Heaven's Light s Our Guide

RAJSHAHI UNIVERSITY OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

REPORT ON INDUSTRIAL ATTACHMENT AT

GHORASHAL POWER STATION

Course No : EEE 4100

Course Title : Industrial Training

Submitted by:

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Section: C

Series: 18

Submitted to:

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DECLARATION

This is to certify that **M Hasibul Galib (1801168)** completed the attachment work titled "REPORT ON INDUSTRIAL ATTACHMENT AT GHORASHAL POWER STATION" under my supervision in the Electrical & Electronic Engineering Department at Rajshahi University of Engineering & Technology (RUET), Rajshahi.

Attachment Supervisor

…….

Dr. Abdul Khaleque

Professor
Department of Electrical & Electronic Engineering
Rajshahi University of Engineering & Technology

Acknowledgement:


GTC-2882

শেখ হাসিনার উদ্যোগ ঘরে ঘরে বিদ্যুৎ

বিদ্যুৎ উন্নয়ন বোর্ড

Bangladesh Power Development Board

CERTIFICATE OF TRAINING

This certificate is awarded to

M Hasibul Galib

ID No: 1801168

Department of Electrical & Electronics Engineering (EEE)

RAJSHAHI UNIVERSITY OF ENGINEERING & TECHNOLOGY

For successfully completing

"Industrial Training" Conducted at

GHORASHAL TRAINING CENTER, BPDB, Palash, Narsingdi.

From 25th March 2023 to 31th March 2023.

(Engr. Mohammad Ali Firoz)
ID No.-01-1683
Deputy Director (XEN)
Ghorashal Training Center
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(Engr. B.M. Arifur Rahman)
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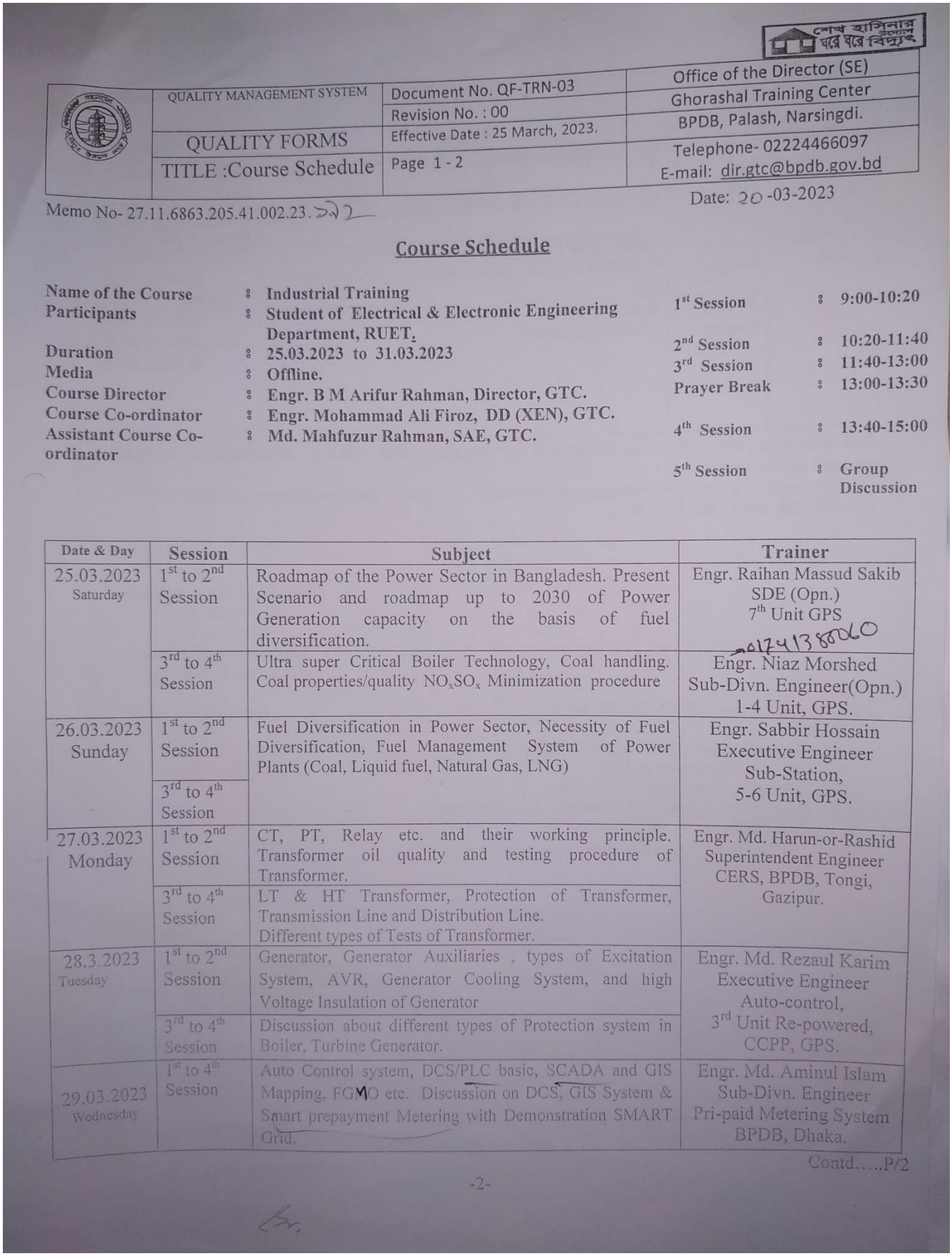
Training Schedule:



QUALITY MANAGEMENT SYSTEM	Document No. QF-TRN-03	Office of the Director (SE)
	Revision No. : 00	Ghorashal Training Center
QUALITY FORMS	Effective Date : 25 March, 2023.	BPDB, Palash, Narsingdi.
TITLE :Course Schedule	Page 1 - 2	Telephone- 02224466097 E-mail: dir.gtc@bpdb.gov.bd

