Gas turbine of MPS

A Turbine has mainly three parts:

a) Nozzle
b) Bucket
c) Shroud

a) Nozzle:

A nozzle is a device designed to control the direction of a fluid flow, as it exits from combustion chamber. Nozzles are frequently used to control the rate of flow, speed, direction, mass, shape, and/or the pressure of the stream that emerges from them. Nozzle increases the velocity of working fluid.

Figure 4.5: Turbine

b) Bucket:

Nozzle increases the velocity of working fluid which then hit the bucket, and with this high force the rotor of turbine rotates.

c) Shroud:

To give on serve some clearance between bucket and body, shrouds are used.

vii) Transition piece:

Transition piece distribute the combustion product equally through all the blades of turbine so that the turbine can run smoothly.

viii) Generator:

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

4.2.3 Gas Booster:

The main objective of the gas booster is to increase the gas pressure. When gas pressure is low in the power station gas booster is used for increasing pressure. Otherwise the output of the power generation will decrease. The normal required gas pressure is minimum 17 bar in MPS. If the gas pressure stays between 12-16 bar, it is possible to compress gas by using gas booster.

Figure 4.6: Gas Booster of MPS

4.3 Combined Cycle Steam Power Station:

A generating station which converts heat energy of gas combustion into electrical energy is known as a steam power station. In the Mymensingh power station steam turbine is a combined cycle power station. A steam power station basically works on the ranking cycle. Steam is produce in the boiler by utilizing the heat of 550°C flue gas or exhaust. The steam is then expanded in the prime mover (i.e. steam turbine) and is condensed in the condenser to be fed into the boiler again. The steam turbine drives the generator which converts mechanical energy of the turbine into electrical energy. This type of power station is suitable where gas and water are available in abundance.

Mymensingh power station has one steam turbine in the steam power plant.

Capacity:
Phase: III
Production: 1×70= 70MW

Figure 4.7: Steam power station of MPS

4.3.1 Schematic Arrangement of Steam Power Plant:

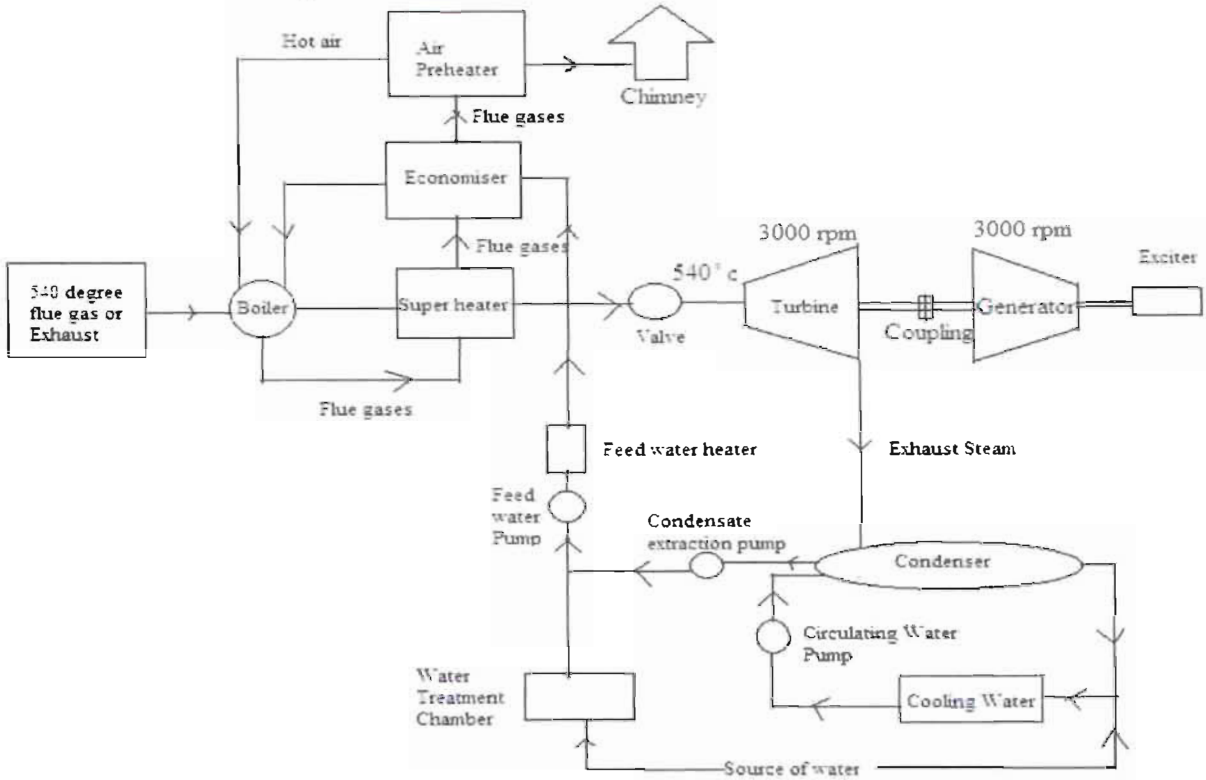


Figure 4.8: Schematic Arrangement of Steam power plants

4.3.2 The main components of the Steam Power Plant:

i) Steam Generating Plant
ii) Steam Turbine
iii) Air Cooling Condenser (ACC)
iv) Feed water
v) Generator

i) Steam Generating Plant:

The steam generating plant consists of a boiler for the production of the steam and other auxiliary equipment of flue gases. Now we describe about the boiler of Mymensingh power station.

Boiler:

The heat of combustion of gases in the boiler converts water into steam at high temperature and pressure. The flue gases from the boiler make their journey through superheater, economiser, air pre-heater and finally exhaust to atmosphere through the chimney.

There are four boilers in the steam power plant in Mymensingh power station. In the boiler section steam is produced and is used to run the turbine. Among four boilers, one boiler is shown below:

Figure 4.9: Boiler of MPS

ii) Steam Turbine:

The heat energy of steam when passing over the blades of turbine is converted into mechanical energy, evidenced by high pressure and temperature. The turbine mainly consists of nozzle and rotary blade wheel. The steam expands from high pressure to a low pressure either in nozzles or in the blade and the kinetic energy is converted into mechanical energy. In other word, it can be defined as a prime mover for the conversion of heat energy of steam into work on a rotating shaft, utilizing fluid acceleration principles in jet and vane machinery. After giving heat energy to the turbine, the steam is exhausted to the condenser which condenses the exhausted steam by means of cold water circulation.

Main parts of Steam Turbine:

a) Stator blade
b) Rotor blade
c) Journal bearing
d) Thrust bearing
e) Turning gear
f) Trip block
g) Main stop valve

h) Control valve
i) Lube oil pump
j) Control oil pump
k) Jacking oil pump

a) Stator blade:

The fixed / variable incident blade attached to the axial flow compressor stator casing.

b) Rotor blade:

The blades which are attached with the rotor of steam turbine is called rotor blade. By exerting a force on the blades, the steam flow causes the rotor to rotate.

c) Journal bearing:

A journal bearing basically is often a cylinder which surrounds the shaft & it is called with some type of fluid lubricant. In this bearing a fluid could be the medium that supports the shaft avoiding metal to metal contact.

d) Thrust bearing:

A thrust bearing is a particular type of rotary bearing. Like other bearings they permit rotation between parts, but they are designed to support a high axial load while doing this.

e) Turning gear:

Turning gear is utilized to reduce eccentricity or out of round of the rotor. When a rotor is standing still it has a tendency to sag due to its weight.

f) Trip block:

It is controlled by using hydraulic pressure. Main valve (stop) is controlled the flow of steam. And this main stop valve is controlled by trip block.

g) Jacking oil pump:

A jacking oil pump also called a lift pump is commonly used in rotor shaft of steam driven turbine generators prior to startup or after shutdown to provide even cooling of the shaft and delaminate rotor distortion caused by sags due to weight & bows due to uneven cooling. It also helps to maintain the oil film between shaft & the bearing till the rotor speed is adequate enough to maintain the film thickness and protects the shaft and bearing.

h) Lube oil pump:

Lube oil systems provide lubrication and cooling to the rotating parts and bearings of the blower, gear box and driver. Lube oil pumping applications include a pump that provides reliability and extended service life with a minimum of maintenance. The typical Lube oil pump must also be capable of operation over a wide range of temperature and liquid thickness conditions.

