NATIONAL INSTITUTE OF TECHNOLOGY

AGARTALA, TRIPURA

AN INPLANT WINTER TRAINING REPORT ON

135MW AgGBPS, NEEPCO Ltd.

(A Govt. of India Enterprises)

SUBMITTED IN THE PARTIAL FULFILLMENT OF THE DEGREE

IN BACHELOR OF TECHNOLOGY IN PRODUCTION

ENGINEERING

SUBMITTED BY:- GAURAV KUMAR

ENROLLMENT NUMBER:- 21UPE093

BRANCH:-PRODUCTION ENGINEERING

135MW, AGARTALA GAS BASED POWER STATION (AgGBPS)

NEEPCO, INDIA

(*A Govt. Of India Enterprises*)

CERTIFICATE

This is to certify that GAURAV KUMAR, B.Tech (6th semester), reg. no: 2114447 of the department of production engineering of National Institute of Technology, Agartala, Tripura has successfully completed this industrial training from 30/12/2023 to 13/01/2024 under my close supervision. During the training period he has successfully submitted report on “Industrial training at AgGBPS, NEEPCO” related to various plant and instruments used in power plant division. While during the training period in AgGBPS, NEEPCO, trainee GAURAV KUMAR was seen to be punctual, sincere and hardworking and his behavior is very good. We wish him all success in life.

Training Co-ordinator **Mentor**

ACKNOWLEDGEMENT

I would like to express our gratitude to **Dr. Prasenjit Dutta (**H.O.D), Dept. of production engineering National Institute of Technology Agartala, Tripura for allotting this training and supporting us throughout the work.

I would like to express a deep sense of gratitude and thanks to **Mr. Nanda Basumatary, H.O.P** of AgGBPS, NEEPCO without whose permission and wise counsel and able guidance, it would have not been possible to pursue my training. In this manner the help rendered by **Mr. Nirup Sarma, DGM (E/M)** and **Mr. Gopal Karmakar, DGM (E/M),** for experimentation is greatly acknowledged. I would also like to thanks **Er. Joydeep Bhattacharjee, Dy. Manager (E/M), Er. Atanu Saha (Asst. Engr.)**and **Er. Abhijit Lodh, Asst. Engr.(E/M)**

Finally, I would also like to express my indebtedness to all who have directly or indirectly contributed to successful completion of industrial training. At last, but not the least I would like to thanks all the staff members of NEEPCO who helped me immensely during my stay.

Sincerely

GAURAV KUMAR

3rd Year, 6th semester B.Tech. Production Engineering
National Institute of Technology Agartala, Tripura

Abstract

I have undergone 15 days in plant training in AgGBPS, NEEPCO where I learned many things theoretically as well as practically. As we know, that field of fossil fuel-based technologies. Natural gas combined cycle (NGCC) power plant we currently at the best position for electricity generation, having efficiency close to 60% since this type of power plant is new for me, I got an exposure to it. I learned the working of various type of machine like turbine, generators, boilers, and pumps etc. I learned about water filtration techniques, Demineralization process, working of boilers, cooling systems, Gas turbine and steam turbine, Electricity Transmission and distribution in switch yard. This training provided me the much needed Industrial Exposure and will definitely be helpful in coming years.

➢ **Table of contents:**

1. Introduction

➢ NEEPCO

:-North Eastern Electric Power Corporation Limited (NEEPCO) is a schedule -A ‘MINI RATNA'

Category-1 Central public sector Enterprise owned by the Government of India under the Ministry of Power, formed on 2 April 1976 to plan, investigate, design, construct, generate, operate and maintain power stations in the North Eastern Region of the country. It has 60% of total installed capacity of North East region, which is 2057 MW. With its headquarter in the charming town of Shillong, the capital of Meghalaya, NEEPCO is a power sector enterprise with its plants in various states of North East India.

The various projects of NEEPCO that are completed are:

- 600 MW Kameng Hydro Electric Project - ARUNACHAL PRADESH
- 405 MW Ranganadi Hydro Electric Project - ARUNACHAL PRADESH
- 110 MW Pare Hydro Electric Project - ARUNACHAL PRADESH
- 275 MW Kopili Hydro Project — ASSAM
- 291 MW Assam Gas based Power Plant — ASSAM
- 60 MW Tuirial Hydro Electric Project- MIZORAM
- 75 MW Doyang Hydro Electric Project-NAGALAND
- 135 MW Agartala Gas Based Power Station - TRIPURA
- 101 MW Tripura Gas Based Power Plant - TRIPURA
- 5 MW Grid Interective Solar Power Project — TRIPURA

The total production capacity of all NEEPCO plants combined is **2057 Mw.**

➢ AGARTALA GAS BASED POWER STATION(AgGBPS)

This is a 135 MW (4 x 21 MW + 2 x 25.5 MW) Combined Cycle Power Plant is located in the West Tripura District of the state Tripura near the capital town of Agartala. It is called the Agartala Gas Based Power Station **(AgGBPS)** and also Agartala Gas Turbine Combined Cycle Power Plant **(AgGBPS).**

Initially the project consisted of 4 Gas Turbines of 21 MW each of European Gas Turbine make operating on natural gas obtained from the gas fields of M/S GAIL at Tripura. The Project was financed through the budgetary support of the Government of India and partially through external commercial borrowings from the Deutsche Bank, Germany. The Project was completed in 1997-98 at a cost of Rs.322.55 Crores with a 50:50 debt equity ratio.

The plant has been converted to combined cycle power plant with installation & commissioning of 4 Nos. HRSG of Thermax make and 2 Nos. Steam Turbine of Siemens make of capacity 25.5 MW each. The project was financed through internal resource and external commercial borrowings from SBI, Singapore with 30:70 debt equity ratio. The plant is presently running as a combined cycle unit with 2 (two) modules consisting of two Gas Turbines, two HRSGs and one Steam Turbine in each module.

Specification

Name: AGARTALA GAS BASED POWER STATION

Capacity: 135 MW (4 x 21 MW +2 x 25.5 MW)

Location: Ramchandra Nagar, TRIPURA (WEST)

Date of Commercial Operation (COD):

GTG-1	**1-April-1998**
GTG-2	**1-April-1998**
GTG-3	**1-April-1998**
GTG-4	**1-August-1998**
STG-1	**1-September-2015**
STG-2	**29-July-2015**

➢ Combined Cycle Power Plant

Combine cycle is a power producing engine or plant that employs more than one thermodynamic cycle. Heat engine are only able to use a portion of the energy of their generation usually less than 50%. The remaining heat from combustion Is generally wasted.

power plant (CCPP) or combined cycle gas turbine (CCGT) plant, as gas turbine generator generates electricity, and waste heat is used to make steam to generate additional electricity via a steam turbine, this last step enhances the efficiency of electricity generation. As a rule, in order to achieve high efficiency, the temperature difference between the input and output heat levels be as high as possible. This is achieved by combining the **Brayton (gas)** and **Rankine (steam)** thermodynamics cycle.

At NEEPCO AgGBPS a combined cycle facility Is set up. The facility consists of 4 Gas Turbines and 2 Steam Turbines. The gas turbines use natural gas as fuel for electricity generation. The heat ejected from the gas turbine is not released into the atmosphere rather it is recovered using

Heat Recovery Steam Generators (HRSG) and is further used to heat water in the boilers to make steam to run the steam turbines. There is one HRSG for every gas turbine.

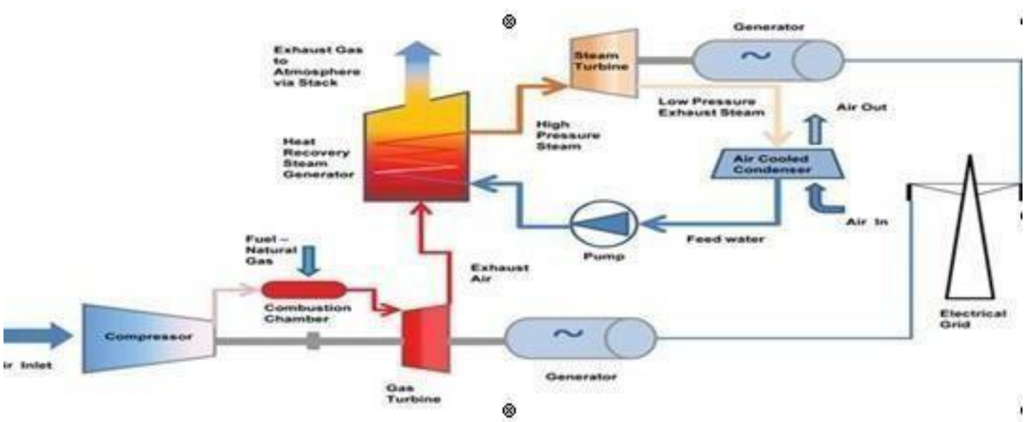
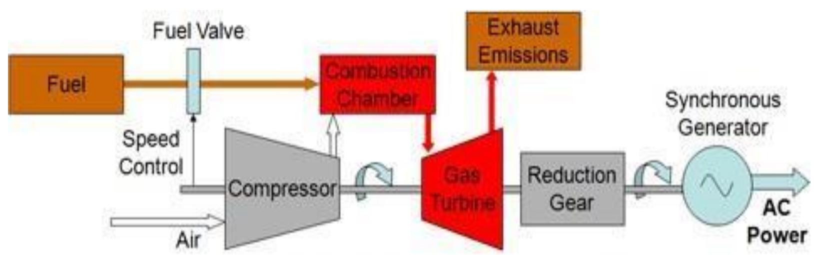


Fig: SCHEMATIC DIAGRAM OF COMBINED CYCLE POWER PLANT

2. Gas Turbine and Power generation

➢ Working principle

"The gas turbine basically operates on the principle of the Brayton cycle, where compressed air is passed and mixed with the fuel, and burned under constant pressure conditions. The resulting hot gas is allowed to expand through a turbine to perform work."