Memo No- 27.11.6863.205.41.002.23.242

Date: 20-03-2023

Course Schedule

Name of the Course : **Industrial Training**
Participants : **Student of Electrical & Electronic Engineering Department, RUET.**
Duration : **25.03.2023 to 31.03.2023**
Media : **Offline.**
Course Director : **Engr. B M Arifur Rahman, Director, GTC.**
Course Co-ordinator : **Engr. Mohammad Ali Firoz, DD (XEN), GTC.**
Assistant Course Co-ordinator : **Md. Mahfuzur Rahman, SAE, GTC.**

1st Session : **9:00-10:20**
2nd Session : **10:20-11:40**
3rd Session : **11:40-13:00**
Prayer Break : **13:00-13:30**
4th Session : **13:40-15:00**
5th Session : **Group Discussion**

Date & Day	Session	Subject	Trainer
25.03.2023 Saturday	1st to 2nd Session	Roadmap of the Power Sector in Bangladesh. Present Scenario and roadmap up to 2030 of Power Generation capacity on the basis of fuel diversification.	Engr. Raihan Massud Sakib SDE (Opn.) 7th Unit GPS 01741388060
	3rd to 4th Session	Ultra super Critical Boiler Technology, Coal handling. Coal properties/quality NO_xSO_x Minimization procedure	Engr. Niaz Morshed Sub-Divn. Engineer(Opn.) 1-4 Unit, GPS.
26.03.2023 Sunday	1st to 2nd Session	Fuel Diversification in Power Sector, Necessity of Fuel Diversification, Fuel Management System of Power Plants (Coal, Liquid fuel, Natural Gas, LNG)	Engr. Sabbir Hossain Executive Engineer Sub-Station, 5-6 Unit, GPS.
	3rd to 4th Session		
27.03.2023 Monday	1st to 2nd Session	CT, PT, Relay etc. and their working principle. Transformer oil quality and testing procedure of Transformer.	Engr. Md. Harun-or-Rashid Superintendent Engineer CERS, BPDB, Tongi, Gazipur.
	3rd to 4th Session	LT & HT Transformer, Protection of Transformer, Transmission Line and Distribution Line. Different types of Tests of Transformer.	
28.3.2023 Tuesday	1st to 2nd Session	Generator, Generator Auxiliaries , types of Excitation System, AVR, Generator Cooling System, and high Voltage Insulation of Generator	Engr. Md. Rezaul Karim Executive Engineer Auto-control, 3rd Unit Re-powered, CCPP, GPS.
	3rd to 4th Session	Discussion about different types of Protection system in Boiler, Turbine Generator.	
29.03.2023 Wednesday	1st to 4th Session	Auto Control system, DCS/PLC basic, SCADA and GIS Mapping, FGMO etc. Discussion on DCS, GIS System & Smart prepayment Metering with Demonstration SMART Grid.	Engr. Md. Aminul Islam Sub-Divn. Engineer Pri-paid Metering System BPDB, Dhaka.

Contd.....P/2

Date & Day	Session	Subject	Trainer
30.03.2023 Thursday	1st to 2nd Session	Practical Visit at 365MW CCPP, 7th Unit, GPS	Asstt. Engineer, Control Room, GPS.
	3rd to 4th Session	Practical Visit at 4th unit, Re-Powering Project, GPS.	Asstt. Engineer, Control Room, GPS.
31.03.2023 Friday.	1st to 2nd Session	Operation of Power Plant Simulator (CCPP). Operation of Power Plant Simulator (Gas Turbine)	Engr, Nishit Kumar Samadder Manager (SE) Maint., 7th Unit, GPS.
	3rd to 4th Session	Examination and Evaluation. **Closing ceremony**.	Director, GTC. & Course co-ordinators. & XEN,GPS.

N.B. Resource persons have been requested to bring lesson note, soft copy of objective types questions for evaluation of trainees.

Contact number : Course Co-ordinator : 01709641977 Associate Course co-crdinator :01718455833

Course Helper :Bon Bihart,MLSS, GTC.

Sd/-
(Engr. B. M. Arifur Rahman)
ID # 01-01285
Director (SE)
Ghorasal Training Center
PDB, Palash, Narsingdi.

Memo No- 27.11.6863.205.41.002.23.192

Date: 20 -03-2023

Copy to:

1. General Manager, Training, PDB, Dhaka.
2. CE, Ghorashal Power Station.
3. DD, RAO, Ghorashal Power Station.
4. DD (XEN)/ DD (Admin.), Ghorashal Training Center.
5. Assistant Director (A/c), GTC.
6. Mr. ----------.
7. Office Copy.

20/3/2023

(Engr. Mohammad Ali Firoz)
ID # 01-01683
Deputy Director(XEN)
Ghorasal Training Center
PDB, Palash, Narsingdi.

Chapter 01: Introduction

1.1. Objectives of Industrial Attachment:

The goal of the industrial attachment is to get practical experience in the field of electrical engineering. Even yet, the major objective of the industrial attachment is to establish a connection between the information acquired from the book and the real world in order to identify any deviations. The knowledge and idea are strengthened as a result, and everything is made very apparent. The goals of an industrial attachment are to create a strong connection between theoretical knowledge and real-world experience, to gain real-world work experience, to relate learnings and apply them in relevant fields, and finally to acquire managerial abilities.

1.2. Power Plant Information:

One of the biggest power plants in Bangladesh is the Ghorashal Power Station (GPS). Power is generated by the Ghorashal power plant. It began operating in 1974, following Bangladesh's independence. The power plant can produce 1375 MW in its entirety.

Seven (7) units at the station produce the necessary electricity. First, during the Pakistani era, two-unit buildings were created. The government added five more units after Bangladesh gained its independence. Here, unit 1 and 2 are retired. Unit 3 and 4 are repowered to combine cycle power plants having installed capacity of 415MW and 410MW simultaneously. Unit 7 is combined cycle power plant with installed capacity of 380MW. The unit 5 is gas based thermal powerplant with derated capacity of 170MW.

In this power station, natural Mithen gas (CH4) is used as fuel of gas turbine and water of Shitalakhya is treated then used in the steam turbine for generating steam. The gas is provided by the Titas Gas Transmission Company.

- Plant Type: Thermal electricity generation
- Location: Ghorashal, Palash, Narsingdi, Bangladesh
- Capacity: 1375 MW.
- Agency: Bangladesh Power Development Board
- Organization Type: Government-owned

1.3. Power Plant Location:

It is situated on the Eastern bank of river Shitalakhya at North East of Dhaka under Palash Thana in Narsingdi district.