Figure 4.10: Lube Oil Pump

i) Control oil pump:

Control oil pump is used to supply oil to the trip block.

j) Control valve:

Control valve controls the flow of steam.

k) Hydraulic oil pump:

A hydraulic oil pump pressurizes the hydraulic fluid in a hydraulic system. The hydraulic oil pump creates a steam of high pressures oil which runs to a valve.

iii) Air Cooling Condenser (ACC):

Air-Cooled Condenser is a recycle process. In order to improve the efficiency of the plant, the steam exhausted from the turbine is condensed. Water is drawn from a nature source of supply such as river, cannel, or underground. It circulates through the condenser. The circulating water takes up the heat of the exhausted steam and itself become hot. This hot water coming out from the condenser is a suitable location down the river. In case of arability of water from the source of supply is not assured throughout the year. During the scarcity of water in the underground, hot water from the condenser is passed on to cooling tower where it is cooled. The cold water from the cooling tower is reused in the condenser.

Figure 4.11: Air-Cooled Condenser

iv) Feed water:

Some water may be lost in the cycle which is suitably made up from external source. The feed water on its way to the boiler is heated by water heaters and economizer. This help in raising the overall efficiency of the plant.

v) Generator:

The steam turbine is coupled to a generator. The generator converts mechanical energy of turbine into electrical energy. The electrical output of the generator is delivered to the bus bars through transformer, circuit breaker, and isolator.

4.3.3 Heat Recovery Steam Generator (HRSG):

A heat recovery steam generator or HRSG is an energy recovery heat exchanger that recovers heat from a hot gas steam. It produces steam that can be used in a process or used to drive a steam turbine. [17]

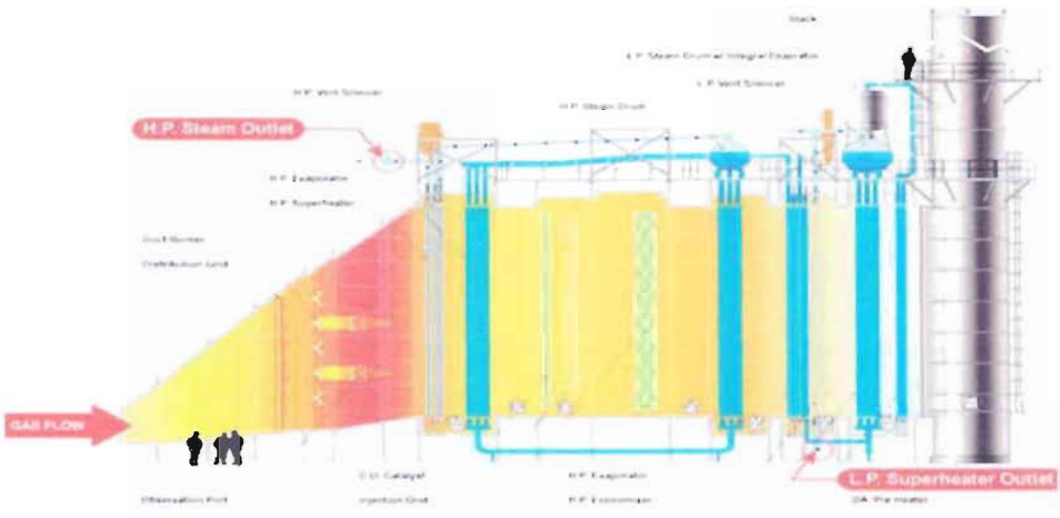


Figure 4.12: Schematic representation of a Heat Recovery Steam Generator (HRSG)

Main parts of HRSG:

a) Boiler feed water pump
b) Feed water drum
c) Economizer(HP &LP)
d) Evaporator
e) Super heater
f) HP/LP drum
g) Deaerator

a) Boiler feed water pump:

Boiler feed water pump is defined as a type (specific) of pump used to pump feed water into a steam boiler.

b) Feed water drum:

A feed water drum is a drum where water is accumulated, which is fed into the steam boiler.

c) Economizer:

Economizer is mechanical devices intended to reduce energy consumption, or to perform another useful function like preheating a fluid.

d) Super Heater:

A super heater is a device used to convert saturated steam or wet steam into dry steam used for power generation or processes. There are three types of super heaters: radiant, convection, and separately fired. [18]

A radiant super heater is placed directly in the combustion chamber.
A convection super heater is located in the path of the hot gases.
A separately fired super heater, as its name implies, is totally separated from the boiler.

A super heater is a device in a steam engine, when considering locomotives, that heats the steam generated by the boiler again, increasing its thermal energy and decreasing the likelihood that it will condense inside the engine. Super heaters increase the efficiency of the steam engine, and were widely adopted. Steam which has been superheated is logically known as superheated steam; non-superheated steam is called saturated steam or wet steam.

e) Evaporator:

Evaporator is used to convert water into saturated steam. Beside this evaporators are used for reducing product volume, remove water prior to drying and to improve product storage life.

f) HP/LP drums:

There are the drums where high pressure and low pressure steam exist.

g) Deaerator:

A deaerator is a device that is widely used for the removal of oxygen and other dissolved gases from the feed water to steam-generating boilers. In particular, dissolved oxygen in boiler feed waters will cause serious corrosion damage in steam systems by attaching to the walls of metal piping and other metallic equipment and forming oxides (rust). Water also combines with any dissolved carbon-di-oxide (CO_2) to form carbonic acid that causes further corrosion. Most deaerators are designed to remove oxygen down to levels of 7 ppb by weight (0.005 cm^3/L) or less.

There are two basic types of Deaerators:

c) The tray-type and
d) The spray-type

4.3.4 Water Treatment:

Boiler requires clean and soft water for longer life and better efficiency. However, the source of boiler feed water is generally a groundwater which may contain suspended and dissolved impurities, dissolved gases etc. Therefore, it is very important that water is first purified and softened by chemical treatment and then delivered to the boiler. The pure and soft water thus available is fed to the boiler for steam generation.

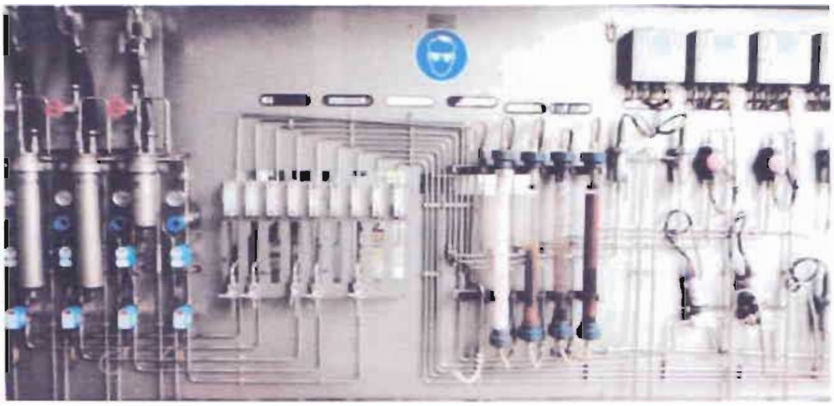


Figure 4.13: Water treatment

4.3.5 Efficiency of Steam Power Station:

The overall efficiency of the steam power station is quite low (about 29%) mainly due to two reasons. Firstly, a huge amount of heat is lost in the condenser and secondly heat loss occurs at various stages of the plant. The heat loss in the condenser cannot be avoided. It is because heat energy cannot be converted into mechanical energy without temperature difference. The greater temperature difference, the greater is the heat energy converted into mechanical energy. This necessitates keeping the steam in the condenser at the lowest temperature. But we know that greater the temperature difference, greater is the amount of heat loss.