Gas Turbine Electric Power Generation

The Gas turbine engines derive their power from burning fuel in a combustion chamber and using the fast-flowing combustion gases to drive a turbine in much the same way as the high-pressure steam drives a steam turbine. A simple gas turbine is comprised of three main sections a compressor, a combustor, and a power turbine.

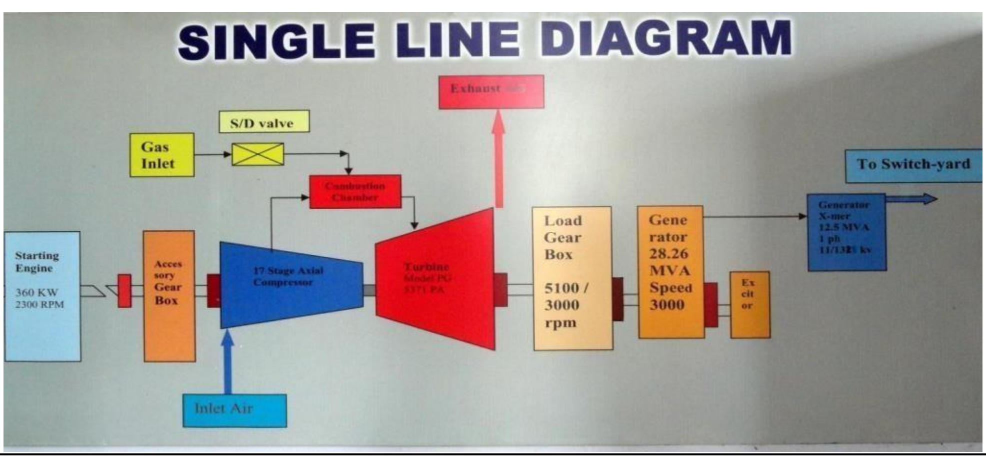


FIG: SCHEMATIC DIAGRAM OF SINGLE LINE GAS TURBINE

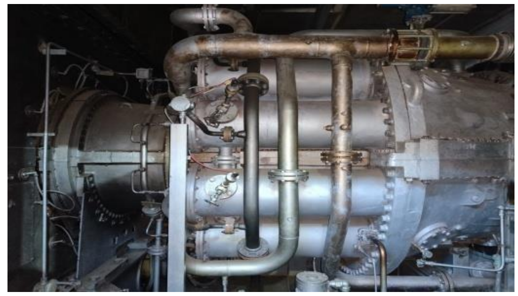
 

Fig: Gas Turbine at AgGBPS

• Parts of the Gas turbine:

1. **Compressor:**

- The compressor is an apparatus used to increase the pressure of air taken from the atmosphere. In gas turbine power plants, rotatory type compressors are generally used.

- The air at atmospheric pressure is drawn by the compressor through an air filter which removes the dust from the air. The rotatory blades of the compressor push the air between the stationary blades to increase the pressure. Therefore, the air at high pressure is available at the output of the compressor.

2. **Combustion chamber:**

- The combustion chamber is an apparatus used to increase the temperature of the compressed air. Here, the air at high pressure from the compressor is brought to the combustion chamber through the regenerator.
- In the combustion chamber, heat is added to the compressed air by burning of fuel oil. The fuel oil is injected through the burner into the combustion chamber at high pressure to ensure the atomisation of oil and its thorough mixing with the air. Consequently, the combustion chamber attains a very high temperature **(about 1700 °C)**. The gases produced by the combustion are suitably cooled to **700 °C** to **800 °C** and then delivered to the gas turbine.

3. **Starting motor:**

- Before starting the gas turbine, the compressor has to be started. For this purpose, an electric motor (M) is mounted on the shaft of the turbine. This motor is energized by the batteries. However, once the power plant is started, a part of mechanical power of the turbine drives the compressor and there is no need of the auxiliary motor now.

4. Gas Turbine:

- The gas turbine is a device which converts heat energy of hot gases into mechanical energy. The products of combustion consisting of a mixture of gases at high temperature and pressure are expanded in the gas turbine and does the mechanical work, i.e., it converts the heat energy into mechanical energy.

5. Alternator:

- Each alternator is coupled to a steam turbine and converts the mechanical energy of the turbine into electrical energy. The alternator may be hydrogen or air-cooled. The necessary excitation is provided by means of main and pilot exciters directly coupled to the alternator shaft.

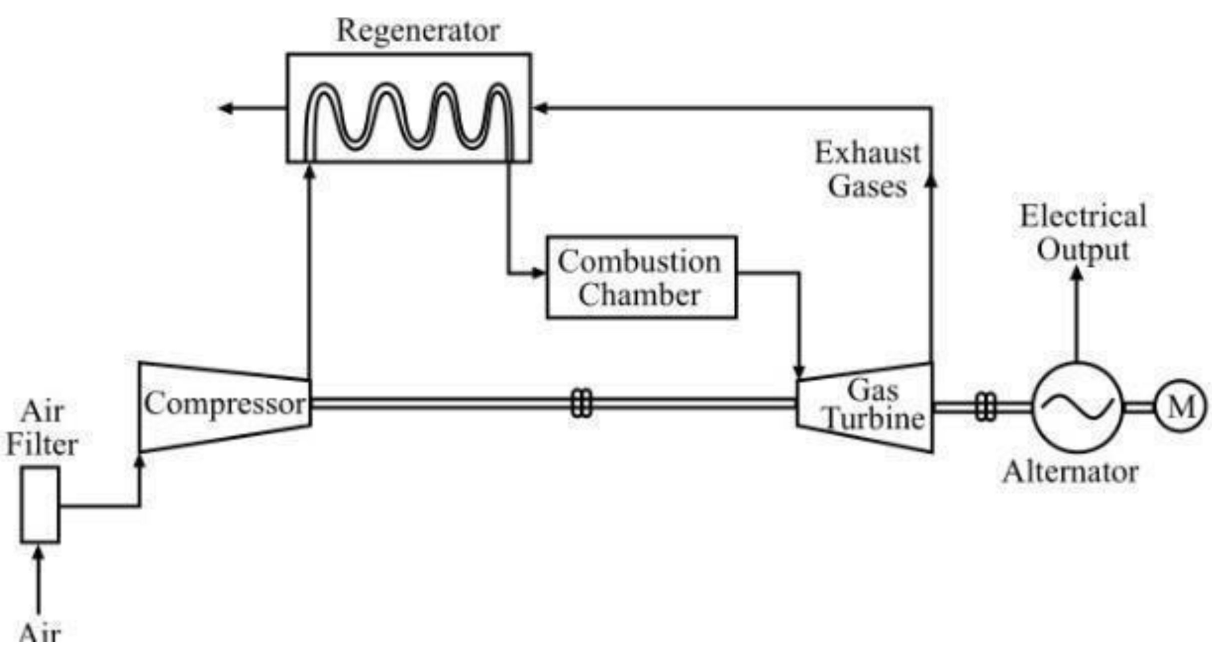


Fig: Schematic diagram of the parts of gas turbine

➢ Thermodynamic Explanation of working of the gas turbine:-

-“***The working of the gas turbine is completely based and performed on the basis of the Braton Cycle where combustion and heat release are done at constant pressure rate***”.

- The thermodynamic process used by the gas turbine is known as Brayton cycle. According to the carnot cycle in which efficiency is maximized by increasing the temperature difference of the working fluid between the input and output of the machine, where as in the Brayton cycle the efficiency is maximized by increasing the pressure difference across the machine.

The gas Turbine is basically comprised of the three main parts**: Compressor (Axial), Combustor and a turbine.**

Working: The working fluid, air is compressed in the compressor (**Adiabatically compression- no heat gain or loss),** then the air and fuel is mixed and burned by using an ignition under constant pressure condition in the combustion chamber **(constant pressure heat addition).** The resulting hot gas is then expanded thoroughly through the turbine to perform work **(adiabatic expansion)**.