Google Map Co-ordinate: **XJHP+XVX**

Chapter 02: Water Treatment Plant

2.1. Introduction of Water Treatment Plant:

The water for the cooling system of the steam turbine and other auxiliary equipment is collected from the nearby river Shitalakkha. However, there are numerous pollutants, silts, and clay in the river's water. Even more particles get mixed into the river water, which shortens the lifespan of the machinery and can harm the equipment.

A plant must be utilized to treat the water used in the cooling and steam producing processes. A water treatment facility is present at Ghorashal Power Station.

2.2. Procedure of Water Treatment:

The water from the river first collected in the clarifier tank through the row water pump. Then the chemical coagulation is done in the clarifier tank. The coagulant is added in the water so that the coagulant can form a kind of polymer. As a result, the clay and other colloids can be separated from the water.

After the coagulation process the water is passed through the mechanical filters through coagulate pump. The water is divided into two parts. one portion of water goes to clarifier tank and the rest of them goes to cation 1^{st} stage exchanger. There the cation exchange resin H+, catches all the cation remaining in the water. Then the water goes to anion 1^{st} stage exchanger. The anion exchange resin OH-, catches all the anion remaining in the water.

The ion-neutral water then goes through degasifier or decarbonizer where the gaseous substances are removed. Then the water goes to partial demi water tank. The partial demi water pump is started then from the demi water tank, the water goes to cation 2^{nd} stage exchanger and then goes to anion 2^{nd} stage exchanger. After that the water comes to mixed bed in which cation and anion resins are contained. Finally, the water is fully demineralized and pumped into demi water reserve tank for further used.

2.3. Steps of producing Demineralized water:

1. Row water pump start
2. Intake water in clarifier
3. Chemical coagulation occurs and coagulated water tank fills
4. Coagulate pump Start
5. Coagulated water comes to mechanical filter
6. Mechanical filter outlet divided into two portions
7. One portion goes to clarified water tank
8. The rest portion goes to cation 1st stage exchanger
9. Then goes to anion 1st stage exchanger
10. Then flowing through decarbonizer and goes to partial demi tank
11. Then partial demi pump Start
12. Water comes to cation 2nd stage exchanger
13. Then anion 2nd stage exchanger
14. Then water comes to mixed bed exchanger
15. Then water comes to Demi water reserve tank

2.4. Water Treatment Plant Images:

Water Pump

Clarifier Tank Inside View

Clarifier Tank

Mechanical Filter

Degasifier

Anion Exchanger

Cation Exchanger

Mixed Bed Exchanger

Demi Water Tank

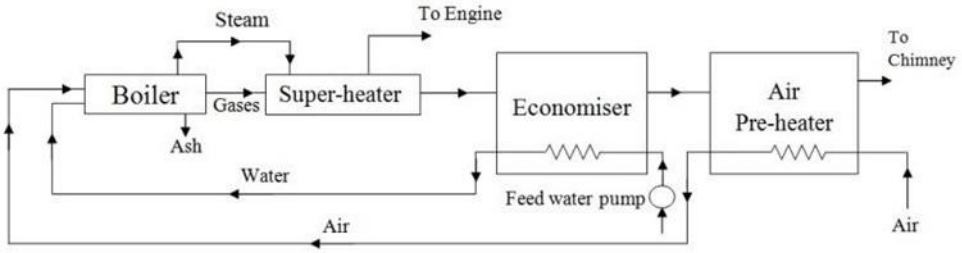
Chapter 03: Boiler

3.1. Introduction to Boiler:

A boiler is a closed vessel used to heat fluid, usually water. Boiling is not always the case with fluids. To be used in various processes or heating applications, the heated or vaporized fluid leaves the boiler.

Water that has been demineralized enters the boiler. Burning fuel in the furnace produces heat that is transferred to the boiler. As the fluid in the boiler warms up, it transforms into extremely hot steam. The mechanical energy is then transformed into electrical energy as the steam is pumped through the steam turbine at a high temperature.

Boilers are essentially just heated containers for fluid. Heat Recovery Steam Generators (HRSG) are utilized in combined cycle power plants in place of boilers. The HRSG uses the unused heat of the gas turbine output and heat up the fluid.



3.2. Equipment and Accessories of Boiler:

The several boiler mountings and accessories used in steam boilers include the water level indicator, pressure gauge, safety valves, stop valve, blow off valve, feed check valve, fusible plug, air pre-heater, super heater, economizer, and feed pump. Steam boilers require the mounting of the boiler and its components in order to function properly, effectively, and satisfactorily.

Boiler Mountings:

- Water level indicator (Water level gauge)
- Pressure gauge
- Safety valves
- Stop valve
- Blow off Valve
- Feed check valve

Boiler Accessories:

- Air pre-heater
- Superheater
- Economizer
- Feed pump

3.3. Boiler Images:

Chapter 04: Steam Turbine

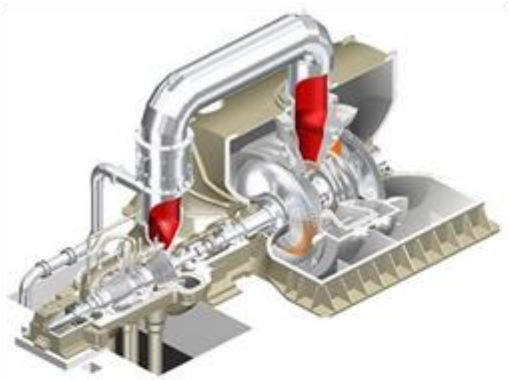
4.1. Working principle of Steam Turbine (ST):

Steam turbines are machines that transform mechanical steam pressure energy into electrical energy. With a generator or alternator, the turbine shaft is connected.

In other terms, a steam turbine generates steam by heating water to a very high temperature applying a heat source. Steam expands and cools as it passes through turbine blades that are in motion. Thus, the steam's potential energy is converted to kinetic energy in the turbine's rotating blade. Because they produce rotary motion, steam turbines are particularly well adapted for powering electrical alternators that produce electricity.