4.3.6 Overall Efficiency:

The ratio of heat equivalent of electrical output to the heat of combustion of coal is known as overall efficiency of steam power station.

Overall efficiency, $\eta_{overall} = \frac{\text{Heat equivalent of electrical output}}{\text{Heat of combustion of coal}}$

The overall efficiency of a steam power station is about 29%.

Chapter: 05

Overview of Instrumentation and Control System

5.1 Induction:

The instrumentation and control (I&C) system architecture, together with plant operation personnel serves as the "central nervous system" of any power station. Mymensingh power station (MPS) also has this I&C department. This department senses basic physical parameters, monitors performance, integrates information, and makes automatic adjustments to plant operations as necessary. This department also responds to failures and off normal events, thus ensuring goals of efficient power production and safety. Therefore, as much as attention as importance should be given for the projects involving the design, testing, operation, maintenance, licensing, operation, and modernization of I&C system. [19]

5.2 Instrument:

Instrument is a mechanical tool on implement used for delicate or precision work. In other word it is a mechanical or electronic device for monitoring, measuring or controlling.

5.3 Control:

A control system is a device, or set of devices to manage, command, direct or regulate the behavior of other devices or system. There are two common classes of control systems, with many variations and combinations: logic or sequential controls, and feedback or linear controls. In MPS use many types of control system. These are:

1) Pressure transmitter
2) Speed transmitter
3) Magnetic pick up(speed sensor)
4) Fire protection system
5) Heat detector
6) Gas detector
7) Flame detector
8) MAK-V
9) PCS-7
10) Gas buster
11) Water treatment unit

5.4 Application of instrument & control:

Instrument and control is mainly used in MPS automation. This is a discipline that includes knowledge and expertise from various branches of engineering including electrical, electronic, chemical, and mechanical and communications and more recently computer and software engineering.

5.5 Automation:

Automation is the technology by which a process or procedure is accomplished without human assistance. Automation is the use of control systems and information technologies to reduce the need for human work in the production of goods and services. In the scope of industrialization, automation is a step beyond mechanization. Whereas mechanization provided human operators with machinery to assist them with the muscular requirements of work, automation greatly decreases the need for human sensory and mental requirements as well. Automation plays an increasingly important role in the world economy and in daily experience.[10]

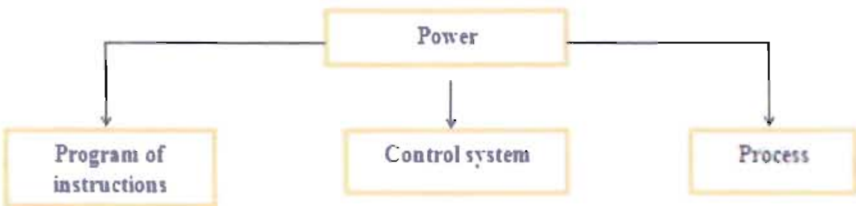


Figure 5.1: Basic elements of a control system

5.6 Control system:

In MPS, two types of control system are used. Those are: open loop system and closed loop system.

5.6.1 Closed loop (feedback) control system:

It is a system in which the output variable is compared with an input parameter and any difference between the two is used to drive the output into agreement with the input.

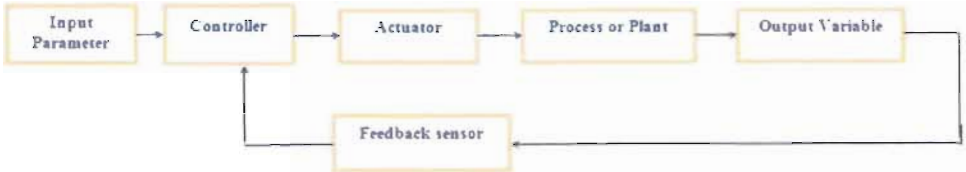


Figure 5.2: Closed loop control system

5.6.2 Open loop control system:

Open loop system starts with a subsystem called an input transducer, which converts the form of the input to that used by controller. Risk that the actuator will not have the intended effect.

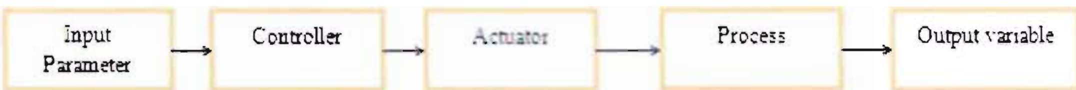


Figure 5.3: Open loop control system

5.7 Distribution control system:

A distribution control system (DCS) refers to a control system usually of a manufacturing system, process or any kind of dynamic system, in which the controller elements are not central in location but are distributed though the system with each component subsystem controlled by one or more controllers. The entire system of controller is connected by network for communication and monitoring.

5.8 SCADA (Supervisory Control and Data Acquisition):

Industrial processes include those of manufacturing, production, power generation, fabrication, and refining, and may run in continuous, batch, repetitive, or discrete modes. Supervisory control was exercise by the operator manually operating various control knobs. These devices were and still are used to do supervisory control and data acquisition on plant, power generating facilities. So those at MPS, this SCADA system are use for their automation system. [20]

5.9 Programmable Logic Controller (PLC):

A programmable logic controller (PLC) or programmable controller is a digital computer used for automatic of electromechanical process, such as control of machinery or factory assemblies, amusement rides or lighting fixtures. PLC is used in many industries and machines.[21]

5.10 MARK (V) gas turbine control system:

The speed tonic MARK (v) gas turbine control system is the latest derivative in the highly successful speed tonic series. The speedtonic gas turbine control system performs many and cool down and voltage matching on the generation of system, monitoring of all turbine, control of auxiliaries function of a verse operating conditions.

It uses shift technology for the control of a new triple- redundant protective module of a significant increase hardware diagnostics.

It consists of nine core / processors. These are R, S, T, C, D, P, PD, QD, and CD. Here R, S and T are called TMR (Triangle Module Redundant). It produces the vote value. C is called communication core. It communicates the vote value of TMR. D work for if C damage then it works the replacement of C. P means protective core. It is used for many protection of turbine. PD means power distribution core. And finally QD and CD is input device.

Figure 5.4: MARK-V using in MPS

5.11 PCS- 7 Control Systems:

PCS- 7 is known as the automation system with field instrument. In MPS, this PCS-7 control system use for steam turbine generator (STG). Block diagram of PCS 7 control system is given below:

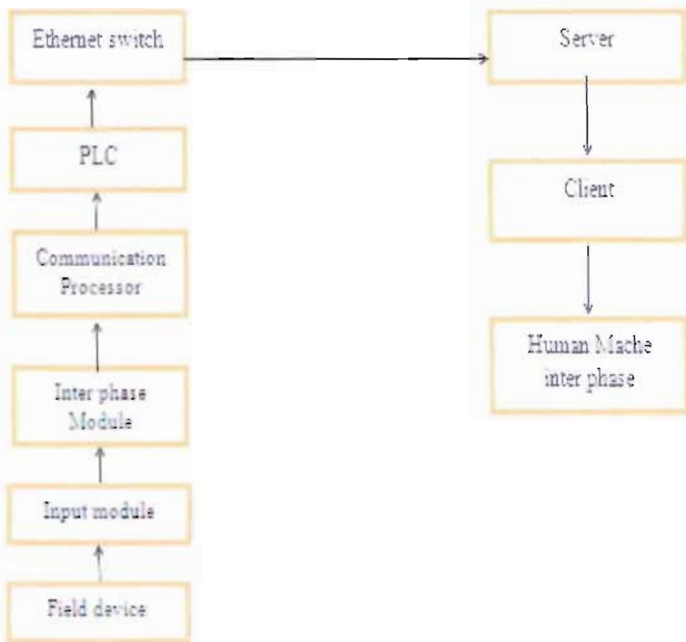


Figure 5.5: Block Diagram of PCS-7 System

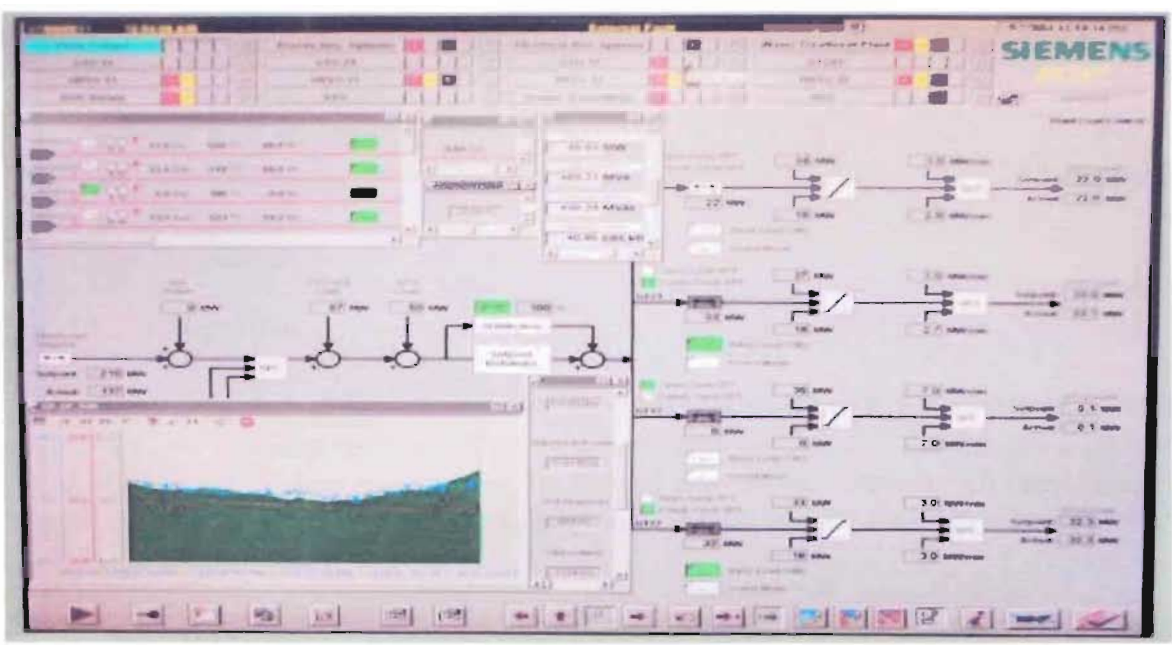


Figure 5.6: PCS-7 using the MPS

Figure 5.7: PCS-7 using the MPS for STG

5.12 List of different instruments:

In case the fine protection system some instrument are used.
They are-

a) Heat detection
b) Smoke detection
c) Flame detection
d) Gas detection
e) Call point
f) Spark plug

5.12.1 Heat detection:

A heat detector is a fire alarm device designed to respond when the converted thermal energy of a fire increases the temperature of a heat sensitive element. The thermal mass and conductivity of the element regulate the rate flow of heat into the element. All heat detectors have this thermal lag. Heat detectors have two main classifications of operation, "rate-of-rise" and "fixed temperature."

5.12.2 Smoke detection:

A smoke detection is a device that detects smoke, typically as an indication of fire.. But the shape can be varying by manufacture or product line. Most smoke detection work either by optical detection or by physical process (ionization).

5.12.3 Flame detection:

The optical Flame detection is a detector that uses optical sensors to detect flames. There is also ionization flame detector, which use current flow to detect flame presence. A flame detector detect Ultraviolet, Visible light, Wideband infrared, Emission of radiation, Sunlight, Heat radiation.

5.12.4 Gas detection:

Gas detection is a device which detects the presence of gases within the area, usually as part of a safety system; this type of equipment is used to detect a gas lack of interface with a control system so a process can be automatically shut down. Gas detection can also make an alarm in the area where the lack is occurring to warn the operator.

5.12.5 Call point:

A call point is a manual switch or device used to produce a siren for announcing the outbreak of a fire.

5.12.6 Spark plug:

A spark plug is an electrical device that fits into the cylinder head of some internal combustion engines and ignites compressed fuels such as aerosol, gasoline, ethanol, and liquefied petroleum gas by means of an spark. Spark plugs may also be used in other applications such as furnaces where a combustible mixture should be ignited. In this case, they are sometimes referred to as flame igniters.

5.13 Some other instrument is used in MPS:

a) Pressure switch
b) Limit switch

5.13.1 Pressure switch:

A pressure switch is a form of switch that makes electric contact when a certain set pressure has been reached on its input. This is used to be providing off/on switching from a pneumatic or hydraulic source. The switch may be designed to make contact either or pressure rise or on pressure fall.

5.13.2 Limit switch:

To know that the valve is open or closed limit switch is used. It is operated by digital signal [0, 1]. Limit Switches are used for the control and monitoring of Automated Machinery and Industrial Equipment. The high quality materials, the combination of mature technology, high precision and practical design make Euchner switches a good, reliable and trouble free choice for your machinery and equipment. Euchner limit switches offer plastic and metal corrosion resistant housings. Certain models are available with direct opening contacts for safety applications.

Figure 5.8: A Limit switch [22]

5.13.3 Relay:

An electrical device connected between the main circuit and the circuit breaker to isolate the faulty section. A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used.

Relays are used where it is necessary to control a circuit by a low power signal (with complete electrical isolation between isolation and controlled circuit), or where several circuit must be controlled by one signal.

5.13.4 Control Valve:

A control valve is a power operate device used to modify the fluid rate in a process system. Process plant consists of hundreds, or even thousands, of control circuit all networked together to produce a product. Each of these control circuits or loops is designed to maintain the plant in safe operating limits. Each of these control loops is designed to keep some important process variable such as:

a) Pressure
b) Flow
c) Level
d) Temperature

The control valve assembly typically consists mainly of the valve body, the terminal trim parts, and an actuator to provide the motive power to operate the valve. A variety of additional valve accessories, which can include positions, transducers, supply pressure regulator, manual operators, snubbers or limit switches are also included to add functionality o various level and to characterize the particular valve.

5.13.5 Pneumatic control valve:

Control valves are valves used to control conditions such as flow, pressure, temperature, and liquid level by fully or partially opening or closing in response to signals received from controllers that compare a "set point" to a "process variable" whose value is provided by sensors that monitor changes in such conditions. Pneumatic control valve is an air operated valve. It can be zero to hundred percent. When it is opened zero percent then no flow will occur. Its main purpose is to control the steam flow.

5.13.6 Pneumatic shut up valve:

Pneumatic shut up valve is also an air operated valve. The basic different between shut up valve and control valve is that shut up valve can only open either zero or hundred percent where control can open zero to hundred at any percentage.

It has three parts:

a) Valve stream
b) Actuator
c) Limit switch

5.13.7 Motor Operated Valve (MOV):

MOV is the valve which is operated by motor.

It parts:

a) Motor
b) Three types of card
c) Control card
d) Communication card
e) Power card
f) Signaling gear
g) Valve steam

In MPS, uses 1.5 KW motor uses as a valve. If temperature is high then this valve is operate. This valve have indicator, signaling gear. Signaling gear use as a switch of this valve. We see three types of card are use of MOV. The power card use for power supplier of motor. Communication card use to communicate the PLC and Valve. And last one is control card use to control the whole MOV. It is used for controlling water steam flow.

5.13.8 Auto deluge valve:

Automatic resetting deluge valve is a quick opening, hydraulically operated different type valve designed for fire protection system service. It is used "automatic water controlled valve" in deluge, precaution, and special types of fire protection system such as foam water and double interlock. It is mainly used for transformer fire protection.

5.13.9 Solenoid Valve:

A solenoid valve is an electromechanical valve for use with liquid or gas. The valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports. Multiple solenoid valves can be placed together on a manifold. Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design.