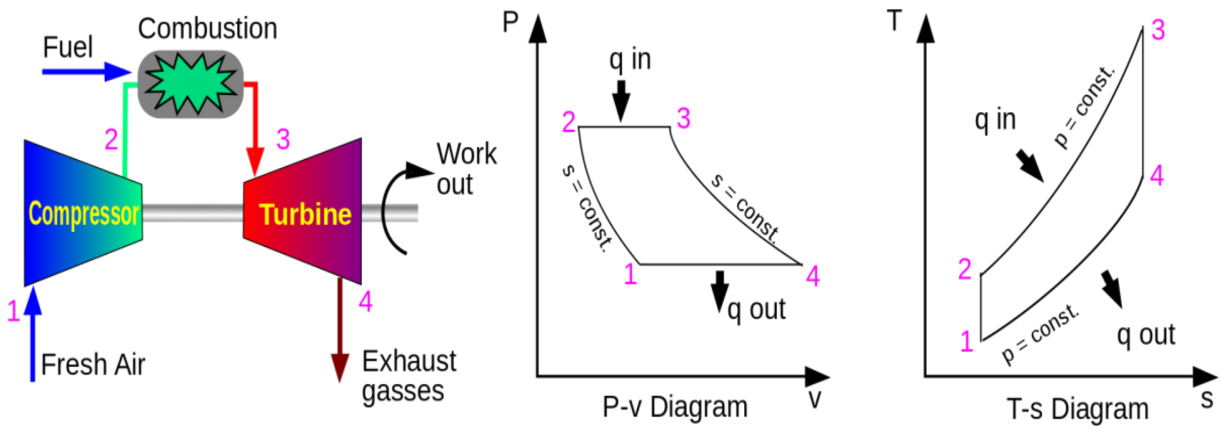


Fig: (i) P v/s V ii) T v/s S diagram of Brayton Cycle

➢ Advantages and Limitation of the Gas Turbine

- **Advantages:**

- It is simple to design and construct as compare to steam turbine

- In gas turbine boiler are not required so they are compact and much smaller in size as compare to steam turbine.

- It has low operating and less Maintenance cost.

- Less amount of loss are done in operation of the gas turbine.

- And easy to operate as compare to the steam turbine.

- **Limitations:**

- The net output of the gas turbine is low since greater power is used for driving the compressor.

- The overall efficiency of the plant is low as 20% because of the exhaust gases still containing heat.

- We can increase the efficiency by using the combine cycle to use that exhaust gas efficiently as compare to release it into atmosphere.

3. Heat Recovery Steam Generator (HRSG)

The HRSG is basically a heat exchanger, or rather a series of heat exchangers, It is also called a boiler, as it creates steam for the steam turbine by passing the hot exhaust gas flow from a gas turbine or combustion engine through banks of heat exchanger tubes, The **HRSG** can rely on natural circulation or utilize forced circulation using pumps. As the hot exhaust gases flow past the heat exchanger tubes in which hot water circulates, heat is absorbed causing the creation of steam in the tubes. The tubes are arranged in sections, or modules, each serving a different function in the production of dry superheated steam. These modules are referred to as economizers, evaporators, superheaters/reheaters and preheaters.

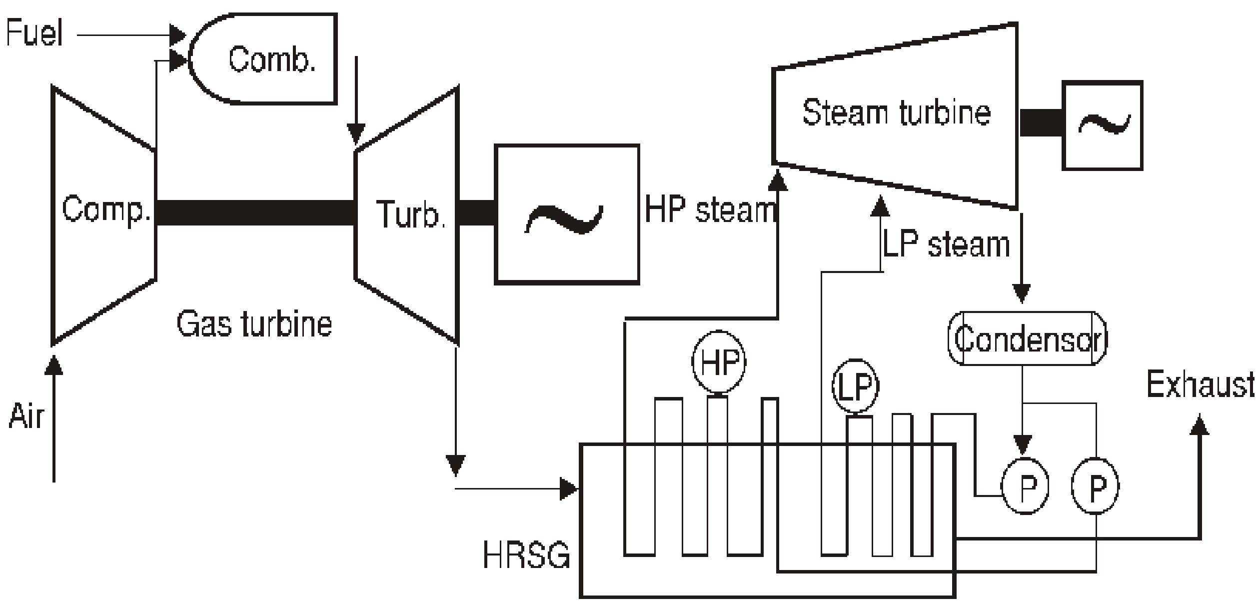


Fig: Combined Cycle Utility Heat Recovery Steam Generator Diagram

➢ Principle Of Operation:

The economizer is a heat exchanger that preheats the water to approach the saturation temperature (boiling point), which is supplied to a thick-walled steam boiler. The boiler is located adjacent to finned evaporator tubes that circulate heated water. As the hot exhaust gases flow past the evaporator tubes, heat is absorbed causing the creation of steam in the tubes. The steam-water mixture in the tubes enters the steam boiler where steam is separated) from the hot water using moisture separators and cyclones. The separated water is recirculated to the evaporator tubes. Steam boilers also serve storage and water treatment functions

An alternative design to steam boilers is a once-through HRSG, which replaces the steam boiler with thin-walled components that are better suited to handle changes in exhaust gas temperatures and steam pressures during frequent starts and stops.

This provides the following attributes:

- Maintains vertical tube module arrangement in horizontal gas path as proven in boiler- type boilers.
- Replaces HP boiler with thin-walled components (separator), which improves operational flexibility.
- Maintains natural circulation flow characteristics and therefore assures the flow stability and even heat distribution.
- Requires no changes in HP economizer and HP superheater.
- Retains proven low pressure and intermediate pressure boilers.

In some designs, duct burners are used to add heat to the exhaust gas stream and boost steam production, they can be used to produce steam even if there is insufficient exhaust gas flow.

Saturated steam from the steam boilers or once-through system is sent to the super-heater to produce dry steam, which is required for the steam turbine. Preheaters are located at the coolest end of the HRSG gas path and absorb energy to preheat heat exchanger liquids, such as water/glycol mixtures, thus extracting the most economically viable amount of heat from exhaust gases.

The superheated steam produced by the HRSG is supplied to the steam turbine where it expands through the turbine blade imparting rotation to the turbine shaft. The energy delivered to the generator drive shaft is converted into electricity. After exiting the steam turbine, the steam is sent to a condenser which routes the condensed water back to the HRSG.

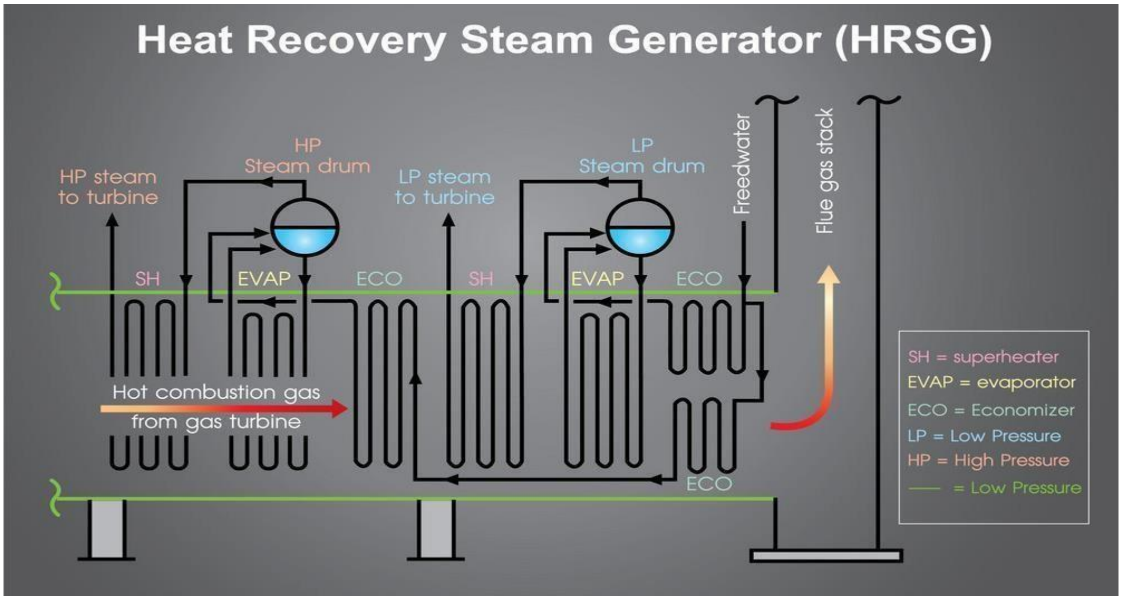


Fig: HRSG (Heat Recovery Steam

➢ PARTS OF HRSG:

- The heat Recovery Steam Generator have the following parts:

- **Economizer:**

The Economizer sections raise the boiler food water to a suitable approach temperature. Evaporator: The HP and LP evaporator systems are of natural circulation. Each pressure evaporator section consists of evaporator heat transfer section, steam boiler, down comers, and risers. The heat transfer section consists of multiple rows of finned tubes, Lower and upper headers, manifolds, vents and drains are included.