The three types of steam turbines are high-pressure, intermediate-pressure, and low-pressure. In the turbine, there are many blades. All the blades are mounted on the shaft of the turbine. The super-heated steam comes from the boiler and impressed on the turbine blades and thus the turbine rotates.

4.2. Schematic diagram and images:



Chapter 05: Unit 01 and Unit 02

5.1. About Unit 01 and Unit 02:

In 1974, the first unit of the Ghorashal Power Station was put into operation. An ordinary steam turbine was unit 01's design. The unit had a 55MW maximum capacity. Units 01 and 02 have boilers, which were produced in the USSR. Russian technical team even designed the entire control panel, control system, and room.

All of the boiler and furnace are suspended. Due to the boiler's tendency to expand when heated, the furnace is suspended. The expansion may be done easily because of suspension.

The boiler in units 01 and 02 of GPS is a water tube boiler.

The demi water tank provides the water, which is subsequently pushed up to the boiler. The water goes from down to up because during that time the water gets more time to be heated in the furnace.

5.2. Control Room:

The unit 01 and unit 02 both are Russian designed units. The control room was so much sophisticated and even there were Russian language written in the control buttons and display.

Chapter 06: Gas Turbine

6.1. Working principle of Gas Turbine (GT):

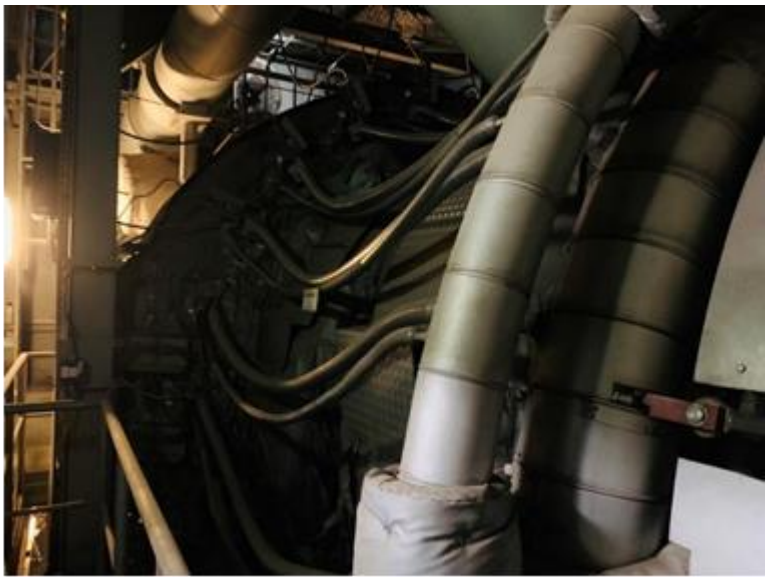
The chemical energy of the fuel is turned into mechanical energy or kinetic energy in a gas turbine, which is a rotating machine that produces shaft power. It is, in other words, a device that delivers mechanical force or power. It accomplishes this using a gaseous working fluid. Devices used in industry can make advantage of the mechanical power generated. In a gas turbine, the working fluid flows continuously. Gas turbines used for power generating are what generate shaft power.

A gas turbine's operation is based on the thermodynamic Brayton Cycle. Two adiabatic work transfers and two heat processes with constant pressure make up the Brayton cycle.

A generator known as an electrical machine is found in a gas turbine power plant, and this generator requires a prime mover, which is a gas turbine, in order to produce electricity.

It converts the chemical energy of the fuel, to put it another way, changes the mechanical energy of natural gas into mechanical energy. After that, a gearbox transmits the mechanical energy to the generator's shaft.

6.1. Schematic Diagram and Images:



Chapter 07: Heat Recovery Steam Generator (HRSG)

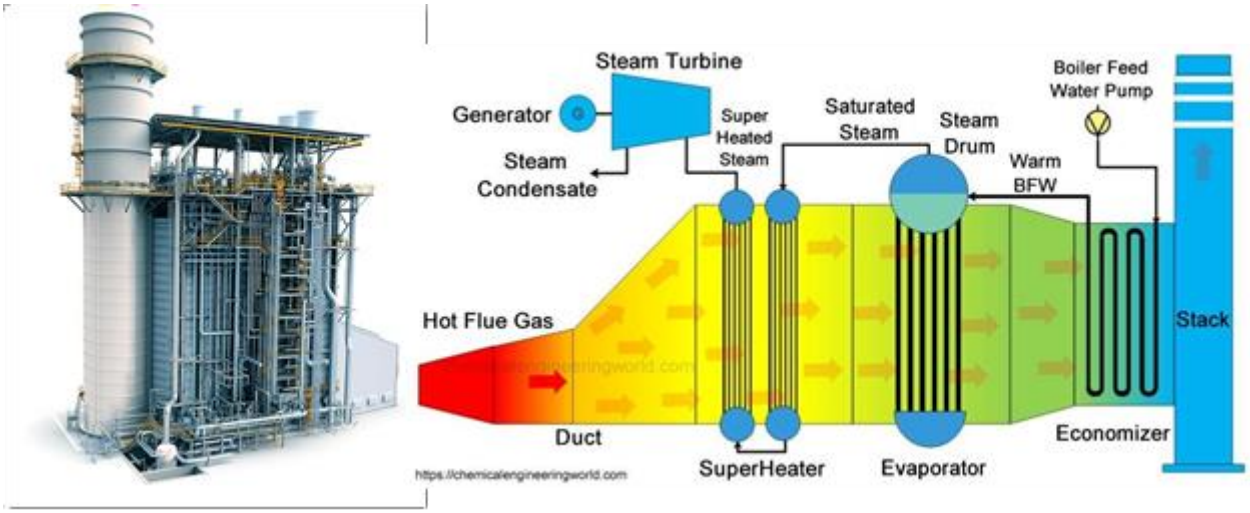
7.1. Introduction to HRSG:

A heat recovery steam generator, often known as an HRSG, is a heat exchanger that recovers energy from a hot gas stream typically the exhaust from a gas turbine. It generates HP superheated steam that can be utilized to power a steam turbine in a combined cycle power plant, along with low pressure steam for heating up other auxiliary components.