5.13.10 Servo valve:

A servo valve is a device used to provide mechanical control of a distance. A servo can be used at a remote location to proportionally follow the angular position of a control knob. The connection is not mechanical, but electrical or wireless. The most common type of servo is that mentioned which gives positional control. Servos are commonly electrical or partially electronic in nature, using an electric motor as the primary means of creating mechanical force, through other types that use hydraulics, pneumatics or magnetic principle are available.
They use to operate the throttle of engine that uses a cruise control. CNC machines use servos to make the motor axes of a machine tool follow the designed tools path. To look the position of servo valve is use LVDT.

5.13.11 LVDT:

The Linear Variable Differential Transformer (LVDT) is a type of electrical transformer used for measuring linear displacement. This type of pressure measurement relies on the movement of a high permeability core within transformer coils. The movement is transferred from the process medium to the core by use of a diaphragm, bellows or bourdon tube. The LVDT operates on the inductance ratio between the coils. Three coils are wound onto the same insulating tube containing the high permeability iron core. The primary coil is located between the two secondary coils and is energized with an alternating current. Equal voltages are induced by the magnetic flux. When the core is move from the center position, the result of the voltages in the secondary windings will be different. The secondary coils are usually wired in series. At

MPS this type of transformer use for control to see the position of another valves (exp: Stroke ratio valve (SRV), gas control valve (GCB)) of GT.

5.13.12 Vibration transmitter:

Vibration transmitter is an instrument used to measure vibration and also it is used in protection purpose. Another name of vibration transmitter is seismic sensor. At MPS this type of transmitter use for stop the extra vibration of gas turbine and steam turbine. They use 2 vibration transmitters in each bearing.

Its input = 24V (DC)
Output = 4 to 20 mA

When it shows 4mA vibration is less and when it shows 20 mA vibration is higher.

5.13.13 Seismic Sensor:

This circuit simulates a seismic sensor to detect vibrations/sounds. It is very sensitive and can detect vibrations caused by the movement of animals or human beings. So it can be used to monitor protected areas to restrict entry of unwanted persons or animals. The circuit uses readily available components and the design is straightforward. A standard piezo sensor is used to detect vibrations/sounds due to pressure changes. The piezo element acts as a small capacitor having a capacitance of a few Nano farads.

5.13.14 Proximity Sensor:

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. It often emits an electromagnetic or a beam of electromagnetic radiation, and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target.

5.13.15 Thermocouple:

A thermocouple is a device consisting of two different conductors (usually metal alloys) that produce a voltage proportional to a temperature difference between either ends of the pair of conductors. Thermocouples are a widely used type of temperature sensor for measurement and control. At MPS using 18 thermocouples used inside gas turbine to measured the exhausted temperature.

5.13.16 Resistance Temperature Detectors (RTD):

Resistance temperature detector or Resistance temperature devices are temperature sensor that exploits the predictable changes in electrical resistance of some materials with changing temperature. RTD's are built from selected metal (typical platinum), which charge resistance with temperature sensitive resistance of the device. The RTD measured the electrical conductivity as it varies with temperature. The electrical resistance generally increases with temperature, and the device is defined as having a position temperature coefficient. The magnitude of the temperature coefficient determines the sensitivity of the RTD. The temperature coefficient defines how much the resistance will change for a change in temperature, and has units of ohms/^{0}C. The greater the temperature coefficient, the more resistance will be change for a given change in temperature. Apart from platinum, other metal are used for RTD's such as Copper and Nickel. Platinum is the most common and has the best linear characteristic of the three, although Nickel has a higher temperature coefficient giving it greater sensitivity.

5.13.17 Temperature transmitter:

RTD/ Thermocouple are connected with temperature transmitter. And it is directly connected with CCR (Central Control Room).

Here,
Input= output of RTD/thermocouple
Output= 4 to 20 mA

5.13.18 Pressure transmitter:

A pressure transmitter measure typically of gases or liquids pressure in an expression of the force required to stop a fluid from expanding and usually stated in terms of force per unit area.

It is of two types:

a) Absolute pressure transmitter
b) Different pressure transmitter.

5.13.18.1 Absolute Pressure Transmitter:

Absolute Pressure Transmitter measure single pressure.

5.13.18.2 Different Pressure Transmitter:

Different pressure transmitter measures the different of pressure. It is used to know the flow rate of fluid, level of fluid in a container. It is also used to know that the filter is also used to know that the filter is filter is block or not.

5.13.19 Flow transmitter:

Flow transmitter provides electrical outputs that are proportional to flow inputs. They use flow meters to measure the flow of liquid and gas. Flow transmitters output analog voltages, analog current, frequency, and pulses. Flow transmitter use three basic types of meters: mass, volumetric and velocity. These devices several meter technologies, including different pressure (DP). The basic operating principle of DP meters is that a pressure drop across a meter is proportional to the square of the flow rate.

5.13.20 Ultrasonic level transmitter:

Ultrasonic level transmitter is used for non-contact level sensing of highly viscous liquids, materials and power. Fluids and fluidized solids flow to become essentially level in their container because of gravity whereas most bulk solids pile at an angle of repose to a peak. The substance to be measured can be inside a container or can be in its natural form. The level measurement can be either continues or point value.

Continues level sensors measure level within a specified range and determine the exact amount of substance in a certain place. While point level sensors only indicate whether the substance is above or below the sensing point.

5.13.21 Simocode:

Simocode pro is a flexible, module, motor management system for motors with constant speeds in the low voltage performance range. It optimizes the connection between the I&C and motor feeder, increasing the system availability and allows significant saving to be made for startup, operation and maintenance of a system. Simocode pro offer comprehensive protection of a motor feeder by mean of a combination different, multi-step and delay able protection and monitoring function.

5.13.22 CDS & Sampling station:

In MPS, there are two important systems. One is chemical dosing system & another one is sampling station.

5.13.22.1 CDS:

Chemical Dosing System (CDS), applied in the thermodynamic system of thermal power plant and the secondary circuit of nuclear power station, can dose metering pumps. So, as to make the quality of water steam be a fine chemical and ensure the safety economy and normal operation the unit. Here to increase or decrease the PH and conductivity the dosing is done.

5.13.22.2 Sampling Station:

In sampling station, have a P_H sensor. It senses the P_H of High Pressure (HP) and Low Pressure (LP) tank. If P_H is high then dosing stator is open and dosing the appropriate chemical in the tank and control the P_H of the water or steam.

5.13.22.3 Dual Analyzer:

Dual analyzer is measure the P_H and conductivity of water. In dual analyzer there is a P_H electrode and conductivity sensor which measures the P_H and conductivity.

5.13.22.4 Dissolve O_2 Analyzer:

There is dissolve O_2 sensor which measure the amount of dissolve O_2 present in the water in term of parts per billion.

5.13.23 Actuator:

Actuators are used for the automation of industrial valves and can be found in all kinds of technical process plants: they are used in waste water treatment plants, power plants and even refineries. This is where they play a major part in automating process control. The valves to be automated vary both in design and dimension. The diameters of the valves range from a few inches to a few meters.

5.13.24 Flow controller:

In sampling station there is follow sensors which show the flow of fluid. It flow occurred it shows the green light otherwise red light.

5.13.25 Temperature controller:

To see and measure temperature of fluid their present a temperature controller in the sampling station. In MPS, use model-TN552GAPP temperature controller.

5.13.26 Manual valve:

At MPS, many types of automatic valves are use. Every automatic valve adjust also have a manual valve. If the automation system does not work then manual valves are use. Manual valves are hand operated.

Chapter: 06

Overview of Plant operation

6.1 Introduction:

In language, an operation is a word which represents a function (for instruction) rather than a term or name. In computer science, an operation is called an instruction.

In MPS, different types of operation are done and there are individual department, for them. Such as Military operation, convert operation, sting operation, business operation, and manufacture operations. But in case of MPS the operation department is the heart of the total power station. The whole power station is controlled by this department. For this reason it is called central Control Room (CCR).