- **Super-heater**: The super-heater section is designed to increase the steam temperature to the temperature stated in heat balance. Superheated steam has a high energy content and is free of moisture. Required crossover tubes, vents, drains and safety valves are included.

- **Thermal insulation**: Thermal insulation is applied to piping, valve, tank and equipment having an operating temperature in excess of 60 °C.

- **Stack**: Typically, the HRSG stacks are of self-supporting and constructed of carbon steel. The HRSG is equipped with an access door located for convenient access in the base section, drains, connecting ductwork with the expansion joint access platforms and vertical ladders with enclosing safety cage to the platform level.

- **Boiler Feed Pump (BFP):**

The boiler feed pump is employed to feed the water from LP drum to HP drum through Economizer. NEEPCO uses16 stage feed pump which is powered by a 250 KW motor rotating at a speed of 2970 rpm. The speed of the pump is controlled by hydraulic coupling or scoop. Mechanical sealing is provided to the boiler feed pump. To maintain a stable thrust on the boiler a balancing line is installed in the BFP stuffing box, NEEPCO have arranged two BFP for each of the HRSG, among which one is employed to service & another is kept in standby.

- **Blowdown and drain system**:

  - Piping and valves are provided for each HRSG to collect blowdown water, boiler overflow water and steam drains. Each HRSG is fitted with two blowdown facilities, one may be designed to operate on a continuous and the other one on an intermittent basis. Both are led to the blowdown flash vessel.

    The same applies for the boiler overflow (Emergency blow down) An intermittent blow down connection is located on each of HP and LP evaporator. This blowdown is used to reduce the solids collected in the evaporator. It is usually operated intermittently, once a shift or shortly after the HRSG is shut down and still pressurized. Also, this blowdown is used to lower the boiler level in case of abnormal high level during operation.

    The continuous blowdown connection is used during normal operation. In conjunction with the chemical feed system, to maintain proper steam boiler water quality.

- **Exhaust gas inlet duct**:

  - The ductwork is properly stiffened, reinforced and complete with expansion joint and necessary doors. HRSG heat exchanger chamber: The HRSG heat exchanger chamber is constructed of carbon steel casing externally reinforced with structural steel. All structural steel is seal welded to the casing to prevent corrosion behind the structural.

- **Dosing system**:

- A chemical dosing system to dose phosphate solution to the boiler water has been provided to condition the boiler water to control scale forming components. Under these two types of dosing is done namely HP dosing& LP dosing.

- In **HP Dosing** tri-phosphate is dosed into the steam drum to maintain a phosphate concentration of 40 to 42 PPM and pH of 10.8 to 114. The Phosphate has the capacity to convert hardness producing insoluble calcium/magnesium salts to soluble sodium salts, which are drained through the blow down. The dosed phosphate desired alkalinity to the boiler water. An alkaline pH minimizes the possibilities of corrosion. Dosing of phosphate to the Boiler water is to be done in a manner that it quickly mixes with the whole boiler water. To enable this, a perforated pipe has been laid along the length of the drum and connected to the HP dosing line through a valve [HP 054] and a NRV [HP 055]

- In **LP Dosing** hydrazine is dosed to the LP drum as needed, to remove the excess oxygen dissolved in the De-mineralized water. The dissolved oxygen can accelerate the corrosion, by getting in touch with iron surface. That's why LP dosing is used to eliminate the chance of corroding of the surface.

- **Boiler Feed Pump (BFP):**
  - The boiler feed pump is employed to feed the water from LP drum to HP drum through Economizer. NEEPCO uses 16 stage feed pump which is powered by a 250 KW motor rotating at a speed of 2970 rpm.

To maintain a stable thrust on the boiler a balancing line is installed in the BFP stuffing box, NEEPCO have arranged two BFP for each of the HRSG, among which one is employed to service & another is kept in standby.

- **High pressure (HP) Steam Drum**:
  - The steam drums are steam/water separators, storage tanks, and water treatment sites for steam purity control. The steam/water mixture entering the drum from the riser tubes usually 5-10% steam depending on the boiler load and pressure. In the steam drum, saturated steam is separated from the steam/water mixture. The separator steam rises up through the drum as feed water enter the drum from economizer.
  - The separated water from the steam/water mixture is then recirculate together with the feed water to the heat absorbing evaporator tubes through the circulation loop. The water flows down the cylinder wall by gravity and is discharged from the cyclone through an annulus located below the water level. The separated water returns to the boiler cycle virtually free of steam. Each steam drum head includes an elliptical manhole, providing access to drum internals and connections for the remote level indicators, level gauges, and other control instruments. Each steam drum also contains. Connections for pressure safety relief valves, vents, pressure indicators, nitrogen blankets, downcomers, riser pipes, continuous blow down, chemical feeds and other control instruments. The drum vents are used to vent air during boiler filling and venting non- condensable gas during start up. Its rated pressure is $66 Kg/cm^2$

- **Low Pressure (LP) Steam Drum**:
  - The water enters the drum from CEP and from DM plants during

initial filling. To increase its efficiency the water is taken through CPH when generation reaches 7MW. It also consists of drum vent. Its rated pressure is 6kg/cm.

- **Diverter, Damper and Bypass Stack System –**

- The function of the diverter damper and bypass stack system is to conduct exhaust gas from the GT exhaust to either the HRSG inlet or to the atmosphere. The main equipment which is responsible for the direction of the exhaust gas is diverter damper. Many CCPP cannot operate in simple cycle mode through the bypass stack because the combustion turbine emissions will exceed the plant's air permit limits. In normal operation the exhaust gasses must pass through the selective catalytic reduction (SCR) located in the HRSG which reduces the carbon monoxide (CO) and Nitrogen Oxide (NOx) emissions below the plant's air permit levels.

- Many CCPP choose not to run in simple cycle mode through the bypass stack because it is not economical without the efficiency benefit of the steam turbine bottoming cycle.

- The system consists of sub-systems with the following functions:

1. Diverter damper to divert the exhaust gas pass.
2. Bypass stack with silencer to conducts exhaust gas to the
3. Atmosphere.
4. Seal air unit to seal the diverter damper.
5. Guillotine damper and shut-off the exhaust gas to HRSG.

4. WATER TREATMENT FACILITY (DM PLANT)

Water treatment is essential before steam generation. Water obtained from various sources contains different types of impurities, which must be removed before converting water into steam. If impurities are not removed this can damage various equipment of the steam power generation unit like boiler, turbine blades, etc. or significantly reduce their lives. Water treatment is carried out in DM Plant (De- mineralization)

Sources of Water:

- There are 3 types of sources of water:-
  1. Surface water-River water, lake water, pond water etc.
  2. Ground water -Bore water, well water.
  3. Sea water-Sea Water.

NEEPCO- AgGBPS uses ground water (bore water) for steam production.

➢ Reservoir:

- Reservoir is used for water storage purpose. Water is taken from here for DM water process work. High-Rate Solid Contact Clarifier: This clarifier is a high rate, solid contact, sludge re- circulation type clarifier, which is minimum time and space and using a minimum amount of Chemicals, produces an effluent of the highest quality, it is used principally for clarification, lime softening, silica reduction or organics reductions of water and waste water containing suspended solids, colour and organic impurities. As such, it provides a means for chemical addition and mixing, Flocculation and up flow clarification in a single unit.

Fig: Reservoir

➢ Water Treatment Process:

- In power plant water is known as the heart of the plant, so it is most necessary to supply salt free water for process. The demineralization is the process of removing mineral salts from water by using ion exchange process. The D.M water reduces the scale formation, Deposition and corrosion of tubes. It increases the life of pipes and tubes in plant. It prevents the deposition of minerals in turbine blades. It removes Mineral salts in the form of cations such as sodium, calcium, iron, copper and anions such as chloride, sulphate, nitrate etc. Also, various other parameters of water like hardness, pH (acidity-alkalinity), conductivity, etc. are check to make the water have optimum characteristics for steam production.
- **Water Treatment are done in two stages**

2) **Pre-Treatment**

↓

1) **De-Mineralization**

➢ **Pre-Treatment**:

- First water is extracted from natural underground reserves using bore-well and stored in reservoir. This water contains a lot of impurities specially mud, silica, salts, and other solid and gaseous impurities in dissolved and suspended form.