HRSG consists of the following components:

- Diverter Damper
- Super Heater
- HP Drum
- LP Drum
- HP Economizer
- HP Evaporator
- LP Evaporator
- Exhaust Stack

7.2. Images of HRSG:



Chapter 08: Unit 03 and Unit 04

8.1. Introduction of Unit 03 and Unit 04:

The Unit 03 and Unit 04 are basically Steam turbine-based power plant. The Unit 03 was commissioned back in 1986 and unit 04 was 1989. Recently the unit 03 and 04 are converted into combined cycle power plant. As a result, the new gas turbine is installed. This project was named as “Repowering”. A Chinese company had got the project for repowering.

The capacity of unit 03 and 04 are 415MW and 410MW respectively. The generator output voltage is 15.75 KV for both the unit.

8.2. Images of Unit 03 and Unit 04:

Nitrogen Cooling System:

Gas Supply from TITAS Gas:

Cooling System:

HRSG with By-pass Stack:

Generator:

Chapter 09: Unit 05

9.1. Introduction of Unit 05:

The Unit 05 of Ghorashal Power Station is a steam turbine based powerplant which takes natural gas as fuel to generate steam through the boiler. It was first commissioned in 1999 with installed capacity of 210MW.

9.2. Images of Unit 05:

Boiler of Unit 05:

Hydrogen storage:

Hydrogen gas is used for cooling purpose as gaseous can reach any points of electrical machines.

Chapter 10: Unit 06

10.1. Introduction of Unit 06:

Unit 06 was first commissioned in 1999. The unit 06 was a steam-based power unit. The unit had a capacity of 210MW.

10.2. Incident of Unit 06:

In 2010, suddenly the power cut out from the Indian side took place. As a result, due to huge demand of power in Bangladesh, the generator overloaded. Some of the generator in the power plants collapsed and switched out of the grid. This also caused huge impact on the Ghorashal power plant.

Due to huge load on the generator, the engineers on the plant ordered to shut down the generator. They tried to isolate the generator from the grid. But due to having no DC power which is the heart of substation and used to operate the protective devices and generating the DC power for creating field for generator, the circuit breakers couldn't be opened. So that the generator can't be isolated from the national grid. Engineers tried their level best but couldn't do anything. By that time the generator started to run as motor and consumed power from the grid. The load on the generator became the turbine. The turbine is so much bulky. So, generator had to bear the load of the turbine which caused too much heat generation. Then the rotor got damaged and the blades got separated from the rotor and huge disaster occurred. After that the blackout occurred in the whole Bangladesh. It took hours for the engineers to stable the grid and bring back to normal operation again.

10.3. Images of Unit 06 machines:

Control Room:

Generator Hall Room:

Generator Stator:

Generator Rotor:

Turbine:

Chapter 11: Unit 07

11.1. Introduction of Unit 07:

In GPS the Unit 07 is a 365 MW Combined Cycle Power Plant (CCPP). A combined-cycle power plant uses both gas turbines and a steam turbine together to produce up to 50 percent more electricity from the same fuel than a traditional simple- cycle plant. The waste heat from the gas turbine exhaust routed directly to the heat recovery steam generator to produce steam and routed to the nearby steam turbine which generates extra power. Combined Cycle Gas Turbine (CCGT) plant can achieve thermal efficiency of around 54% in base-load operation, in contrast to a single cycle steam power plant which is limited to efficiencies of around 35–42%. Combining two or more thermodynamic cycles result in improved overall efficiency, reducing fuel costs.

11.2. Complete Combine Cycle Process:

11.2.1. Gas filtration Process:

The hydrogen, nitrogen and the gas from TITAS is filtrated through several stages. Through a cyclone converter the dust particle is filtered.

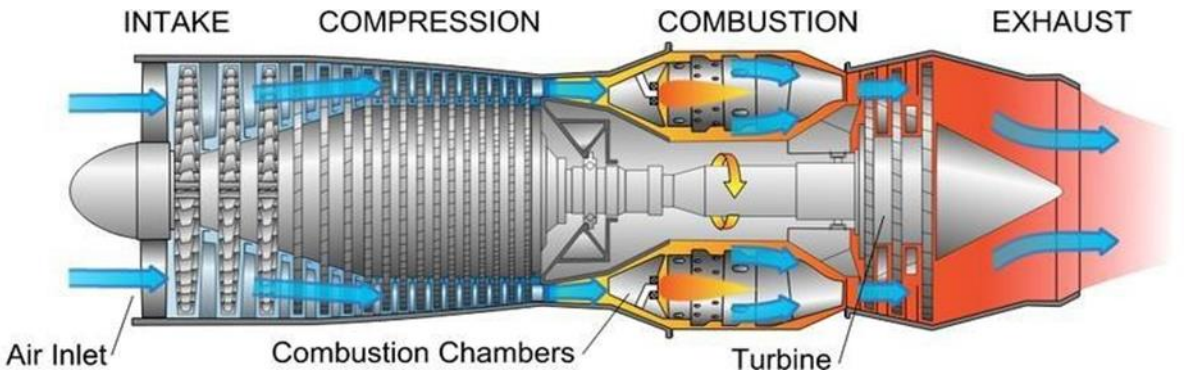
11.2.2. Air Intake:

The air is drawn through the large air inlet section where it is cleaned cooled and controlled. Heavy duty gas turbines are able to operate successfully in a wide variety of climates and environments due to inlet air filtration systems that are specially designed to suit the plant location.

Air intake consists of several air filters. Each air filter block is called an array.

11.2.3. Gas Turbine:

A gas turbine, also called a combustion turbine, is a type of internal combustion engine.



It has an upstream rotating compressor coupled to a downstream turbine, and a combustion chamber in between. The gas turbine is the heart of the power plant. A gas turbine is a combustion engine that can convert natural gas or other liquid fuels to mechanical energy which then drives a generator that produces electrical energy or power output.

11.2.4. Bypass Stack:

If Gas turbine's exhaust gas is not supplied into the HRSG then the exhaust gas is by passed and released into the air using the bypass stack. The bypass stack and the HRSG are separated using a damper shield.