Figure 6.1: Central Control Room of MPS

6.2 Main purpose of operation department:

The operation department does the overall monitoring of the power plant. For monitoring and controlling the whole power plant operation the operation department has some jobs.

6.2.1 Inspection in every hour:

The operation departments have to do some inspection in every hour. These are

a) Gas turbine
b) HRSG (Heat Recovery Steam Generator)
c) BOP
d) WTU (Water Treatment Unit)

e) Switch yard
f) Instrument air compressor
g) Gas booster compressor
h) Electrical room
i) STG
j) ACC

6.2.2 Running Machine:

The operation departments also run the main machine of MPS.

These are:

a) Gas turbine.
b) HRSG
c) Gas turbine
d) WTU
e) STG

6.2.3 Data entry:

The operation department also entry the data of STG, WTU, and GT in every four hours. And also how much power is delivered to the grid it is also noted in every hour.

6.2.4 Communication:

The operation department has to contact with the National Load Dispatch Centre (NLDC) and Mymensingh grid time to time.

6.2.5 Fault Notification:

Fault notification to respective department is also done by operation department by using Continuous Maintenance Monitoring System (CMMS).

6.2.6 Other:

To see the progress of work is also done by operation department. And also work permit is given by this department.

In one word we can say that, the total control and monitoring is observed and done by the operation department.

6.3 Responsibility:

There are some responsibilities which must be obeyed by the person who are connecting with the department.

These responsibilities are:

a) Monitor and control his assigned equipment or machine.
b) Carry out machine logging data check as laid down by operating authority.
c) Maintain the log sheet legibly, up to the minute and available for inspection at all times.
d) Any severe changes in machine or system condition should be made known as soon as possible to the shift engineer or supervisor.
e) In addition to log data readings, the operator should make physical inspection of the units, surround and support equipment.
As a general guide inspection for:
i) leaks-liquid and air.
ii) Unusual noise and vibration.
iii) Loose piping or support.
iv) Brush gear, sparking in case of DC motor etc.
v) Debris around guards, air inlet screen and rotating equipment.

f) The operator should ensure the validity of the unit ventilating and CO_2 firefighting systems maintain all compartment doors and panel securely closed.
g) Machine condition and shift take over should be verified through the daily log books and liaison with the hand over operator.
h) Must notify the shift in charge if you have cause to leave the control cab for more than a few minutes.
i) Vigilance should be considered the fundamental priority. Observations made immediately prior to an occurrence are infinitely more valuable than observations made after the event.
j) All alarm should be noted in the dairy log book and the shift in charge notified as necessary. In a multi alarm situation the flashing alarm should not be cancelled until it is recorded in the log as the first alarm.
k) The control cab should be maintenance clean and dust free at all time.

6.4 Instructions for GT operation:

The operation engineer shall follow the steps mention below for operating the GT unit:

1) Cold start:

PRIOR to STAT order:

Checking should be made for following:

i) Lube oil to be within level limit.

ii) Lube oil temperature to be more than 10^0c.

iii) Cooling water to be within level limit in the cooling water tank.

iv) Fuel oil for starting diesel engine within level limit.

v) Lube oil for the diesel engine to be within level limit.

vi) Lube oil for starting diesel engine is visually acceptable.

vii) Gate valves in the cooling water circuit to be in open position.

viii) Turbine, generator, auxiliary and load gear component to be visually acceptable on the following:

a) Tightness of bolts.
b) Mechanical pants free from damage.
c) Lube free from leakage and accumulation on the floor.
d) Compartments cooling ventilation in open position.

ix) Healthy power supply for motor and other equipment to be ensure.

x) Healthy power supply at all control and protection panel to be ensured.

xi) The following to be visually normal:

a) Electrical room LV panel.
b) Emergency power panel.
c) DC distribution panel.
d) Safe AC panel.

xii) Unit battery to be charge and charger functioning properly.

xiii) Availability of gas pressure and no leakage in the fuel gas system from pressure reducing station up to the SRV and GCV filtration skid.

xiv) 132KV switchyard equipment's, unit step up XFR, site auxiliary XFR acceptable on visual inspection.

xv) The emergency diesel engine for:

a) Fuel tank level.
b) Lube oil level.

c) Cooling system.
d) Starting mode selector switch to be in AUTO position.
e) Battery voltage and charge condition.

xvi) The sight firefighting skid:

1) Diesel engine driven fire pump for:
   a) Fuel tank level.
   b) Lube oil level.
   c) Cooling system.
   d) Battery voltage and charger condition.
   e) Cooling and sealing oil level.
   f) Inlet and outlet valves position should be open.
   g) Priming of the pumps.

2) Ac motor driven pumps:
   a) Starting mode selector switch should be in auto position.
   b) Healthy AC power supply.
   c) Priming of the pumps.
   d) Cooling and sealing oil level.
   e) Motor space heater in operation.

3) AC motor driven jockey pumps:
   a) Starting mode selector switch, this should be in AUTO position.
   b) Firefighting loop pressure should be 7-9 bars.
   c) Healthy power supply.

After checking all these things GT is ready to run.

6.5 Start up the GT (typical sequence with diesel starting mean and gas fuel):

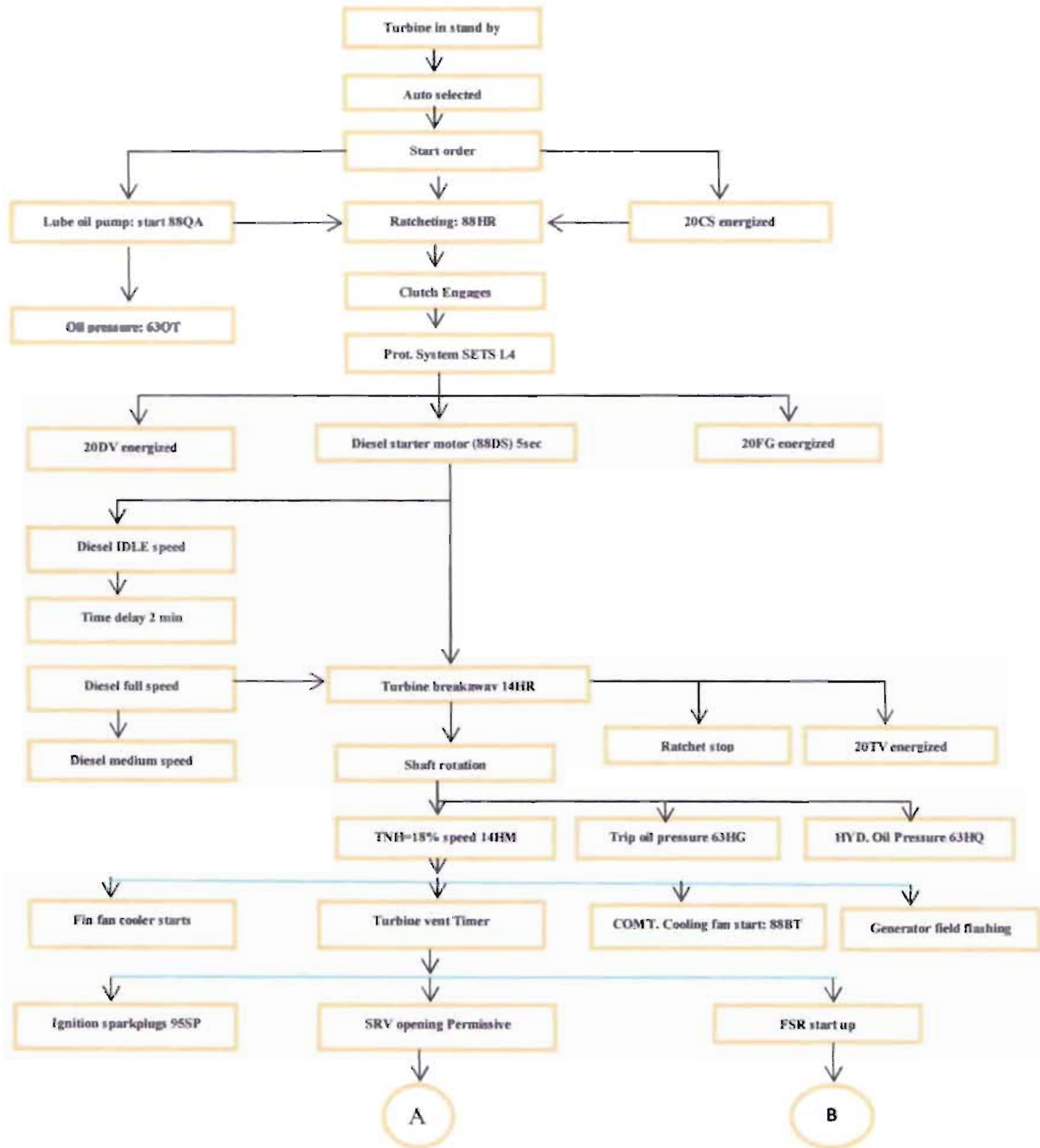


Figure 6.2(a): Block Diagram of Startup GT [2]