- The water from the reservoir is then passed through Degasser / Aerator where itis passed in a zig-zag motion. This removes the gaseous impurities and some solid impurities.

- The water is then treated with Alum and lime. Alum acts as a coagulant and removes suspended solids from water. Lime acts as pH booster.

- Then the water is sent for filtration. Filtration consists of passing the water through packed layers of sand charcoal etc. Now bleaching powder is added to the water that has come out of filtration. Bleaching powder contains chlorine and hence acts as disinfectant.

Fig: Degasser/Aerator

NOW THE WATER SENT TO DE- MINERALISATION

➢ De-Mineralization Of Water:

- De-mineralization of water has 3 main steps, they are

1. Activated Carbon filtering

2. Strong Acid Cation (SAC) Treatment

3. Strong Base Anion (SBA) Treatment

4. Mixed Bed treatment

- **Activated Carbon filtering**:

  - After pre-treatment the water is stored in tanks containing activated charcoal/carton. It is employed for the process of removing organic compounds and extracting free dire from water, thereby making the water suitable for discharge or use in manufacturing processes. The DM Plant at NEEPCO AgGBPS has two activated carbon filtering tanks which perform the filtration process.

- **Strong Acid Cation (SAC) Treatment:**

  - After activated carbon filtering, the water is sent for Strong Acid Cation (SAC) treatment in SAC tanks. These tanks contain strong acid cation resins. The strongly acidic cation exchange resins are bead-like products which have a sulfonic acid group in the cross-linked styrene frame. SAC is a cation exchange process. There are two SAC tanks in the DM plant to carry out this operation. After SAC treatment the hardness of water is removed and pH of water obtained is less than 3.5.

- **Strong Base Anion (SBA) Treatment:**

  - After SAC treatment the water is sent for Strong Base Anion (SBA) treatment in SBA tanks. It contains strongly basic anion exchange resin with quaternary ammonium groups Incorporated into the styrene frame. SBA is an anion exchange process. There are two SBA tanks in the DM plant to carry out this operation. After SBA treatment Silica content In water is less than 0.2 pm, Conductivity less than 5 micro siemens and pH obtained is 7.8 to 8

- **Mixed Bed Treatment:**

  - After passing water through cation then anion exchanger it is passed through mixed bed unit. In mixed bed cation and anion resins are mixed and while water passes through it, as it passes through thousands of cation/anions exchanger resulting final effluent of very good quality water. It is similar to conventional ion exchanger a cylindrical steel vessel. Internally rubber lined containing resin bed above which there is free space to allow expansion of resin when back washed. In addition to the usual distributors, a mixed bed is fitted with a center distribution and collection system. At the time of regeneration, the bed is back washed. This expands the resin bed and allows the heavy cation resin to sink to bottom and lighter anion resin rises to top. After some time when back wash is stopped the resins settle without upsetting the separation. There is a well- defined interface between the cation and anion resin bed and that interface is just at the level of center distributors Anion resin can be regeneration with caustic and rinsed. Spend caustic solution and rinse water can be withdrawn through the center distributors. After this cation resin can be regenerated and rinsed. In that case caustic will now be acid inlet/rinse water inlet. When both the resins are regenerated and rinsed the excess water is drained down to the surface of the bed and the resins are mixed thoroughly, with the help of air blowing. The air is blown in through bottom distributors and out through the air release at the top. After proper mixing the space above the bed is filled from above and unit is put into final rinse.

Fig: ACF Tank, SAC Tank, SBA Tank

- **Degasser:**

  - Degasser is an integral part of any demineralization plant, where it is generally placed between cation and anion exchanges and removes Carbon Dioxide, which is generated by dissociation of carbonic acid at cation outlet water. In this Degassing processes, Degasser Tower is utilized, which is made coating. Low air pressure is generated at the bottom of the tower that drives out CO_2 and the degassed water is collected in a sump beneath the tower.

Fig: Mixed Bed

Fig: Bleaching Powder

Fig: Retention Chamber

Fig: Pre-Treated water

Fig: Dual Media Filter

Quality of Effluent Water:

The quality of effluent water of SAC, Degasifier, SBA & MB will have the following property.

SAC Outlet Water Parameter

pH at 25 ℃	**2.8 to 3.5**
Free Mineral Acidity (FMA)	**Should be Equal to Equivalent Mineral Acidity (EMA)**
Hardness ppm as $CaCO_3$	**NIL**
Sodium ppm as Na^+	**<0.005**

Degasifier Outlet Water Parameter

Residual free CO2 ppm	**<5.0**

SBA Outlet Water Parameter

pH at 25 ℃	**7.5 to 9.0**
Total silica SiO_2 ppm	**<0.05**
Conductivity(µs/cm)	**< 2.0 preferably < 1.0**
Chloride (ppm as Cl)	**NIL**

MB Outlet Water Parameter

pH at 25 ℃	**6.8 to 7.2**
Total silica SiO_2 ppm	**<0.02**
Conductivity(µs/cm)	**< 0.2**
Sodium ppm as Na^+	**<0.003**

CHEMICAL REACTIONS INVOLVED IN DM PLANT

1)$NH3PO4 \leftrightarrow Na2PO4 + Na+ \leftrightarrow (+H2O) \leftrightarrow NaOH + H+$

$(Main\ Reason\ for\ pH\ boost)$

$\downarrow$

$\downarrow \leftrightarrow (+O2)$

$\downarrow$

$H2O$

2)$C4H9NO$

$\leftrightarrow$ $Basic\ in\ Nature\ in\ all\ phase\ (Water\ or\ Steam).$

$(Morpholine)$

3)$N2H4 + O2 -> 2NH3 + H2O ->$
$NH4OH\ (Low\ Pressure\ Drum\ pH\ increases)\ (Hydrazine\ Reaction)$

5. STEAM TURBINE AND POWER GENERATION

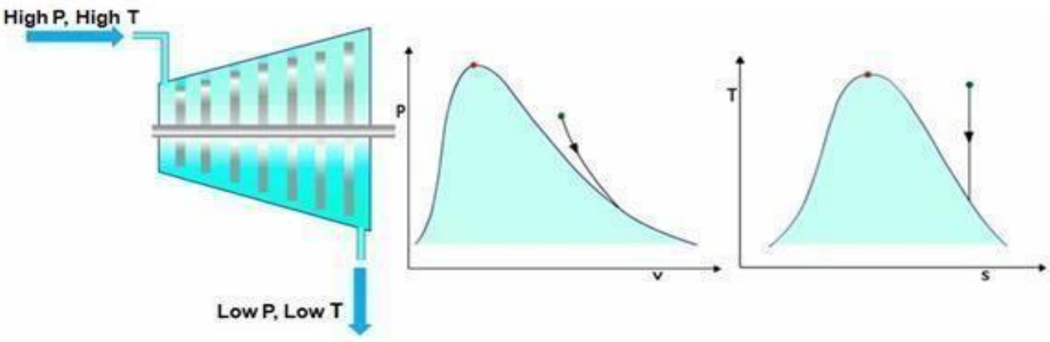
A steam-electric power station is a power station in which the electric generator is steamy driven. Water is heated, turns into steam and spins a steam turbine which drives an electrical generator. After it passes through the turbine, the steam is condensed in a condenser. The greatest variation in the design of steam-electric power plants is due to the different fuel sources. Worldwide, most electric power is produced by steam-electric power plants, which produce about 86% of all electric generation. The only other types of plants that currently have a significant contribution are hydroelectric and gas turbine plants, which can burn natural gas or diesel. Photovoltaic panels, wind turbines and binary cycle geothermal plants are also non-steam electric, but currently do not produce much electricity

➢ Steam Production:

Steam is most essential to run a steam turbine. Steam in a power plant is produced by heating water in boilers. In NEEPCO-AgGBPS the water required for steam production is obtained from underground natural reserves using bore well and is purified by the DM plant and then supplied to boiler. The heat required to make the steam is obtained from gas turbines by the use of Heat Recovery Steam Generators (HRSG). There are also Boiler Feed Pumps (BFP) to assist the process. The steam produced is of two types i.e., Low Pressure (LP) Steam and High Pressure (HP) steam. Hence two types of Boilers are used i.e., LP Steam drum (For producing LP steam) and HP Steam drum (for producing HP steam). Both LP and HP steams are used to run the turbine. After the steam has passed over the turbine it is condensed to form water which is then again heated to make steam for the turbine and hence forms a cyclic process. However, if quality of steam produced is less it can be recovered by allowing de-mineralized water to enter the boilers from DM plant.