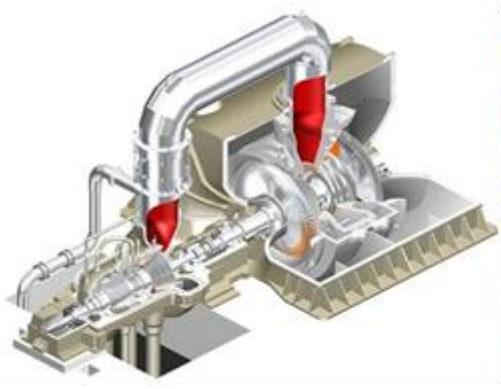
The damper is motorized controlled and can be opened and closed. When the exhaust gas is passed into the HRSG then the damper closes the bypass stack and passes the gas into the HRSG.

11.2.5. HRSG:

The exhaust gas is passed into the HRSG. The water is fed through the feed water pump to the HRSG. The exhaust gas converts the water into super-heated steam. The steam is passes into the steam turbine.

11.2.6. Steam Turbine:

Steam turbines are machines that transform mechanical steam pressure energy into electrical energy. With a generator or alternator, the turbine shaft is connected. In other terms, a steam turbine generates steam by heating water to a very high temperature utilizing a heat source. Steam expands and cools as it passes through turbine blades that are in motion. Thus, the steam's potential energy is converted to kinetic energy in the turbine's rotating blade. Because they produce rotary motion, steam turbines are particularly well adapted for powering electrical alternators that produce electricity.



11.2.7. Synchronous Generator:

The rotor of the synchronous generator and the turbine are mechanically connected. The rotor and turbine both rotate. The three-phase voltage is produced when the stator winding is severed by the electric flux. The rotor, stator, and exciter are components of the generator.

11.2.8. Transformer and Grid:

The generated voltage is stepped up using a power transformer and connected to the grid with the protective equipment such as CT, PT, lighting arrester, Relay, Circuit breaker and isolators.

11.2.9. Cooling Tower:

The steam after hitting the turbine converts into heated water. Then to reuse the water it is dropped from a certain height and cooled in natural process in cooling tower.

11.2.10. CCCW and OCCW pumps:

CCCW stands for ‘Close Circulating Cooling Water’ which is demineralized water. This CCCW is used to cool the electrical and mechanical equipment. To cool down the CCCW, normal water is used which is called as OCCW. The term OCCW stands for ‘Open Circulating Cooling Water’. This water is directly taken from the river or water reservoir.

Chapter 12: Switching Yard

12.1. Transformer:

A static device called a power transformer is used to transfer electricity from one circuit to another without impacting the frequency. Transformers are considered static devices because they don't have any rotating or moving elements. Transformers require an AC source to function. The mutual induction concept drives the operation of transformers.

Low voltage electrical power generation is extremely cost-effective. This low voltage level power can theoretically be sent to the receiving end. If this low voltage electricity is transferred, it will result in higher line current, which will in fact result in higher line losses.

But if the voltage level of a power is increased, the current of the power is reduced which causes reduction in ohmic or I^2R losses in the system, reduction in cross-sectional area of the conductor i.e. reduction in capital cost of the system and it also improves the voltage regulation of the system. Because of these, low level power must be stepped up for efficient electrical power transmission. This is done by step up transformer at the sending side of the power system network. Electrical power transformer thus plays a vital role in power transmission.

12.2. Potential Transformer, Current Transformer:

A potential transformer (P.T.) is an instrument transformer which is used for the protection and measurement purposes in the power systems. A potential transformer is mainly used to measure high alternating voltage in a power system. Potential transformers are step- down transformers.

A current transformer (C.T.) is an instrument transformer which is used for the protection and measurement purposes in a power system. The C.T. is primarily used to measure high alternating currents in a power system.

12.3. Lighting Arrester:

Lightning arrester is used at GPS substation to protect the equipment of substation from the lighting surge. A lightning arrester is a device to protect other equipment of the system from the sky lightning or a surge voltage. Lightning occurs when clouds are highly charged with respect to ground. It has a high voltage terminal and a ground terminal. There are various types of lightning arrester. In GPS, polymer metal oxide and zinc oxide arresters are mainly used.

12.4. Circuit Breaker:

A circuit breaker is an electrical device which works as a switch and operates automatically when any abnormality founds in voltage and current flow.

It is a protective device. It protects the whole electrical system from abnormal condition like overload, short circuit etc. If any abnormality occurs, the circuit breaker automatically disconnects the circuit from the system. There are three types of circuit breakers in GPS.

Depending on the arc quenching medium, circuit breaker is classified into the following types:

- Oil Circuit Breaker (OCB)
- Air Circuit Breaker (ABCB)
- *SF6* Circuit Breaker (SCB)
- Vacuum Circuit Breaker (VCB)
- Gas Circuit Breaker (GCB)

Oil Circuit Breaker:

In oil circuit breaker, oil is used as an arc quenching medium. Mineral oil has a good insulating property. The fixed contacts and the moving contacts are immerged in the oil. When circuit breaker disconnects, arc creates and this arc is quenched by oil vaporization. GPS has some oil circuit breakers.

Air Blast Circuit Breaker:

In air blast circuit breaker, high pressure air is used as an arc quenching medium. When arc creates for sudden break of circuit, high pressure air flows to the arc between fixed contacts and the moving contacts to cool down the arc. This operation is very safe and has a very low maintenance problem. GPS has a lot of air blast circuit breakers.

SF_6 Circuit Breaker:

Sulphur hexafluoride (SF_6) gas is used as the arc quenching medium in SF_6 circuit breakers. SF_6 circuit breakers have very good arc quenching property. At GPS, the weight of the SF_6 gas is 26 kg and the total weight of the device is 3530 Kg. The temperature range of the SF6 circuit breaker is – 25°C to +55°C. The SF_6 circuit breakers in GPS are made by Siemens, Germany.

Vacuum Circuit Breaker:

A vacuum circuit breaker is such kind of circuit breaker where the arc quenching takes place in vacuum. The technology is suitable for mainly medium voltage application. The salient feature of vacuum as an arc quenching medium is that as soon as the arc is produced in vacuum, it is quickly extinguished due to the fast rate of recovery of dielectric strength in vacuum.