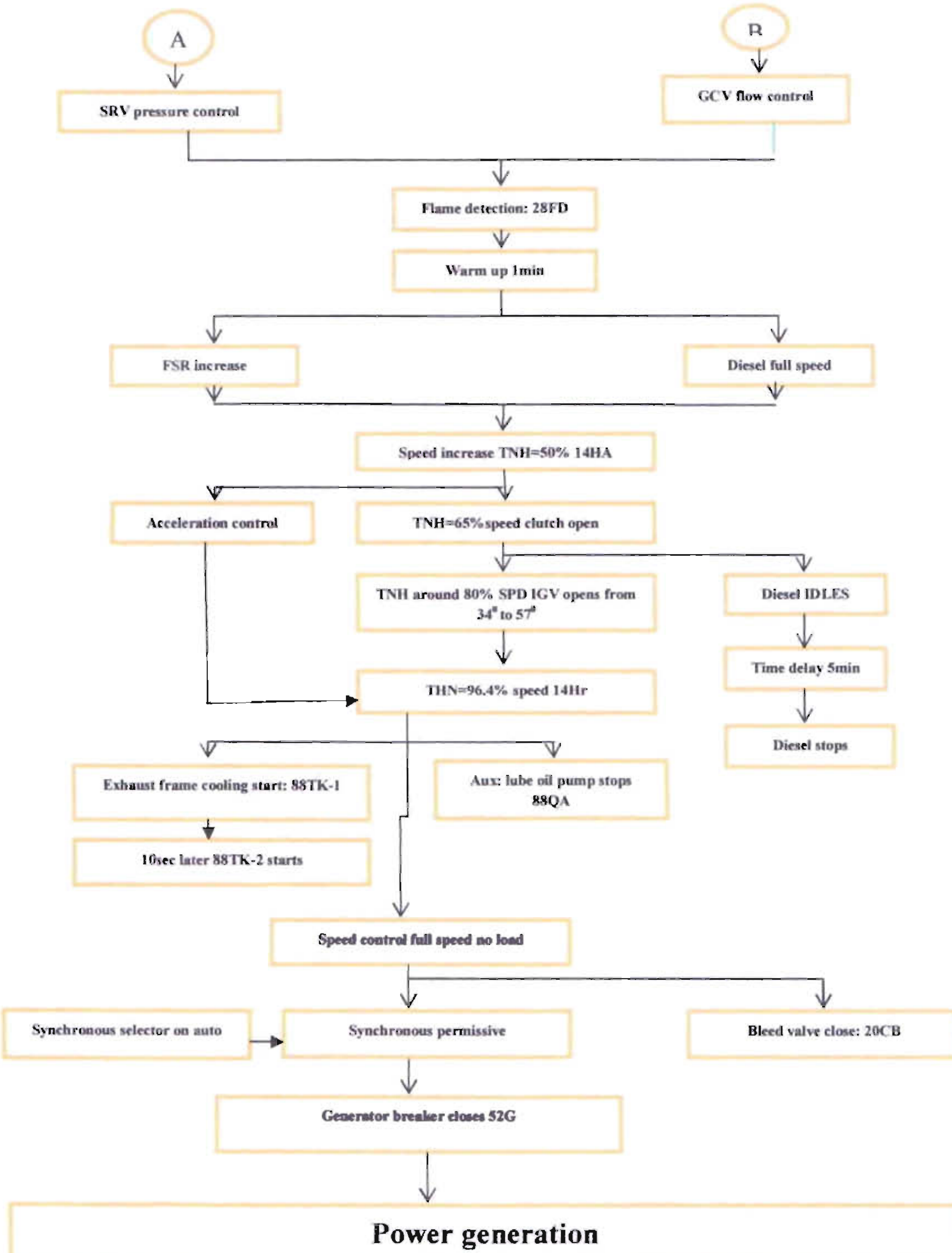


Figure 6.2(b): Block Diagram of Startup GT [2]

6.6 Shutdown (typical sequence with diesel starting mean and gas fuel):

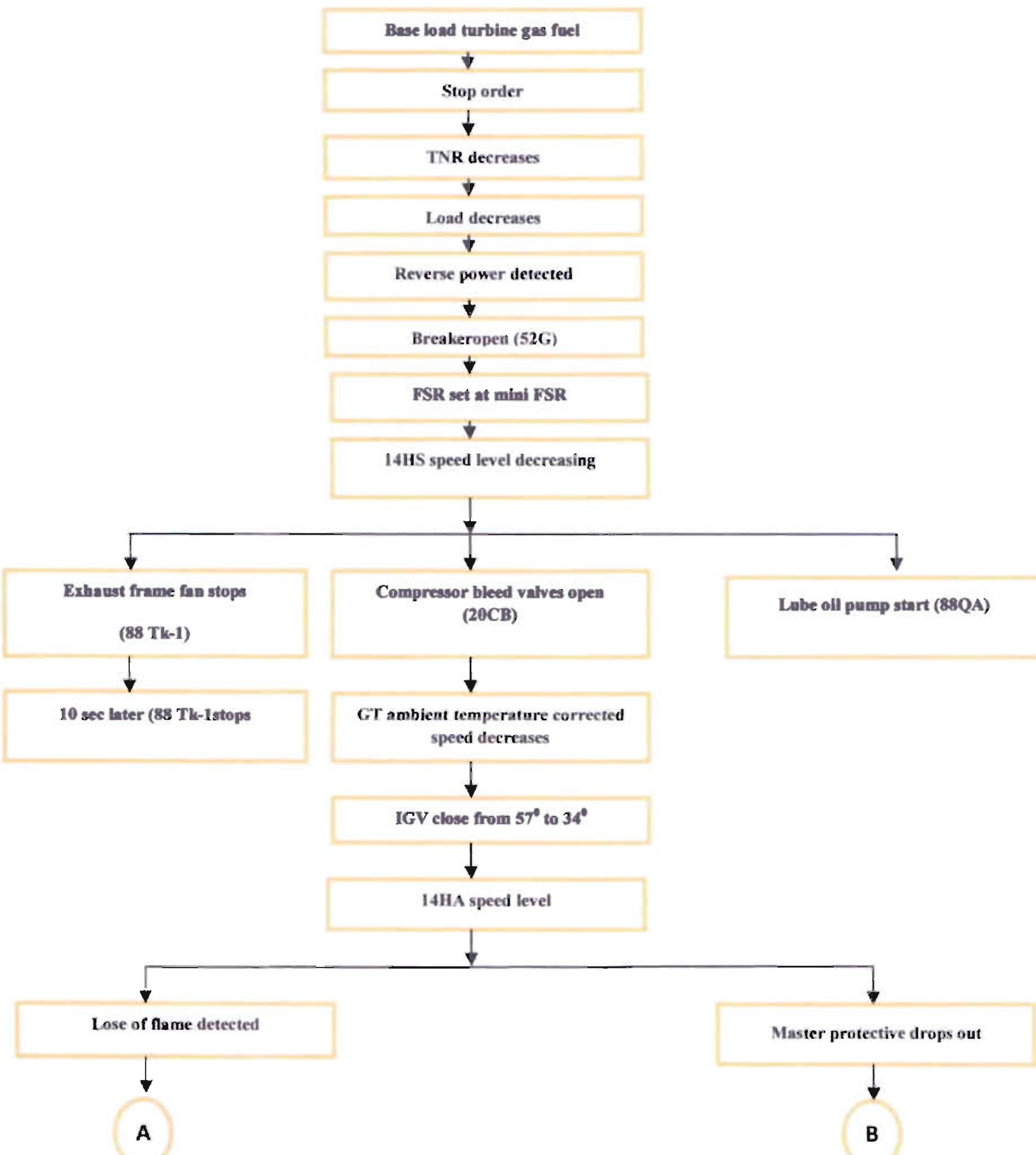


Figure 6.3(a): Block Diagram of Shutdown GT [2]

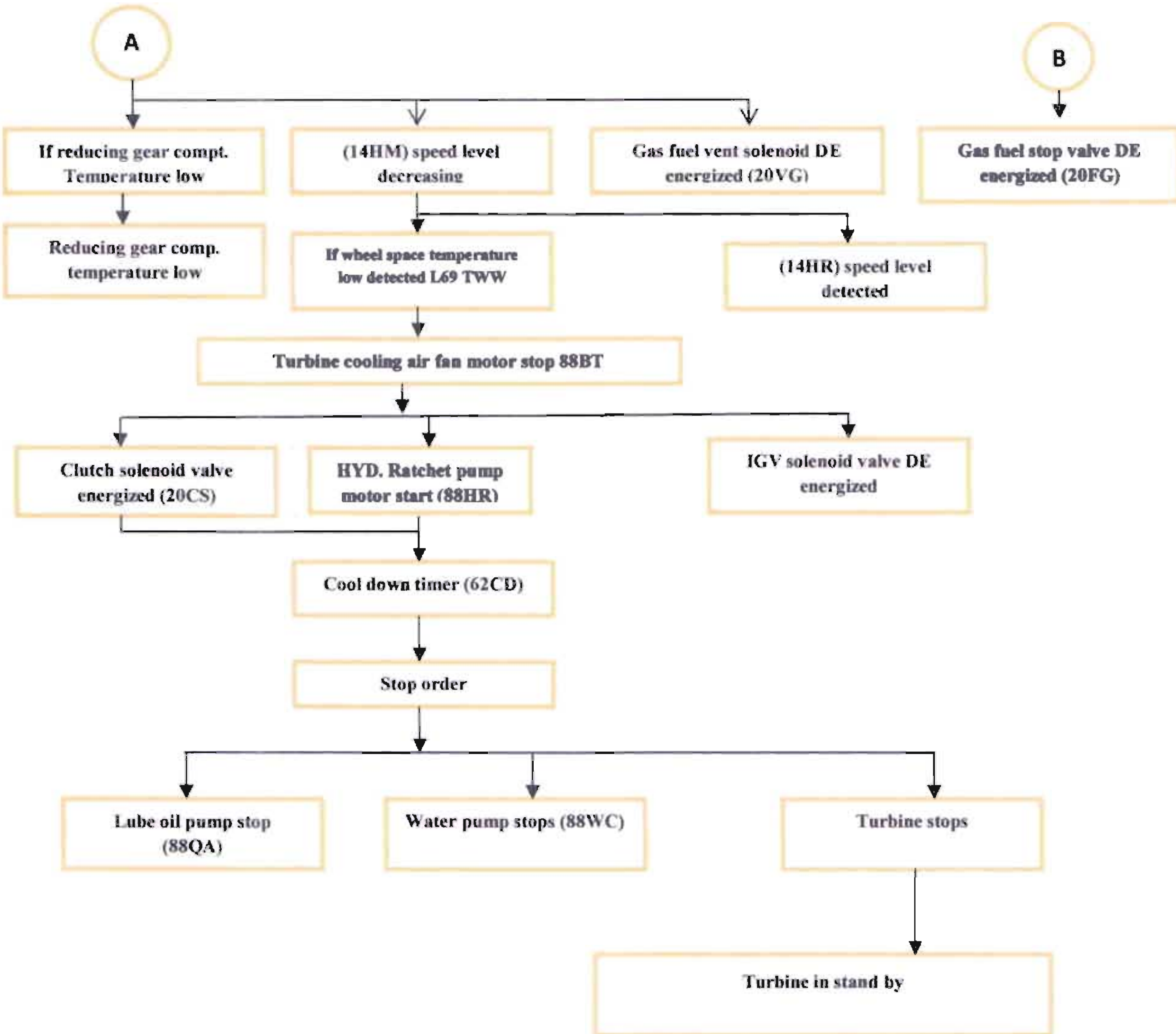


Figure 6.3(b): Block Diagram of Shutdown GT [2]

Chapter: 07

Conclusion

7.1 Future Plan of RPCL:

RPCL has some future plans to improve its power generation, distribution as well as revenue collection. Some constructional changes of equipments will be made in RPCL. RPCL is currently constructing three power plant projects. As a result it is expected that 230 MW power productions will be increased. It is expected that within 2013, these plants will be established. [2]

Recent constructional projects of RPCL are given below:

Sl. No	Plan	Capacity	Construction period
1.	Raozan 25 MW Dual Fuel Power Plant Project	25 MW	23-03-2011
2.	Project Detail - 150 MW Power Plant Project of BPDP - RPCL Power generation Ltd. at Kadda, Gazipur	150 MW	03-05-2011
3.	52 MW Dual Fual RPCL- Gazipur Power Plant Project	52 MW	24-08-2010

Table 7.1: Recent development plan of RPCL

7.2 Problems:

In our internship program we faced some problems. Those are given below:

a. Our instructor at RPCL showed us every equipment practically. But did not explain all the informations clearly. Because they do not have institutional teaching experience.
b. We faced some problems during internship program, because we had not completed some prerequisite courses which were related to the internship program.
c. During our internship GT-2 unit was stopped for lack of gas pressure.

7.3 Recommendations:

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

a. More theoretical knowledge about power generation, protection system, power equipments.

b. When a plant trips, it is difficult to restart. So all equipments of power station are checked every day. So we may go with instructors and understand everything practically.

c. Every candidate should complete the pre-requisite courses (that means at least "**Power Station**" & "**Switchgear**") before intern.

d. Internship time period 15 days (100 hours) is not enough to be able to understand the functions of a power plant efficiently.

e. EEE dept. in EWU should sign MOU (Memorandum of Understanding) with prospective companies like RPCL, ASPCL, Energy Pac, Summit Power etc. for ensuring internship program for the students.

7.4 Discussion:

We passed 15 days at RPCL during our internship program. Our achievements from RPCL are: practical knowledge about different equipments in power generation, knowledge about different power plants in Bangladesh and higher confidence to face interview in future. RPCL could be regarded as the practical ground to apply theoretical knowledge learnt in classes. We were lucky enough to continue our internship program in RPCL, which is a reputed power station and had been awarded as National Electricity Week (2010). It gave us an opportunity to apply our theoretical knowledge in practice. The authorities in RPCL were very concerned about all kinds of safety. The friendly environment in RPCL encouraged us to co-operate with each other. We learned a lot and obtained practical knowledge from our internship at RPCL, which will help us in our future.

Appendix

RPCL - Rural Power Company Limited

MPS - Mymensingh Power Station

REB - Rural Electrification Board

PBS - Palli Bidyut Samity

EPC - Engineering, Procurement and Construction

ST - Steam Turbine

GT - Gas Turbine

PT - Potential Transformer

CT - Current Transformer

CB - Circuit Breaker

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