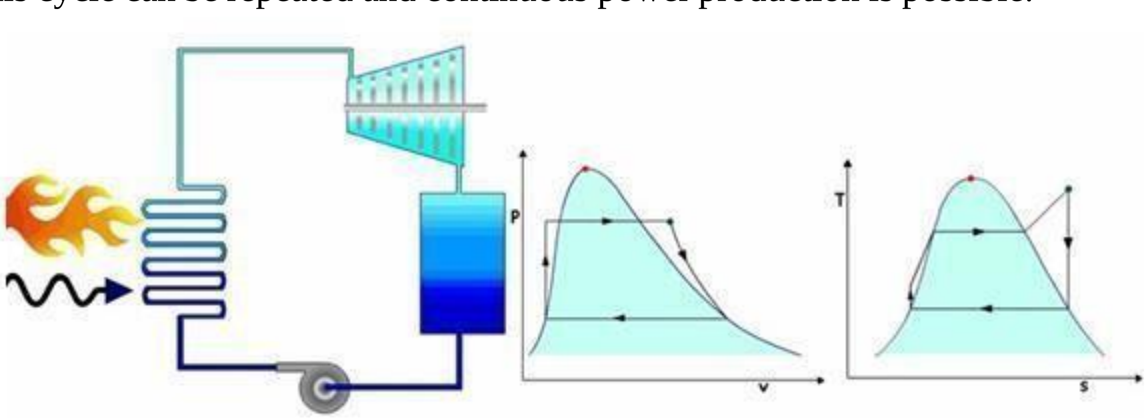
➢ Energy absorption from steam

-When turbine blades get rotated by high pressure high temperature steam, the steam loses its energy. This in turn will result in a low pressure and low temperature steam at the out of the turbine. Here steam is expanded till saturation point is reached. Since there is no heat addition or removal from the steam, ideally entropy of the steam remains same. This change is depicted in the following PV and T-s diagrams. If we can bring this low pressure, temperature steam back to its original state, then we can produce electricity continuously.



➢ Heat Addition in Boiler & Rankine Cycle:

-Here external heat is added to the fluid in order to bring fluid back to its original temperature. This heat is added through a heat exchanger called a boiler. Here the pressure of the fluid remains the same, since it is free to expand in heat exchanger tubes. Temperature rises and liquid gets transformed to vapour and regains its original temperature. This completes the thermodynamic cycle of a thermal power plant, called Rankine Cycle. This cycle can be repeated and continuous power production is possible.



➢ Condenser Heat Rejection - Cooling Tower:

-In order to reject heat from the condenser a colder liquid should make contact with it. In a thermal power plant continuous supply of cold quid is produced with the help of a cooling tower. Cold fluid from the cooling tower absorbs heat from a condenser and gets tested, this heat is rejected to the atmosphere via natural convection with the help of a cooling tower

➢ Steam Turbine and its Accessories:

- **Steam Turbine:-**

A steam turbine is a machine that extracts thermal energy from pressurized steam and uses it to do mechanical work on a rotating output shaft. Because the turbine generates rotary motion, it is coupled to a generator to harness its motion into electricity. Such turbogenerators are the core of thermal power stations. The steam turbine is a form of heat engine that derives much of its improvement in thermodynamic efficiency from the use of multiple stages in the expansion of the steam, which results in a closer approach to the ideal reversible expansion process.

The HP and LP steam produced in the boilers is fed to turbine which turns rotate the blades thus giving mechanical energy to alternator through reduction gearbox. This turbine is a combination of impulse and reaction turbine. The exhaust pressure of which is 0.9 kg/cm^2

When the steam passes through different stages in turbine the temperature as well as pressure of steam gets drop and the exhaust is passed through duct of air-cooled condenser. Before turbine rolling, bearing gear has to be engaged and should be run for a minimum 15- 17 hours to increase the casing temperature and to avoid the expansion of turbine blades. This happen if the HP steam is directly fed to stationary turbine blades by opening the Emergency Stop Valve (ESV). Bearing gear is rotates at turbine shaft ata speed of 108 rpm during starts up Bearing gear is said to an auto engaged mode so that when the turbine gets tripped it starts automatically. Bearing gear gets auto engaged when the turbine shaft reaches at a speed of 350 rpm while shutdown.

There are two Steam Turbines at NEEPCO-AgGBPS. Each turbine produces 25.5 Mw electricity and in total both produce 51 Mw of electricity.

When turbine blades get rotated by high pressure high temperature steam, the steam loses its energy. This in turn will result in a low pressure and low temperature steam at the outlet of the turbine. Here steam is expanded till saturation point is reached. Since there is no heat addition or removal from the steam, ideally entropy of the steam remains same. If we can bring this low pressure, low temperature steam back to its original state, then we can produce electricity continuously.

- **Condenser:**

Compressing a fluid which is in gaseous state requires a huge amount of energy, so before compressing the fluid it should be converted into liquid state. A condenser is used for this purpose, which rejects heat to the surrounding and converts steam into liquid. Ideally there will not be any pressure change during this heat rejection process, since the fluid is free to expand in a condenser.

- **Pump:-**

At exit of the condenser fluid is in liquid state, so we can use a pump to raise the pressure. During this process the volume and temperature (2-3 °C rise) of fluid hardly changes, since it is in liquid state. Now the fluid has regained its original pressure.

- **Boiler:**

Here external heat is added to the fluid in order to bring fluid back to its original temperature. This heat is added through a heat exchanger called a boiler. Here the pressure of the fluid remains the same, since it is free to expand in heat exchanger tubes. Temperature rises and liquid gets transformed to vapour and regains its original temperature. This completes the thermodynamic cycle of a thermal power plant, called Rankine Cycle. This cycle can be repeated and continuous power production is possible.

- **Gland Sealing System**:

Gland sealing system is provided to seal the inlet & outlet of a turbine so that the high pressure steam cannot escape from the turbine casing, except through the exhaust Gland seating is a low-pressure system that is led to a sealing gland. The steam seal the gland, which may either a carbon ring or labyrinth type against air at the vacuum end of the shaft.

- **Pressure Reducing & De-Superheating System (PRDS)**:

The main function of PRDS is to reduce the temperature & pressure of HP steam, so that it can be used as motive steam & gland sealing steam. Usually, water from CEP discharge is sprayed into the steam. As a result, the temperature as well as the pressure gradually decreases.

- **Boot Tank:**

The partially condensate water from turbine exhaust duct is stored into the boot tank or drain tank. This water sometimes fed to CST by some drain boot pumps.

- **LP and HP Steam Dumping:**

This system is used when there is continuous production of steam and the steam cannot be supplied to turbine due to various faults. It consists of spraying system through which water coming from cooling tower is sprayed and the temperature and pressure gets reduced before entering into exhaust line of Steam turbine which is then condensed by means of Air-cooled condenser.

➢ WORKING PRINCIPLE OF THE STEAM TURBINE

The working principle of Steam turbine is based on Rankine cycle and depends on the dynamic action of the steam. A high-velocity steam is coming from the nozzles and it strikes the rotating blades which are fitted on a disc mounted on a shaft. This high- velocity steam produces dynamic pressure on the blades in which blades and shaft both start to rotate in the same direction. Basically, in a steam turbine pressure energy of steam extracts and then it converted into kinetic energy by allowing the steam to flow through thew nozzles. The conversion of kinetic energy does mechanical work to the rotor blades and the rotor is connected to a steam turbine generator which acts as a mediator. Turbine generator collects mechanical energy from the rotor and converts into electrical energy. Since the construction of steam turbine is simple, its vibration is much less than the other engine for same rotating speed.

Fig: Steam Turbine at NEEPCO AgGBPS

PHYSICAL PARAMETERS OF STEAM TURBINE GENERATOR AT NEEPCO:

MAIN PARTS	TURBINE, GENERATOR AND EXCITOR
TYPE	IMPULSE-REACTION COMBINED TURBINE
STAGES	22
PRESSURE	62 bar
TEMPERATURE	475 DEGREE CELCIUS
RPM OF TURBINE	6000
RPM OF GENERATOR	1500
GEAR RATIO (LOAD GEAR BOX)	4.032

6. AIR COOLED CONDENSER (ACC)

The exhaust steam from the STG is cooled & condensed by the air-cooled condenser & stored in the condensate storage tank. It consists of a huge duct which is later divide into two, followed by various small pipes which are connected to the common header to condensate storage tank. There are many heat exchangers attached with the small pipes to make the process quicker.

There are 6 huge fans which act as air coolers rotating at a rated speed of 1500 rpm (each fan) for each of the steam turbine. As there is no pump given to extract the exhaust gas from STG, hence a negative pressure is maintained inside ACC duct. This process is usually done by taking ejector into service. It also extracts all non-condensable gases from duct. The Air- Cooled Condenser installed in this project is of A-frame shape. There are a total 12 nos. of ACC fans for two STG unit and the blades of each fan are set at an angle of 15-17° depending upon the voltage consumed by fan.

Air Cooled Condenser fans runs on 415 volts. When the ACC fans rotates it provides the cooling medium (air) in the upward direction (due to set blade action) which makes the exhaust present in duct to condensate and later is collected in condensate tank.

Fig: ACC (NEEPCO AgGBPS)

➢ CONDENSATE STORAGE TANK:

The condensate storage water, collected by the air cooling of steam through ACC is stored in the condensate storage tank. For intake of the steam through the outlet duct, it is required to maintain a negative pressure in the line. That's why an ejector system is installed throughout the ACC line and CST tank. For the proper maintenance of the pump, it is required to maintain the level between 60-70%

➢ FIELD DETAILS:

LOCATION	INLET LINES	OUTLET LINES
In ACC block, between ejector & CEP	1. From cooling fan 2. From recirculation pump 3. From Ejector (After) condenser & Inter condenser) 4. From DM water unit 5. From Dumping device 6. From Boot Tank	1. To GSC

➢ Condensate Extraction Pump:

The condensate extraction pump extracts the condensed water from condensate storage tank and delivers it into the ejector. It is also used to fill up the LP drum during start up if needed through CPH bypass. NEEPCO has arranged two CEP for each of the steam turbine among which one is employed for the service and another is kept in the standby.

Ejector:

Steam jet Ejectors are based on the venture ejector principle & operated by passing motive steam through an expanding nozzle. The nozzle provides controlled expansion of the motive steam to convert pressure into velocity which creates a negative pressure or gas are then completely mixed and then passed through the diffuser, where the gases velocity is converted into sufficient pressure to meet the predetermined discharge pressure. The ejector maintains a negative pressure into discharge line, condensate storage tank. The condensate water from condensate storage tank is supplied to ejector through condensate extraction pump and then supplied to gland sealing condensate.

FIELD DETAILS:

LOCATION	INLET LINES	OUTLET LINES
In ACC block, above condensate storage tank	7. From cooling fan 8. From CEP 9. From Pressure reducing & De-superheating system	1. To GSC 2. To Atmosphere 3. To CST

7. LUBRICATION SYSTEM

➢ GAS TURBINE LUBE OIL SYSTEM:

“The lubrication oil is the life blood of the gas turbine and it is very important for the gas turbine to perform its function and to extend the length between overhauls. Fluid film journal bearings play a significant role in the machine’s overall reliability and rotor- bearing system vibration and performance characteristics.”

Turbine engines oil systems can also be classified as a pressure relief system that maintains a somewhat constant pressure: the full flow type of system, in which the pressure varies with engine speed, and the total loss system, used in engines that are for short duration operation (target drones, missiles, etc.). The most widely used system is the pressure relief system with the full flow used mostly on large fan type engines. One of the main functions of the oil system in turbine engines is cooling the bearings by carrying heat away, circulating oil around the bearing.

This gas turbine engine has an oil tank. The lubricant oil is supplied from the tank to the lube pump which pushes liquid throughout the filter into two different branches. The first branch lubricates the first journal bearing and additional equipment like fuel, and auxiliary gear pumps. The second branch lubricates the other bearing and gear pumps.

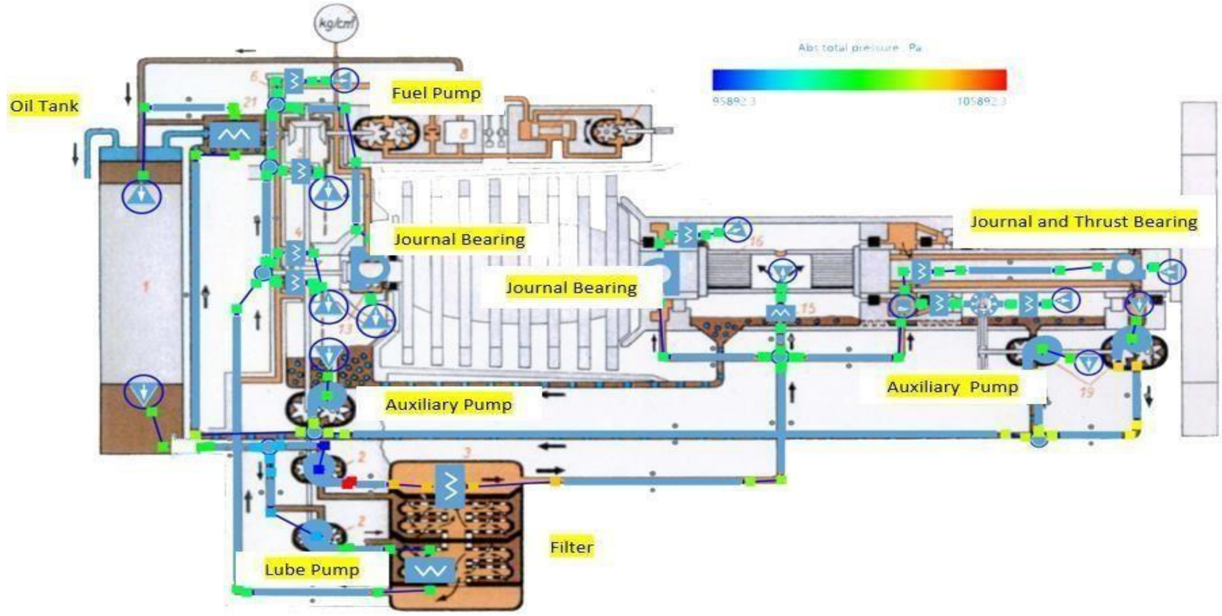


Fig: Gas Turbine Lube oil system

➢ STEAM TURBINE LUBE OIL SYSTEM:

Steam turbines are widely used in the power industry as prime movers for generators. As a paramount component to a company's production, these machines generally run on continuous operating schedules. Maintenance professionals are challenged with implementing tactics that enhance equipment performance given the turbine's extreme operating conditions associated with lengthy periods of time in service, such as high temperatures, water contamination and lengthy periods of time in service.

Lubrication plays a vital role in supporting optimal steam turbine performance. Selecting an inadequate lubricant can have expensive consequences, including unexpected shutdowns and high labour costs associated with frequent cleaning and filtering of lubrication systems and inspections of journal bearings.

➢ Selection Criteria:

A steam turbine oil's most important functions are to:

- Lubricate bearings, both journal and thrust. Depending on the type of installation, this also may include the hydraulic control system, oil shaft seals, gears and flexible couplings.
- Provide efficient cooling.
- Prevent sludge, rust and corrosion while in service.
- Maintenance professionals need to evaluate and monitor several integral properties of their steam turbine oil to achieve these optimal performance characteristics. Some of these attributes include viscosity, viscosity index, foam resistance, rust and corrosion prevention and oxidation stability.

➢ Uses:

- Lubrication and cooling of turbine and generator bearings
- Metallic debris flush out from bearings.
- Supply of Control Oil to Governing and Protection System
- Supply of Control Oil to LP Bypass Governing.

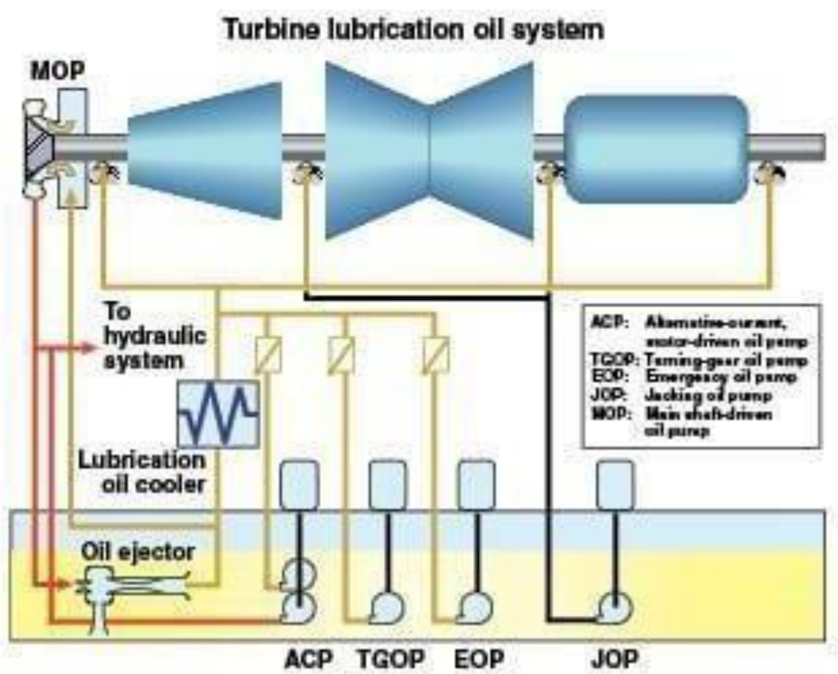


Fig: Steam Turbine lubes oil system

8. ELECTRICAL SYSTEMS

The generator coupled to Turbine through reduction gear generates 11KV power which is given to 132 KV switch yard via set-up transformer where the 11 KV is being stepped up into 132 KV.

There is tapping of 11 KV which is given to UAT (unit auxiliary transformer) where 11KV is stepped down to 6.6 KV

This 6.6 KV is required to run the 8 no of BFP. Again 6.6 KV is being stepped down to 415 Volt in VFD (variable frequency drive). VFD is used to operate the ACC fans.

6.6 KV is also stepped down to 415 Volt in station transformer. Station transformer is used for CEP, Battery charge, HRSG MCC, STG MCC, Emergency MCC and HVAC MCC.

From station transformer 415 volt is stepped down to 220 Volt in lightning transformer.

- **Generator:**

In electricity generation, a generator is a device that converts motive power (mechanical energy) into electric power for use in an external circuit. Sources of mechanical energy include steam turbines, gas turbines, water turbines, internal combustion engines, wind turbines and even hand cranks.

- **Switch Yard:**

Before electricity is consumed, three steps are followed: production, transmission and distribution. In the first, the generator produces the electricity from a primary energy source. The transmission step consists of moving the electricity produces at generating stations to consumption locations. Thereafter, the electricity must be distributed to each house, factory or business. Electricity generated by the generators flows to transformers that step up the voltage in preparation for travel over long distances. The most powerful generating stations are more than one thousand kilometers from major consumption centers. Electricity travels more easily at high voltage because there are fewer energy losses.

Towers are the most visible pieces of equipment in the electricity transmission chain. The high voltage conductors on the towers are made of aluminium a lightweight material and very good conductor offering a better price-quality ratio than other metals such as silver, gold or copper. Each conductor is stranded with wires twisted together around a steel core that gives the conductor its required strength.

Fig: Switch Yard of NEEPCO (AgGBPS)

- **Transformer:**

A transformer is a static electrical device that transfers energy by inductive coupling between its winding circuits. A varying current in the primary winding creates a varying magnetic flux in the transformers core and thus a varying magnetic flux through the secondary winding. This varying magnetic flux induces a varying electromotive force (EMF) or voltage in the secondary winding. Transformers are essential for the transmission, distribution and utilization of electrical. As an essential element of all nuclear, thermal or hydraulic power stations. generator transformers are step-up transformers with delta connected LV windings energized by the generator

voltage, while star connected HV windings are connected to the transmission lines. Constantly, faced with voltage changes either due to load rejection or switching operations, followed by generator over excitation, it must also maintain the ability to withstand overloads. The high rated current involved requires absolute control of the magnetic field inside the tank to avoid localized overheating of associated metallic parts. Transformers are used to increase voltage before transmitting electrical energy over long distances through wires. Wires have resistance which loses energy through joule heating at a rate corresponding to square of the current. By transforming power to higher voltage transformers enable economical transmission of power and distribution. Consequently, transformers have shaped the electricity supply industry, permitting generation to be located remotely from points of demand. All but a tiny fraction of the worlds electrical power has passed through a series of transformers by the time it reaches the consumer

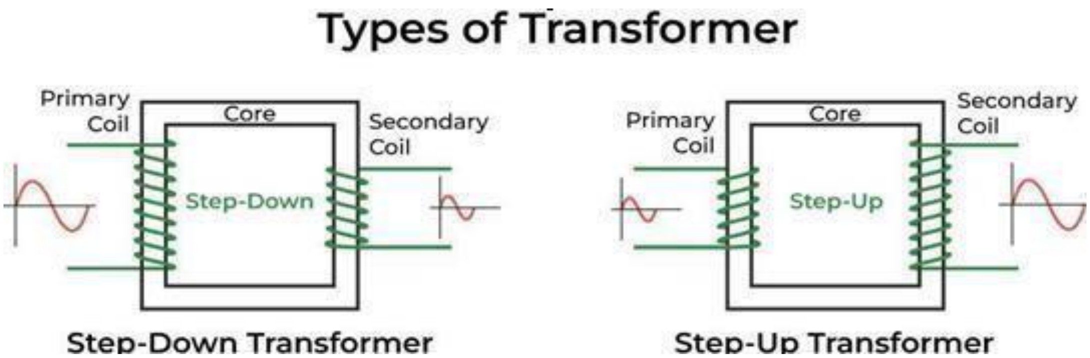


Fig: Transformer of AgGBPS

- **Bus Duct:**

  In electrical power distribution, a bus duct is sheet metal duct containing either copper or aluminium busbar for the purpose of containing a substantial current of electricity. It is an alternative means of conducting electricity to power cables or cables bus

- **The Unit Auxiliary Transformers (UAT):**

  The Unit Auxiliary Transformers is the power Transformer that provides power to the auxiliary equipment of a power generating station during its normal operation. This transformer is connected directly to the generator output by the tap of the isolated phase bus duct and thus becomes cheapest source of power to the generating station.

- **Emergency Diesel Generator (EDG):**

An Emergency Diesel Generator is the combination of a diesel engine with an electric generator to generate electric energy. This is a specific case of engine generator. Diesel generating sets are used in places without connection to power grid, or as emergency power-supply if the grid fails as well as for more complex applications such as peak looping, grid support and export to the power grid.

- **Lightening Arrestor (LA):**

Lightening arrestors are the Instrument that are used in the incoming feeders so that to prevent the high voltage entering the main station. This high voltage is very dangerous to the Instruments used in the substation. Even the Instruments are very costly, so to prevent any damage lightening arrestors are used. The lightening arrestors do not let the lightening to fall on the station. If some lightening occurs the arrestors pull the lightening and ground it to the earth. In any substation the main important is of protection which is firstly done by these lightening arrestors. The lightening arrestors are grounded to the earth so that it can pull the lightening to the ground. The lightening arrestor works with an angle of 30 to 45 making a cone.

- **Isolator:**

Isolator is a manually operated mechanical switch which separates a part of the Electrical power. Its main purpose is to isolate one portion of the circuit from the other and is not intended to be opened while current is flowing in the line. Isolator are generally used on both ends of the breaker so that repair or replacement of circuit breaker can be done without any danger.

- **Current Transformer (CT):**

  Current transformers are basically used to take the readings of the currents entering the substation. This transformer steps down the current from 800 amps to 1 amp. This is done because we have no instrument for measuring of such a large current. The main use of this transformer is

  1. Distance Protection
  2. Backup Protection
  3. Measurement

- **Potential Transformer:**

  There are two Potential Transformers (PT) used in the bus connected both side of the bus The potential transformer uses a bus isolator to protect itself. The main use of this transformer is to measure the voltage through the bus. This is done so as to get the detail information of the voltage passing through the bus to the instrument. There are two main parts in it

  1. Measurement
  2. Protection

- **Bus Bar:**

  The bus is a line in which the incoming feeders come into and get into the instruments for further step up or step down. The first bus is cd for putting the incoming feeders in la single line. There may be double line in the bus so that if any fault occurs in the one the other can still have the current and the supply will not stop. The two Lines in the bus are separated by a little distance by a conductor having a connector between them. This is so that one can work at a time and the other works only if the first is having any fault.

Specification of Different Machineries

GENERATORS:

1	Gas Turbine Generator	MVA 28.9 Gen volt: 11 KV; PF: 0.8 No. of poles: 02 Ratted speed: 3000 rpm Make: Alstom Model: T-600 Site rating: 21 MW	04 nos.
2	Steam Turbine Generator	Make: TDPS, standard .IS4712 2001 MVA Rating: 32.5 MVA No. of poles: 4 Speed: 1500 rpm	02 nos.

MECHANICAL RATINGS:

1	Gas Turbine	Model: G 5371 (PA) No of shafts:1 Shaft Rotation: Counter Clockwise Make: GE	04 nos.
2	Auxiliary Gear of GTG	Type: A519 Special	04 nos.
3	HRSG	Make: Thermax LTD Boiler Main Fuel: Exhaust Gas Max working/Design Pressure: 78 (HP) and 9 (LP) Boiler rating	04 nos.

4	Ejector	Make: Mazda LTD Model: 2x2 Stage: 2 Pressure: 9 Kg/cm²	02 nos.
5	Steam Turbine	Make: Siemens Model: SST-300 (C21/V5608) Generator Type: Condensing type steam Speed: 6000 rpm Power: 25,800 KW Pressure (Inlet): 62 Bar Pressure (Extraction) : 5.30 Bar Pressure (Exhaust): 0.18 Bar Temperature (Inlet): 475°C Temperature (Exhaust): 57.83°C	02 nos.

6	STG Gear Box	Make: Triveni Rated power: 30500 KW (40901 HP) Input/Output Speed: 6048/1500 Ratio: 4.032 No of Teeth (Gear / Pinion): 125/31 Lube Oil Grade: ISO VG 46 Lube Oil Flow: 590 LPM Lube Oil Pressure: 1.5-2.0 Kg/cm²	02 nos.

9. CONCLUSION

***AgGBPS** is a combined cycle power plant which produces power by utilizing the exhaust of the gas turbine generators to run the steam turbine generators.*

One speciality of this plant is that it is capable of **black start** i.e., even if there is no power in the entire north east region, it is able to run the plant through the use of DG (Diesel Generator).

- **Vision:**

To be a leading integrated Electric Power Company of the country with a strong environment conscience.

- **Mission:**

To harness the huge power potential of the country, from conventional and non- conventional sources, with minimal impact on the environment through a planned development of power generation projects by an integrated approach covering all aspects of investigation, planning, design construction, operation and maintenance of power projects, which in turn would effectively promote the development of the nation as a whole.

10. SAFETY PRECAUTIONS

- All personnel must wear the correct protective clothing. All personnel must avoid contact with turbine casing, valve bodies, drains and gas lines, which could result in serious burns.
- Do not wear loose clothing, neckties, etc. near rotating machinery.
- All personnel should develop safety awareness.
- All personnel are to wear correct ear protection when working in the vicinity of the turbines.

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