Gas Circuit Breaker:

Gas circuit breakers protect electrical power stations and distribution systems by interrupting electric currents, when tripped by a protective relay. Instead of oil, air, or a vacuum, gas circuit breaker uses gas to cool and quench the arc on opening a circuit. Advantages over other media include lower operating noise and no emission of hot gases, and relatively low maintenance. Developed in the 1950s and onward, gas circuit breakers are widely used in electrical grids at transmission voltages up to 800 kV, as generator circuit breakers, and in distribution systems at voltages up to 35 kV.

Gas circuit breakers may be used as self- contained apparatus in outdoor air- insulated substations or may be incorporated into gas insulated switchgear (GIS) which allows compact installations at high voltages.

12.5. Isolator:

An isolator is a device used for isolating a circuit or equipment from a source of power. An isolator is a mechanical switching device that, in the open position, allows for isolation of the input and output of a device.

12.6. BUS bar:

Busbars are solid metal bars used to carry current. Typically made from copper or aluminum, busbars are rigid and flat wider than cables but up to 70 percent shorter in height. In the substation of GPS, there are 132 KV and 230 KV bus bars. An electrical conductor that's makes a common connection between several circuits "the bus-bar in this transmit power either way between any components of the system".

Chapter 13: Grid

13.1. Introduction to Grid:

An electric grid is a system of integrated electricity producers and users connected by transmission and distribution lines, and it is managed by one or more control centers. Most people refer to the system for delivering electricity when they discuss the "power grid," or "grid," in general.

Two primary functions constitute the switching system as a whole. One is 132 KV, while the other is 230 KV. The 230 KV BUS and the 132 KV BUS are separate buses.

13.2. Transmission Line:

Transmission lines in an electric power system transmit electric energy from one location to another. Alternating or direct current, or a system that combines the two, can be carried by them. Additionally, overhead and subsurface cables can also carry electric current.

13.3. Transmission Pole:

An overhead power transmission pole is a special structure designed to hold the wires of overhead power lines, as well as lightning protection cables, at a given distance from each other and from the earth's surface.

Chapter 14: Fire Safety and Security

14.1. Need of Fire safety and protection:

The large amount of Power demand is met from the GPS. As a result, the fire safety and protection of the station should be ensured. Fire can be easily generated in the electrical power system equipment due to excessive heat. So, to prevent any dangerous situation and national catastrophe fire safety and protection must be taken and maintained strictly.

14.2. Plant Fire safety and security:

The whole plant is well equipped fire safety and protection. The GPS is a KPI (Key Point Installation). There is an Army base camp inside the GPS for security purpose and for quick response in any case.

Chapter 15: Central Equipment Repair Center (CERS)

15.1. Introduction to CERS:

In Bangladesh, CERS situated in Gazipur is the place where the damaged transformers are brought and repaired which can save us from wasting money for the new one. There were several units for repairing a transformer. This CERS not only repairs transformers, but also improve them and tests the meters for measuring power and test the PT & CTs. The units were more specifically lab.

15.2. Iron core and winding repairing unit:

There may have some problems in the core or the winding of the transformer. If there is problem in core or winding, they are sent there. The open circuit, short circuit and meggar testing is done first to detect the damaged point. If there is damage in winding or wire, the core laminations are opened and the windings are taken out for repairing. After repairing, the windings are again placed as before and then it will need the transformer oil next. But the transformer oil needed to centrifuged. So, they will be recombined later.

3-phase transformers with bare lamination and opened high voltage coil:

3-phase bare transformers:

3-phase bare transformers without upper lamination:

Winding of low voltage side:

Winding machine:

Insulation between two winding:

Insulation between two winding:

15.3. High voltage testing laboratory:

Here, the transformers are tested. 5/10kV is applied to test the output at high tension side and low-tension side. Then the insulation is tested by a megger which measures the resistance from high to low voltage side and DAR is determined by taking the ratio of insulation resistance at 60 sec to 15 sec. if the DAR is in between 1 to 3, then this is called standard.

Applied voltage at LT side and measured at HT side:

Applied voltage at LT side and measured at HT side:

Applied voltage at LT side and measured at HT side:

15.4. Centrifuging lab:

If there is moisture in the transformer oil, it will reduce the breakdown voltage of the oil. As a result, accident can happen. So, to remove the added moisture, the oil is centrifuged. This process is done at centrifuging laboratory.

Centrifuging machine:

Centrifuging machine:

15.5. Transformer heater:

After combining every part, it is needed to heat the transformer to limit the moisture inside. So, the transformer is set there. This heater can heat one power transformer or two three phase distribution transformers at a time.

15.6. CT, PT testing lab:

Here, the current transformers and potential transformers. The testing is done by a digital machine which measures its characteristics and gives the outputs automatically. The machine is mainly megger and the other functions are programmed by a built-in computer application.

Current and Potential transformers:

CT, PT testing machine:

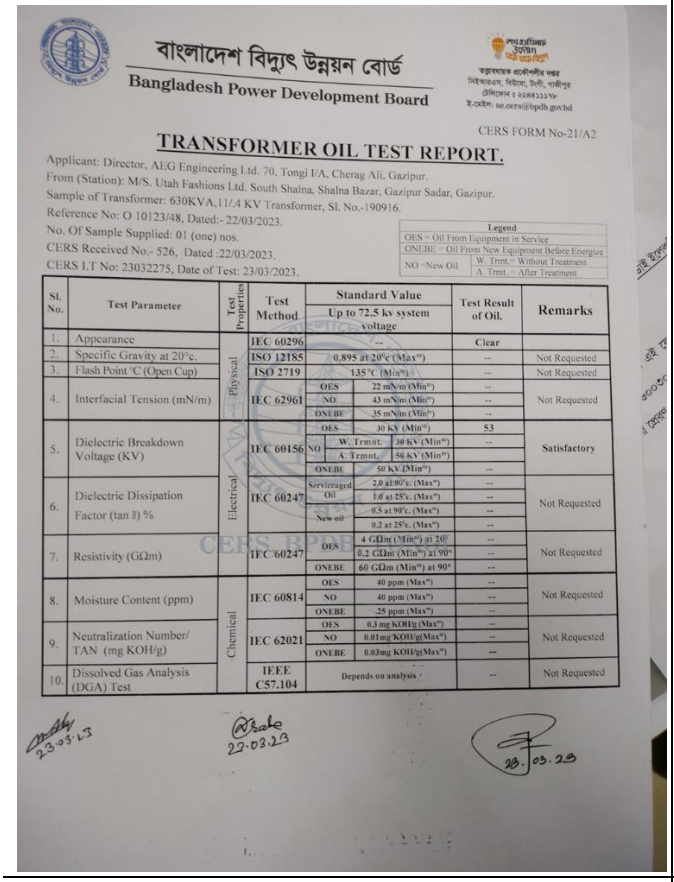
CT, PT testing machine:

Megger automated CT, PT testing machine:

15.7. Oil Test lab:

The nature of oil is another important parameter of the transformer. So, before using the oil, the oil must be tested. There are 10 types of tests for oil. The test reports says if the oil is okay to use or not.

Transformer oil test report:



বাংলাদেশ বিদ্যুৎ উন্নয়ন বোর্ড
Bangladesh Power Development Board

CERS FORM No-21/A2

TRANSFORMER OIL TEST REPORT.

Applicant: Director, AEG Engineering Ltd. 70, Tongi I/A, Cherag Ali, Gazipur.
From (Station): M/S. Utah Fashions Ltd. South Shalna, Shalna Bazar, Gazipur Sadar, Gazipur.
Sample of Transformer: 630KVA,11/.4 KV Transformer, Sl. No.-190916.
Reference No: O 10123/48, Dated:- 22/03/2023.
No. Of Sample Supplied: 01 (one) nos.
CERS Received No.- 526, Dated :22/03/2023.
CERS LT No: 23032275, Date of Test: 23/03/2023.

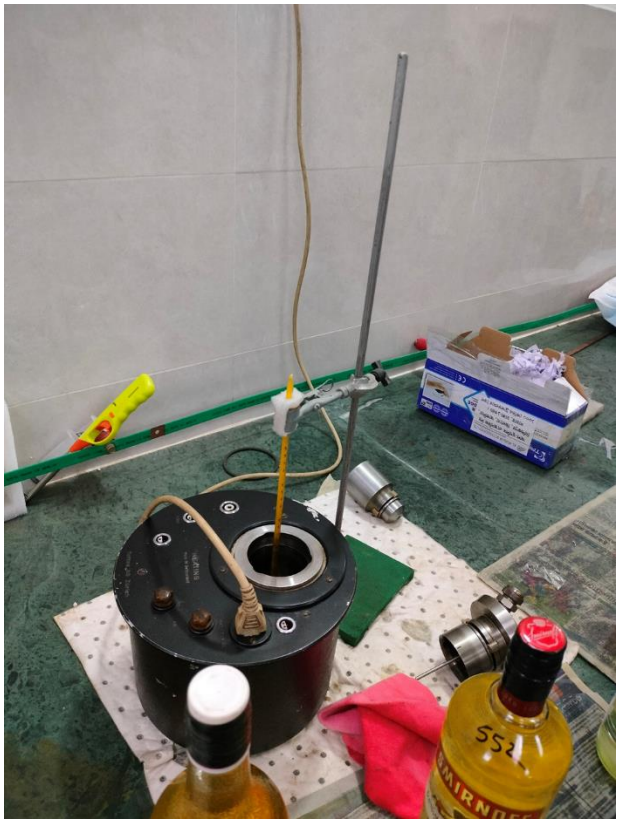
Legend
OES = Oil From Equipment in Service
ONEBE = Oil From New Equipment Before Energize
NO = New Oil
W. Trmt. = Without Treatment
A. Trmt. = After Treatment

Sl. No.	Test Parameter	Test Properties	Test Method	Standard Value Up to 72.5 kv system voltage		Test Result of Oil.	Remarks
1.	Appearance	Physical	IEC 60296	--		Clear	
2.	Specific Gravity at 20°c.		ISO 12185	0.895 at 20°c (Max^m)		--	Not Requested
3.	Flash Point °C (Open Cup)		ISO 2719	135°C (Min^m)		--	Not Requested
4.	Interfacial Tension (mN/m)		IEC 62961	OES	22 mN/m (Min^m)	--	Not Requested
				NO	43 mN/m (Min^m)	--	
				ONEBE	35 mN/m (Min^m)	--	
5.	Dielectric Breakdown Voltage (KV)	Electrical	IEC 60156	OES	30 KV (Min^m)	53	Satisfactory
				NO	W. Trmnt. 30 KV (Min^m)	--	
					A. Trmnt. 50 KV (Min^m)	--	
				ONEBE	50 KV (Min^m)	--	
6.	Dielectric Dissipation Factor (tan δ) %		IEC 60247	Serviceaged Oil	2.0 at 90°c. (Max^m)	--	Not Requested
					1.0 at 25°c. (Max^m)	--	
				New oil	0.5 at 90°c. (Max^m)	--	
					0.2 at 25°c. (Max^m)	--	
7.	Resistivity (GΩm)		IEC 60247	OES	4 GΩm (Min^m) at 20°	--	Not Requested
					0.2 GΩm (Min^m) at 90°	--	
				ONEBE	60 GΩm (Min^m) at 90°	--	
8.	Moisture Content (ppm)	Chemical	IEC 60814	OES	40 ppm (Max^m)	--	Not Requested
				NO	40 ppm (Max^m)	--	
				ONEBE	25 ppm (Max^m)	--	
9.	Neutralization Number/ TAN (mg KOH/g)		IEC 62021	OES	0.3 mg KOH/g (Max^m)	--	Not Requested
				NO	0.01mg KOH/g(Max^m)	--	
				ONEBE	0.03mg KOH/g(Max^m)	--	
10.	Dissolved Gas Analysis (DGA) Test		IEEE C57.104	Depends on analysis		--	Not Requested

23.03.23 22.03.23 23.03.23

Samples of transformer oil:

Flash Point tester:



Specific Gravity tester:

15.8. Meter testing lab:

The meters used to measure the power passing through the meter. This meter has to be tested to avoid unwanted problems. This testing is done in this laboratory.

Meter Testing report: