A

Summer Training Report

On

"National Thermal Power Corporation"

Unchahar

Submitted by

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Course: B.Tech (DUAL DEGREE) (Third Year)

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IIT BHUBANESWAR

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ACKNOWLEDGEMENT

With deep reverence and profound gratitude, I express my sincere thanks to **Mr. Bholendra Kumar Gupta (Dy. General Manager) (EDC)** for giving me an opportunity to do training at NTPC Unchahar. I also would like to thank **Sh. T N Yadav AGM (Operation) and Sh. R K Singh AGM (EMD)** who has helped me at the working sites, explaining and giving me all the information, I needed to complete this report. I am also very much thankful to **LAXMI KANT SINGH** and **SIVANG DEEP** for helping me throughout the training. At last I would like to convey my thanks to all the members of the staff of NTPC Unchahar who have helped me at every stage of training.

Training Period: May, 30 to June 27, 2022.

NIKHIL TYAGI

3RD YEAR

ELECTRICAL ENGINEERING

B.TECH, DUAL DEGREE

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ABSTRACT

I was appointed to do 4-week training at this esteemed organization from 30 MAY, 2022 to 27 June, 2022. I was assigned to visit the various department the s of plant, which were;

Operation (Familiarization)

EMD (Project Report)

This report contains detail study of plant operation and generator system and it protection feature and switchyard and it component.

These 4 weeks training was a very educational adventure for me. It was really amazing to see the plant by yourself and learn how electricity, which is one of our daily requirements of life, is produced. This report has been made by my experience at NTPC Unchahar. The material in this report has been gathered from my notes, senior student reports and trainers manuals and power journals provided by training department. The specification and principles are as learned by me from the employees of each division of NTPC.

TABLE OF CONTENTS

Contents	Page no.
Acknowledgement	2
Certificate	3
Abstract	4
1: INTRODUCTION	
2: NTPC Unchahar	
3: Basic thermal power plant	
• Coal cycle	
• Steam cycle	
• Water cycle	
4: Rankine cycle	
5: coal handling plant	
6: boiler part	
7: steam turbine	
8: generator	
9: switchyard	
10: conclusion	

Part 1: INTRODUCTION

India’s largest power company, NTPC was set up in 1975 to accelerate power development in India. NTPC is emerging as a diversified power major with presence in the entire value chain of the power generation business.

NTPC symbolized hop of the country suffering from crippling power black-outs, the Government of India, which was trying to pull an ailing, economy back on the track and the World Bank, which was supporting the country in many development initiatives. Thus, NTPC was created not only to redraw the power map of India but also excel in is performance and se benchmarks for others to follow. It succeeded on both counts.

Today with an installed capacity of 68,961.68 MW, NTPC contributes one fourth of the Nations Power generation, with only one fifth of India total installed capacity. An ISO 9001:2000 Certified company, it is world world`s 10th largest power generation in the world, 3rd largest in the Asia.

It is one of the largest Indian companies in terms of market cap. The corporation recorded a generation of 25 billion unit(BUS) per month; through 23 coal based and 7 gas based, 1 hydro,1 wind and 18 solar and 1 small hydro plant power plant spread all over the country and also has 9 coal, 4 gas, 8 hydro based and 5 renewable energy plants in joint venture. Rated as one of the best company to work for in India, it has developed into a multi-location and multi-fuel company over the past three decades.

Total revenue of NTPC is 120,042.43 cr.

Part 2: NTPC UNCHAHAR

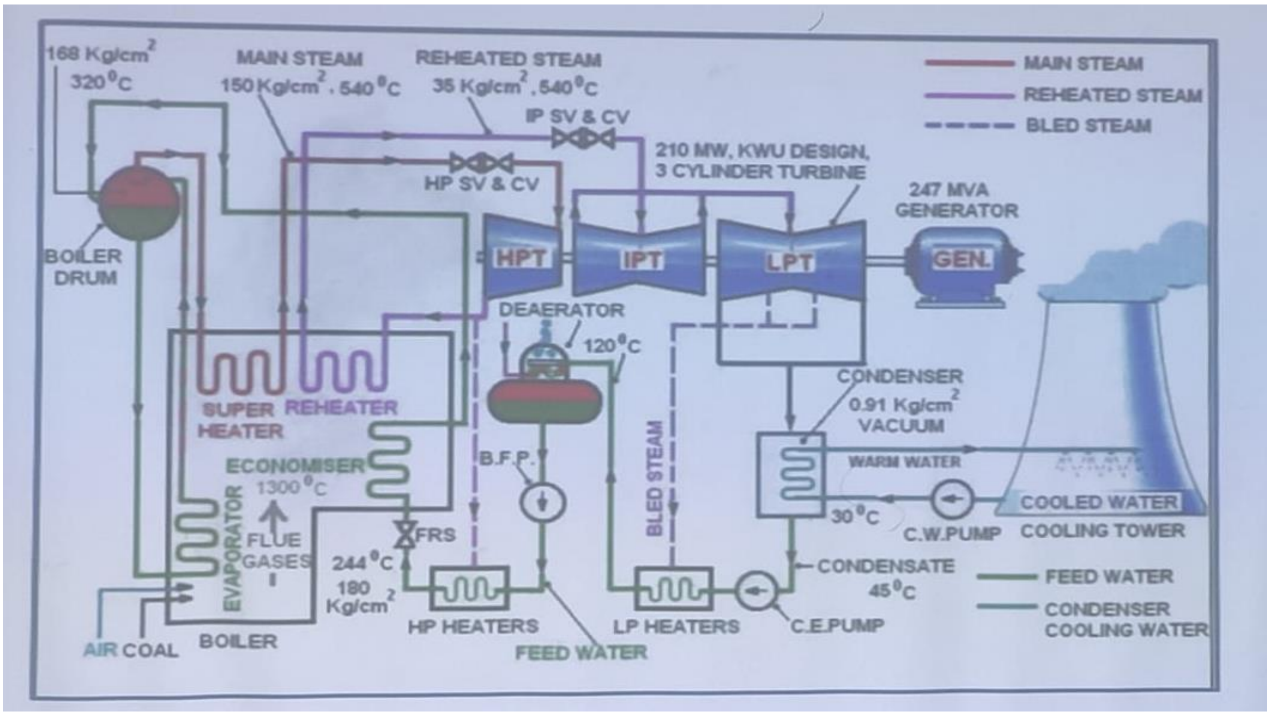
NTPC Unchahar , commissioned in 1998 in Unchahar, Raebareli, Uttar Pradesh. It's a four stage 1550 MW coal based unit.the first unit of 210 MW was commissioned in 1988. It ha total 6 unit, of which 4 are of 210 MW and 6th one is of 500 MW. The main source of water supply is Sarda Sahyak Canal and secondary is Dalmau Canal in case of shortage of water .

Stage	Unit Number	Installed Capacity (MW)	Date of Commissioning	Status
First	1	210	1988 November	Running
First	2	210	1989 March	Running
Second	3	210	1999 January	Running
Second	4	210	1999 October	Running
Third	5	210	2006 September	Running
Fourth	6	500	2017 April	Running[4]

Currently it is supplying to 9 feeders including fathepur, Raebareli, malwan and Kanpur.

The main plant equipment is supplied by BHEL.

Here the 1 to 5 unit have critical boilers and the 6th unit is super critical boiler.



PART 3: BASIC THERMAL POWER PLANT:

The thermal power plant at unchahar is based on rankine cycle which include three cycle to produce economical electricity.

1: Coal cycle: The coal, brought to the station by train or other means, travels from the **coal handling plant** by conveyer belt to the coal bunkers, from where it is fed to the **pulverizing mills** which grinds it as fine as face powder. The finely powdered coal mixed with pre-heated air is then blown into the **boiler** by fan called **Primary Air Fan** where it burns, more like a gas than as a solid in convectional domestic or industrial grate, with additional amount of air called secondary air supplied by **Forced Draft Fan.** As the coal has been grounded so finely the resultant ash is also a fine powder. Some of this ash binds together to form lumps which fall into the **ash pits** at the bottom of the furnace. The water quenched ash from the bottom of the furnace is conveyed to pits for subsequent disposal or sale. Most of ash, still in fine particles form is carried out of the boiler to the **precipitators** as dust, where it is trapped by electrodes charged with high voltage electricity. The dust is then conveyed by water to disposal areas or to **bunkers** for sale while the cleaned flue gases pass on through **ID Fan** to be discharged up the **chimney**.

2: Steam cycle: the heat released from the coal has been absorbed by the many kilometres of tubing which line the boiler walls. Inside the tubes is the **boiler feed water** which is transformed by the heat into the steam at high pressure and temperature. The steam super-heated in further tubes (Super Heater) passes to the **turbine** where it is discharged through the nozzles on the turbine blades. Just the energy of the wind turns the sail of the wind-mill, so the energy of the steam, striking the blades, makes the turbine rotate. The remaining heat is used to pre heat the air in air pre heater and pre heat the water in economiser.

The steam is then converted back to water in condenser by creating low pressure and colling through the water from canal. The water is then repressurised and heated through pump and LPH and HPH and back to boiler.

3: Water cycle: the water is taken up from sharda canal, the pre treatment like collection of big partical like leaf grass trash is being done, then chemical like clorine and sulphur is mixed and then

Rankine cycle

The Rankine cycle is a thermodynamics cycle which converts heat into work. The heat is supplied externally to a closed loop, which usually uses water as the working fluid. This cycle generates about 80% of all electricity power used throughout the world, including virtually all solar thermal, biomass, coal and nuclear power plants. It is named after William John Macqueen Rankine, a Scottish polymath.

DESCRIPTION: A Rankine cycle describes a model of the operation of a steam heat

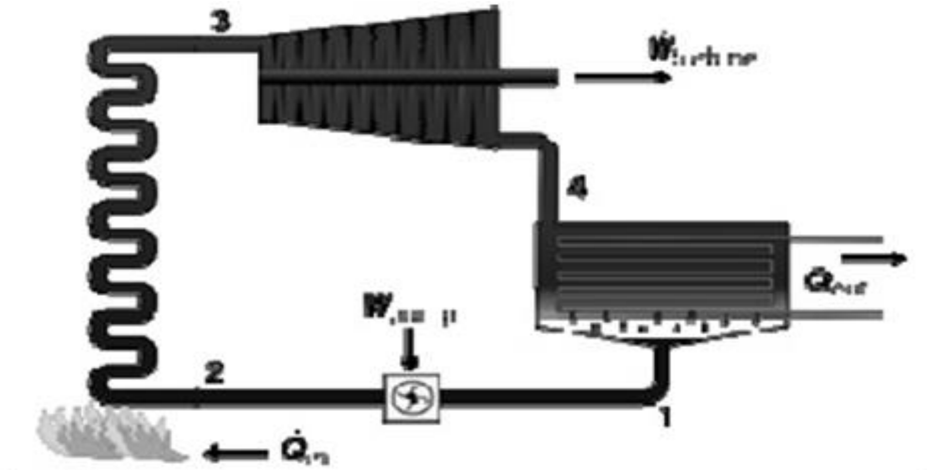


Figure 2.3 Operation of Rankine cycle

that a pump is used to pressurize liquid instead of gas. This requires about $1/100^{th}$ (1%) as much energy Engines most commonly found in power generation plants. Common heat sources for power plants using the Rankine cycle are coal, natural gas ,oil, and nuclear.

The Rankine cycle is sometimes referred to as a practical Carnot cycle as, when an efficient turbine is used, the T-S diagram will begin to resemble the Carnot cycle. The main difference is as that compressing a gas in a compressor (as in the Carnot cycle).

The efficiency of a Rankine cycle is usually limited by the working fluid. Without the pressure going super critical the temperature range the cycle can operate over is quite small, turbine

entry temperature are around 30°C. This gives a theoretical Carnot efficiency of around63% compared with an actual efficiency of 42% for a modern coal-fired power station. This low turbine entry temperature (compared with a gas turbine) is why the Rankine cycle is often used as a bottoming cycle in combined cycle gas turbine power stations. The working fluid in a Rankine cycle follows a closed loop and is re-used constantly. The water vapour and entrained droplets often seen billowing from power stations is generated by the cooling systems (not from the closed loop Rankine power cycle) and represents the waste heat that could not be converted to useful work. Note that cooling towers operate using the latent heat of vaporization of the cooling fluid. The white billowing clouds that form in cooling tower operation are the result of water droplets which are entrained in the cooling tower air flow; it is not, as commonly thought, steam. While many substances could be used in the Rankine cycle, water is usually the fluid of choice due to its favourable properties, such as nontoxic and uncreative chemistry, abundance, and low cost, as well as its thermodynamic properties. One of the principal advantages it holds over other cycles is that during the compression stage relatively little work is required to drive the pump, due to the working fluid being in its liquid phase at this point. By condensing the fluid to liquid, the work required by the pump will only consume approximately 1% to 3% of the turbine power and so give a much higher efficiency for a real cycle.
The benefit of this is lost somewhat due to the lower heat addition temperature. Gas turbines, for instance, have turbine entry temperatures approaching 1500°C.Nonetheless, the efficiencies of steam cycles and gas turbines are fairly well matched.

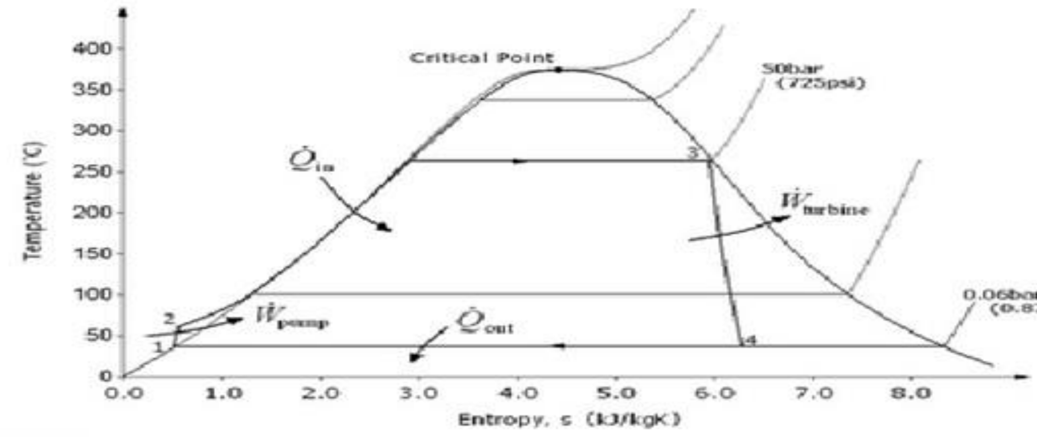


Figure 2.4 T-S diagram of a typical Rankine cycle

T-S diagram of a typical Rankine cycle operating between pressures of 0.06bar and 50bar .There are four processes in the Rankine cycle, each changing the state of the working fluid. These states are identified by number in the diagram to the right.

i. **Process 1-2:** The working fluid is pumped from low to high pressure, as the fluid is a liquid at this stage the pump requires little input energy.
ii. **Process 2-3:** The high pressure liquid enters a boiler where it is heated at constant pressure by an external heat source to become a dry saturated vapour.

iii. Process 3-4: The dry saturated vapour expands through a turbine, generating power. This decreases the temperature and pressure of the vapour, and some condensation may occur.

iv. Process 4-1: The wet vapour then enters a condenser where it is condensed at a constant pressure and temperature to become saturated liquid. The pressure and temperature of the condenser is fixed by the temperature of the cooling coils as the fluid is undergoing a phase change.

In an ideal Rankine cycle the pump and turbine would be isentropic, i.e. the pump and turbine would generate no entropy and hence maximize the net work output. Process 1-2 and 3-4 would be represented by vertical lines on the T-S diagram and more closely resemble that of the Carnot cycle.

The Rankine cycle shown here prevents the vapour ending up in the super heated region after the expansion in the turbine, which reduces the energy removed by the condensers.

Coal handling plant (CHP):

The coal is carried up to plant by railways, depending on the type of wagon we have three type of unloading process:

1: manual unloading: here the worker unload the coal from the wagon, it is very time consuming and costly also.

2: BOX in (using wagon tippler for unloading): the railway gives us 10 hour to unload the wagon , for that we separate the wagons and tippled the wagon using the wagon tippler on the rack from where it is carried to the crusher.

3: BOBR : this is very quick process, in bottom open bottom release (BOBR) technology the wagon are open from the side. Pressure is applied by the compressor to open the bottom gates of the wagon so that the coal gets released over the track hopper and wagon get unloaded quickly.

Various equipment used in CHP: -

1. **WAGON TIPPLER**: - The wagon tippler is a most important device in thermal power project. The Wagon tippler turns back the wagon at 135-degree angle and the structure of the wagon tippler is to be very heavy. Upper side of the wagon is fixed with the many angles for supporting the wagon. When the wagon is fixed on the Platform then whole platform is turned back and the coal fall down in the wagon tippler hopper. The unloading time of the Rack is 6hours

2. **PADDLE FEEDER**: - They have been installed on conveyors below the manual unloading track hopper. There are 6 nos. of paddle feeders, 3 on each conveyer. 3 Paddle Feeders of each conveyer move to and fro within a limiting range. The rotating

part of the paddle feeder is called as plough wheel. Plough wheel has 6 blades. By the rotation of the plough wheel, the coal of the track hopper gets accumulated between the blades and is discharged on the conveyor below it.

3. **VIBRATING FEEDER**: - They have been installed below the track hoppers of wagon tippler. The coal is accumulated over the vibrating feeder so by giving vibrations to the vibrating feeder we discharge the coal from track hopper to the conveyors. Their main purpose is to provide uniform feeding on the conveyors. The vibrating feeders consist of a tray to which vibrator body is fixed on the rear end.

4. **TRANSFER POINTS: -**Transfer Point is provided with flap gate and Conveyer. In transfer Point the coal is transferred from one conveyer to other conveyer.

5. **PRIMARY CRUSHER (ROTARY BREAKER): -** In Primary Crusher House, the coal breaks in Rotary Breaker. Here the coal comes from the Transfer point; breaks here and the stone fall down to a separate place. Coal is converted from 300mm to 150mm size.

   Part of the Primary Crusher House – a- Rotary Breaker b- Belt Feeder

6. **SECONDARY CRUSHER (RING GRANULATOR): -** In Secondary crusher House first the magnetic part separate from the coal and then feed to the Secondary Crusher. This Crusher breaks the coal in 20mm size and coal is sent to the Flap Gate and then feeded to the conveyer. The Secondary crusher is hammer type. H.T. motor are used for breaking of the coal. Specifications are 700KW 6.6KVMotor.

7. **CROSS BELT MAGNETIC SEPRATORS: -** They will remove the ferrous particles, which passes along with the coal. It consists of electromagnet around which a belt is moving. It is suspended from top, perpendicular to the conveyor belt at certain height. Whenever any iron particle passes below the CBMS, it is attracted by the magnet and stick to the cross belt below it. The CBMS capacity is of 50kg.

8. **METAL DETECTOR: -** The purpose of installation is to detect any metallic piece passing through the conveyor. Whenever the pieces pass below the search coil of the metal detector, it gives the trip command to the conveyor. Simultaneously, sand bag marker will fall on the conveyor belt so that the metal can be searched easily and removed.

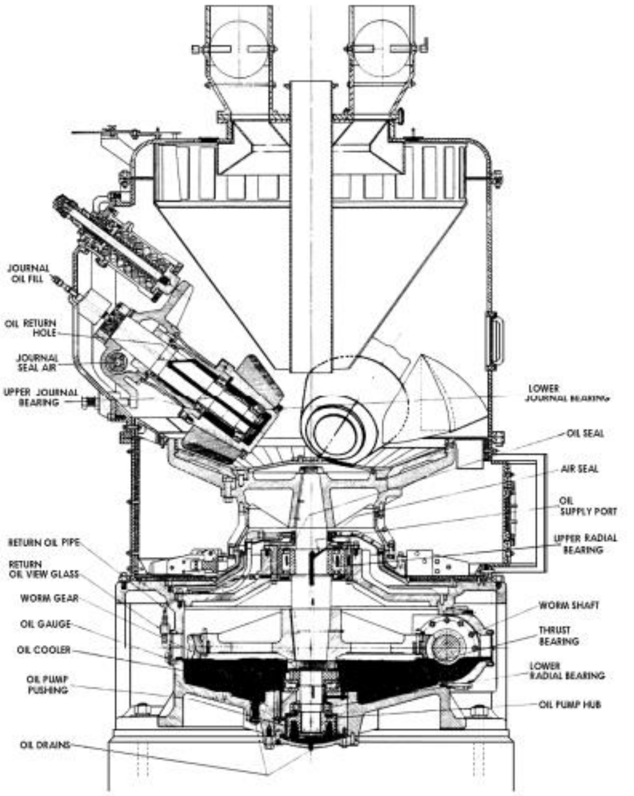
9. **STACKER/RECLAIMER: -**It is a very important device. The whole Structure of it is called Super Structure. It stacks the excessive coal and reclaims the coal on its requirement. It is a two-way device.

10. **TRANSFER TOWER*: -*** Here the coal is send to the Tipper. Transfer Tower is provided with a coal sampler.

11. **TIPPER: -** The Tipper is a three-way device to feed the coal in Bunker. It is moveable device. It is move on its track.

12. **BUNKER: -** Here the coal is collected from the tipper and stored. The capacity of the bunker for Stage-I is 4800MT & Stage-II is 8700MT

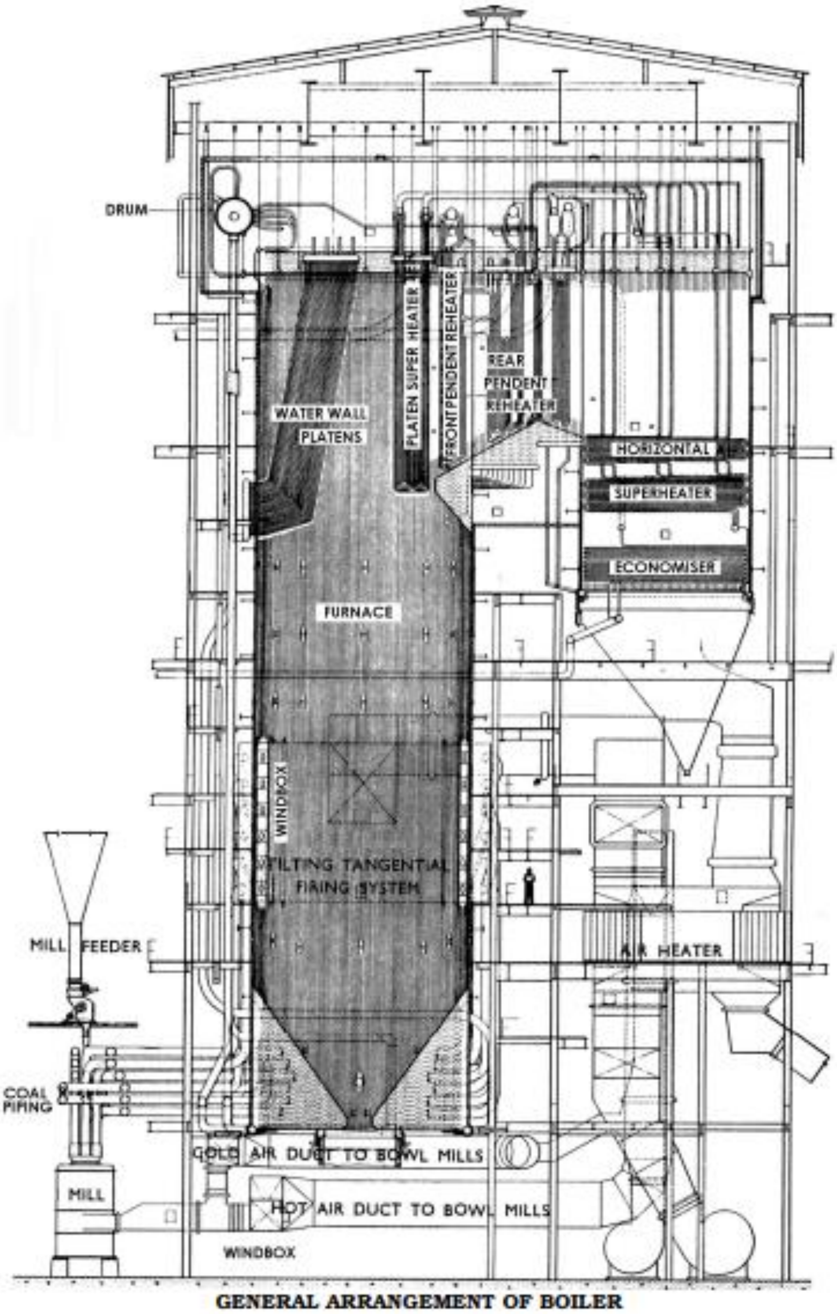
MILL:



BOWL MILL

The bowl mill consists essentially of a reduction gear box, mill side and liner assembly forming air and mill reject chamber, revolving bowl and scrapper, separator body with separator body liner assembly, grinding rolls and journal assembly, pressure spring assembly, classifier, multi port outlet assembly, central feed pipe and separating inner cone. Pre-crushed coal is fed by the RC Feeder through central feed pipe into the revolving bowl of the bowl mill. Centrifugal force feeds the coal uniformly between the bullring and independently rotating spring-loaded rolls to travel through the outer periphery of the bowl. The springs, which load the rolls, impart the pressure necessary for grinding. The partially pulverised coal continues up over the edge of the bowl due to centrifugal force. Hot and cold primary air mixed in the dustings enter the mill side housing below the bowl and is directed upwards past the bowl around the separator body liners which carry pulverised coal upwards into the deflector openings at the top of the inner cone.

Boiler part:



GENERAL ARRANGEMENT OF BOILER

Fresh steam from boiler is supplied to the turbine through the emergency stop valve. From the stop valves steam is supplied to control valves situated on H.P. cylinders on the front bearing end. After expansion through 12 stages at the H.P. cylinder steam flows back to boiler for reheating and reheated steam from the boiler cover to the intermediate pressure turbine trough two interceptor valves and four control valves mounted on the I.P. turbine. After flowing trough I.P. turbine steam enters the middle part of the L.P. turbine through cross over pipes. In L.P. turbine the exhaust steam condenses in the surface condensers welded directly to the exhaust part of L.P. turbine. The selection of extraction points and cold reheat pressure has been done with a view to achieve the highest efficiency. These are two extractions from H.P. turbine, four from I.P. turbine an done from L.P. turbine. Steam at 1.10 to 1.03 g/sq cm Abs is supplied for the gland sealing. Steam for this purpose is obtained from deaerator through a collection where pressure of steam is regulated. From the condenser condensate is pumped with the help of 3*50% capacity condensate pumps to deaerator through the low pressure regenerative equipments.

I. FURNACE

- Furnace is primary part of boiler where the chemical energy of the fuel is converted to thermal energy by combustion. Furnace is designed for efficient and complete combustion. Major factors that assist for efficient combustion are amount of fuel inside the furnace and turbulence, which causes rapid mixing between fuel and air. In modern boilers, water furnaces are used.

II. BOILER DRUM

Drum is of fusion-welded design with welded hemispherical dished ends. It is provided with stubs for welding all the connecting tubes, i.e. down comer, risers, pipes, saturated steam outlet. The function of steam drum internals is to separate the water from the steam generated in the furnace walls and to reduce the dissolved solid contents of the steam below the prescribed limit of 1ppm and also take care of the sudden change of steam demand for boiler.

- The secondary stage of two opposite banks of closely spaced thin corrugated sheets, which direct the steam and force the remaining entertained water against the corrugated plates. Since the velocity is relatively low this water does not get picked up again but runs down the plates and off the second stage of the two steam outlets.
- From the secondary separators the steam flows upwards to the series of screen dryers, extending in layers across the length of the drum. These screens perform the final stage of the separation.
- Once water inside the boiler or steam generator, the process of adding the latent heat of vaporization or enthalpy is underway. The boiler transfers energy to the water by the chemical reaction of burning some type of fuel.
- The water enters the boiler through a section in the convection pass called the economizer. From the economizer it passes to the steam drum. Once the water enters the steam drum it goes down the down comers to the lower inlet water wall

headers. From the inlet headers the water rises through the water walls and is eventually turned into steam due to the heat being generated by the burners located on the front and rear water walls (typically). As the water is turned into steam/vapour in the water walls, the steam/vapour once again enters the steam drum.

- The steam/vapour is passed through a series of steam and water separators and then dryers inside the steam drum. The steam separators and dryers remove the water droplets from the steam and the cycle through the water walls is repeated. This process is known as natural circulation.
- The boiler furnace auxiliary equipment includes coal feed nozzles and igniter's guns, so out blowers, water lancing and observation ports (in the furnace walls) for observation of the furnace interior. Furnace explosions due to any accumulation of combustible gases after a trip out are avoided by flushing out such gases from the combustion zone before igniting the coal.
- The steam drum (as well as the super heater coils and headers) have air vents and drains needed for initial start-up. The steam drum has an internal device that removes moisture from the wet steam entering the drum from the steam generating tubes. The dry steam then flows into the super heater coils. Geothermal plants need no boilers incest they use naturally occurring steam sources.
- Heat exchangers may be used where the geothermal steam is very corrosive or contains excessive suspended solids. Nuclear plants also boil water to raise steam, either directly passing the working steam through the reactor or else using an intermediate heat exchanger.

III. WATER WALLS:

Water flows to the water walls from the boiler drum by natural circulation. The front and the two side water walls constitute the main evaporation surface, absorbing the bulk of radiant heat of the fuel burnt in the chamber. The front and rear walls are bent at the lower ends to form a water-cooled slag hopper. The upper part of the chamber is narrowed to achieve perfect mixing of combustion gases. The water wall tubes are connected to headers at the top and bottom. The rear water wall tubes at the top are grounded in four rows at wider pitch forming the grid tubes.

IV. REHEATER:

Reheater is used to raise the temperature of steam from which a part of energy has been extracted in high-pressure turbine. This is another method of increasing the cycle efficiency. Reheating requires additional equipment i.e. heating surface connecting boiler and turbine pipe safety equipment like safety valve, non return valves, isolating valves, high pressure feed pump, etc; Reheater is composed of two sections namely the front and the rear pendant section, which is located above the furnace arc between water-cooled, screen wall tubes and rear wall tubes.

V. SUPERHEATER:

- Whatever type of boiler is used, steam will leave the water at its surface and passing to the steam space. Steam formed above the water surface in a shell boiler is always saturated and become superheated in the boiler shell, as it is constantly. If superheated steam is required, the saturated steam must pass through a super heater. This is simply a heat exchanger where additional heat is added to the steam.
- In water-tube boilers, the super heater may be an additional pendant suspended in the furnace area where the hot gases will provide the degree of superheat required. In other cases, for example in CHP schemes where the gas turbine exhaust gases are relatively cool, a separately fired super heater may be needed to provide the additional heat.

VI. ECONOMIZER:

- The function of an economizer in a steam-generating unit is to absorb heat from the flue gases and add as a sensible heat to the feed water before the water enters the evaporation circuit of the boiler.
- Earlier economizer were introduced mainly to recover the heat available in the flue gases that leaves the boiler and provision of this addition heating surface increases the efficiency of steam
generators. In the modern boilers used for power generation feed water heaters were used to increase the efficiency of turbine unit and feed water temperature.
- Use of economizer or air heater or both is decided by the total economy that will result in flexibility in operation, maintenance and selection of firing system and other related equipment. Modern medium and high capacity boilers are used both as economizers and air heaters. In low capacity, air heaters may alone be selected.
- Stop valves and non-return valves may be incorporated to keep circulation in economizer into steam drum when there is fire in the furnace but not feed flow. Tube elements composing the unit are built up into banks and these are connected to inlet and outlet heaters.

VII. AIR PREHEATER:

- Air pre heater absorbs waste heat from the flue gases and transfers this heat to incoming cold air, by means of continuously rotating heat transfer element of specially formed metal plates. Thousands of these high efficiency elements are spaced and compactly arranged within 12 sections. Sloped compartments of radially divided cylindrical shell called the rotor. The housing surrounding the rotor is provided with duct connecting both the ends and is adequately scaled by radial and circumferential scaling.

- Special sealing arrangements are provided in the air pre heater to prevent the leakage between the air and gas sides. Adjustable plates are also used to help the sealing arrangements and prevent the leakage as expansion occurs. The air preheater heating surface elements are provided with two types of cleaning devices, soot blowers to normal devices and washing devices to clean the element when soot blowing alone cannot keep the element clean.

II. ASH HANDLING PLANT

The widely used ash handling systems are:

i. Mechanical Handling System

ii. Hydraulic System

iii. Pneumatic System

iv. Steam Jet System

The hydraulic system carried the ash with the flow of water with high velocity through a channel and finally dumps into a sump. The hydraulic system is divided into a low velocity and high velocity system. In the low velocity system the ash from the boilers falls into a stream of water flowing into the sump. The ash is carried along with the water and they are separated at the sump. In the high velocity system a jet of water is sprayed to quench the hot ash. Two other jets force the ash into a trough in which they are washed away by the water into the sump, where they are separated. The molten slag formed in the pulverized fuel system can also be quenched and washed by using the high velocity system. The advantage of this system are that its clean, large ash handling capacity, considerable distance can be traversed, absence of working parts in contact with ash.

Fly Ash Collection:

Fly ash is captured and removed from the flue gas by electrostatic precipitators or fabric bag filters (or sometimes both) located at the outlet of the furnace and before the induced draft fan. The fly ash is periodically removed from the collection hoppers below the precipitators or bag filters. Generally, the fly ash is pneumatically transported to storage silos for subsequent transport by trucks or railroad cars.

Bottom Ash Collection and Disposal:

At the bottom of every boiler, a hopper has been provided for collection of the bottom ash from the bottom of the furnace. This hopper is always filled with water to quench the ash and clinkers falling down from the furnace. Some arrangement is included to crush the clinkers and for conveying the crushed clinkers and bottom ash to a storage site.

STEAM TURBINE:

A steam turbine is a mechanical device that extracts thermal energy from pressurized steam and converts it into useful mechanical work. From a mechanical point of view, the turbine is ideal, because the propelling force is applied directly to the rotating element of the machine and has not as in the reciprocating engine to be transmitted through a system of connecting links, which are necessary to transform a reciprocating motion into rotary motion. Hence since the steam turbine possesses for its moving parts rotating elements only if the manufacture is good and the machine is correctly designed, it ought to be free from out of balance forces. If the load on a turbine is kept constant the torque developed at the coupling is also constant. A generator at a steady load offers a constant torque. Therefore, a turbine is suitable for driving a generator, particularly as they are both high-speed machines. A further advantage of the turbine is the absence of internal lubrication. This means that the exhaust steam is not contaminated with oil vapour and can be condensed and fed back to the boilers without passing through the filters. It also means that turbine is considerable saving in lubricating oil when compared with reciprocating steam engine of equal power. A final advantage of the steam turbine and a very important one is the fact that a turbine can develop many time the power compared to a reciprocating engine whether steam or oil.

STEAM CYCLE:

The thermal(steam) power plant uses a dual(vapor + liquid) phase steam, regenerative feed water heating and re heating of steam cycle. It is a closed cycle to enable the working fluid (water) to be used again and again. The cycle used is 'Rankine cycle' modified to include superheating of

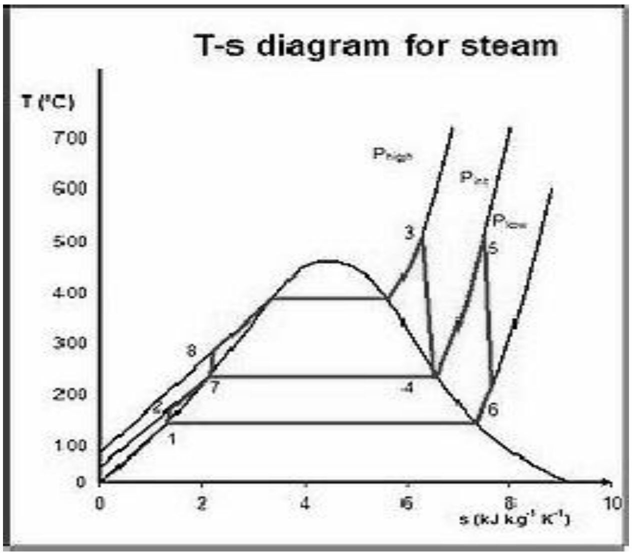


Figure 3.9 Steam cycle diagram

MAIN TURBINE:

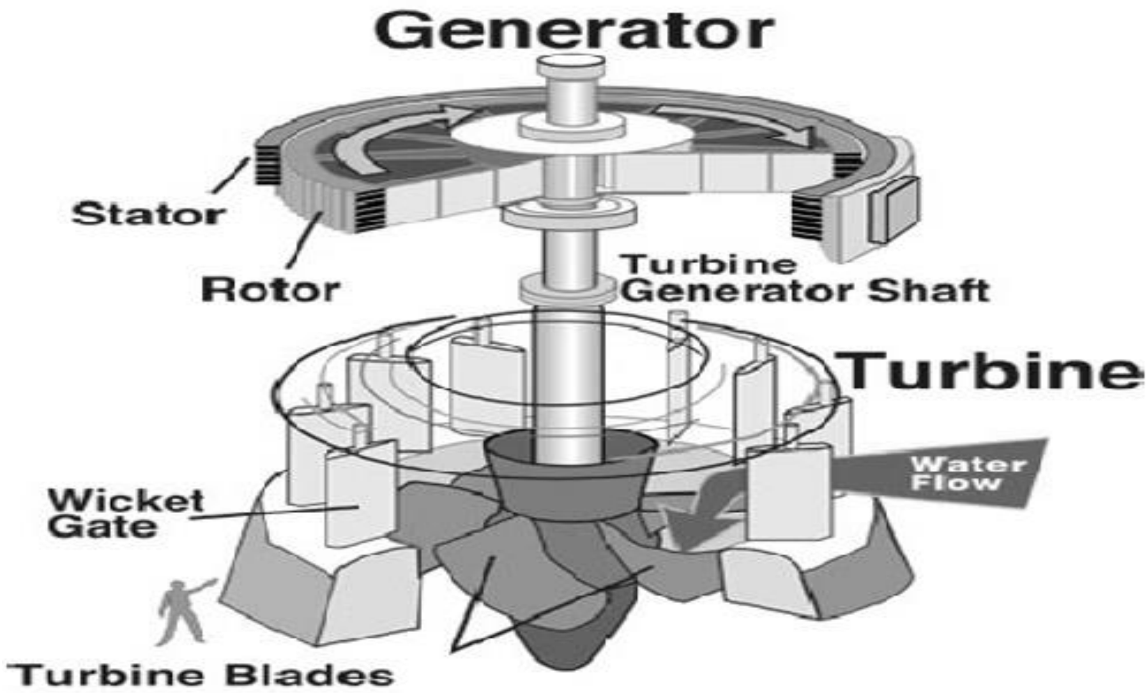
The 210MW turbine is a tandem compounded type machine comprising of H.P and I.P cylinders. The H.P turbines comprise of 12 stages, I.P turbine has 11 stages and the L.P turbine has 4 stages of double flow.

The H.P and I.P turbine rotors are rigidly compounded and the L.P. motor by the lens type semi flexible coupling. All the three rotors are aligned on five bearings of which the bearing no. 2 is combined with the thrust bearing.

The main superheated steam branches off into two streams from the boiler and passes through the emergency stop valve and control valve before entering the governing wheel chamber of

the H.P turbine. After expanding in the 12 stages in the H.P turbine the steam is returned in boiler for reheating.

The reheated steam for the boiler enters the I.P turbine via the interceptor valves and control valves and after expanding enters the L.P turbine stage via 2 nos of cross-over pipes. In the L.P. stage the steam expands in axially opposite direction to counter act the trust and enters the condensers placed below the L.P turbine. The cooling water flowing throughout the condenser tubes condenses the steam and the condensate collected in the hot well of the condenser. The condensate collected is pumped by means of 3*50% duty condensate pumps through L.P heaters to deaerator from where the boiler feed pump delivers the water to boiler through H.P heaters thus forming a close cycle.



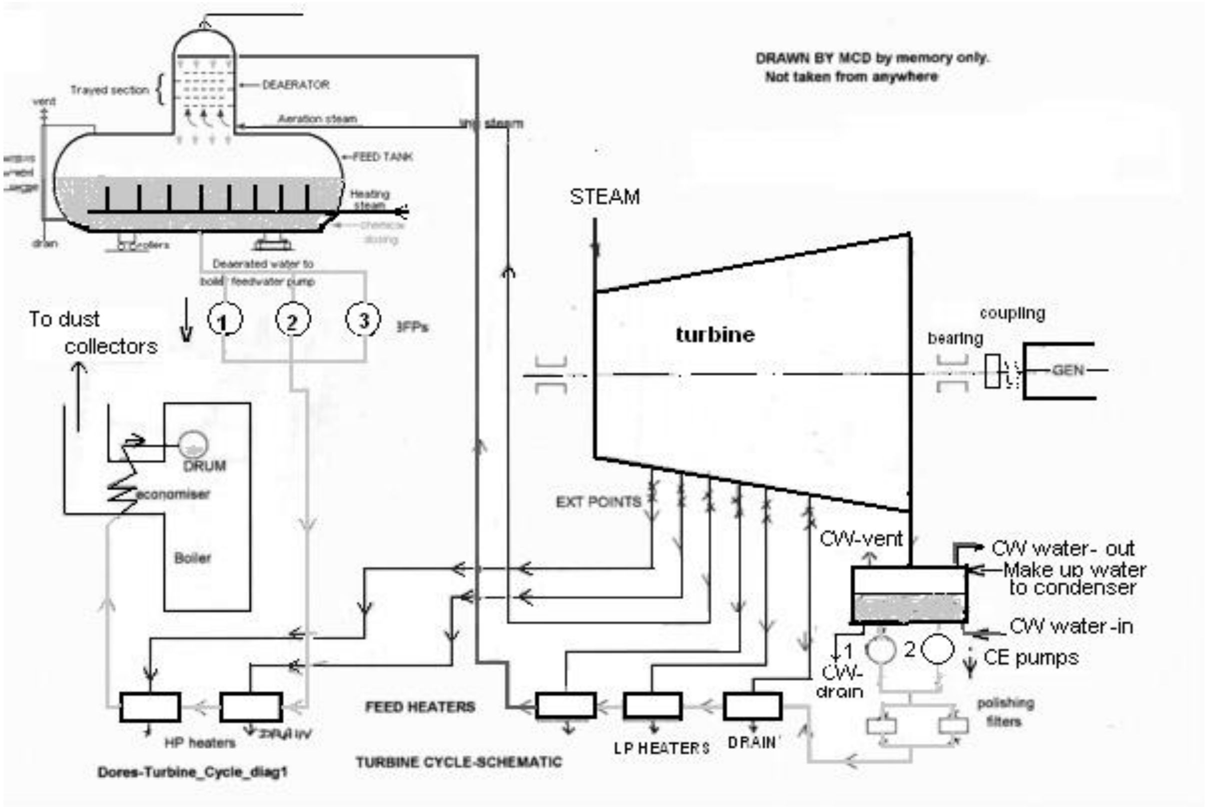


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Figure 3.10 Turbine & Turbine Cycle

The selection of extraction points and cold reheat pressure has been done with a view to achieve a high efficiency. These are two extractors from H.P turbine, four from I.P turbine and one from L.P turbine. Steam at1.10 and 1.03 g/sq.cm .As is supplied for the gland scaling. Steam for this purpose is obtained from deaerator through a collection where pressure of steam is regulated. From the condenser, condensate is pumped with the help of 3*50% capacity condensate pumps to deaerator through the low-pressure regenerative equipments. Feed water is pumped from deaerator to the boiler through the H.P. heaters by means of 3*50% capacity feed pumps connected before the H.P. heaters.

TURBINE COMPONENTS:

- Casing.
- Rotor
- Blades
- Sealing System
- Stop & control valves
- Coupling & Bearing
- Barring Gear

TURBINE CASINGS:

HP Turbine Casing:

- Outer casing: a barrel-type without axial or radial flange.
- Barrel-type casing suitable for quick startup and loading.

- The inner casing- cylindrically, axially split.
- The inner casing is attached in the horizontal and vertical planes in the barrel casing so that it can freely expand radially in all the directions and axially from a fixed point(HP- inlet side)

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I.P Turbine Casing:

- The casing of the IP turbine is split horizontally and is of double-shell construction.
- Both are axially split and a double flow inner casing is supported in the outer casing and carries the guide blades.

ROTORS:

HP Rotor:

- The HP rotor is machined from single Cr-Mo-V steel forging with integral discs.
- In all the moving wheels, balancing holes are machined to reduce the pressure difference across them, which results in reduction of axial thrust.
- First stage has integral shrouds while other rows have surroundings, riveted to the blades are periphery.

I.P Rotor:

- The IP rotor has seven discs integrally forged with rotor while last four discs are shunk fit.

BLADES:

- Most costly element of the turbine.
- Blades fixed in stationary part are called guide blades/ nozzles and those fitted inmoving part are called rotating/working blades.
- Blades have three main part:
  1. Aerofoil: working part.
  2. Root.
  3. Shrouds.
- Shroud is used to prevent steam leakage and guide steam to next set of moving blades.

VACUUM SYSTEM:

This comprises of:

Condenser: 2 for 200MW unit at the exhaust of L.P turbine.

Ejectors: One starting and two main ejectors connected to the condenser located near the turbine.

C.W Pumps: Normally two per unit of 50% capacity.

CONDENSER:

There are two condensers entered to the two exhausters of the L.P.

turbine.These are surface-type condensers with two pass arrangement. Cooling water pumped into each condenser by a vertical C.W. pump through the inlet pipe.

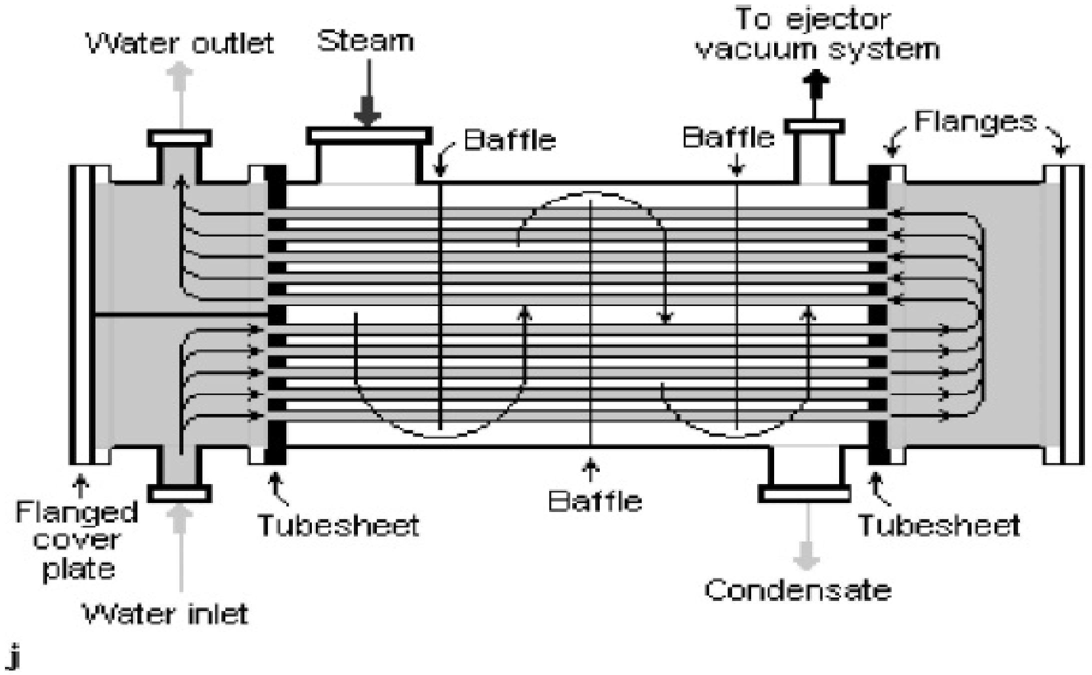

Figure 3.11 A Typical Water Cooled Condenser

Water enters the inlet chamber of the front water box, passes horizontally through brass tubes to the water tubes to the water box at the other end, takes a turn, passes through the upper cluster of tubes and reaches the outlet chamber in the front water box. From these, cooling water leaves the condenser through the outlet pipe and discharge into the discharge duct. Steam exhausted from the LP turbine washes the outside of the condenser tubes, losing its latent heat to the cooling water and is connected with water in the steam side of the condenser. This condensate collects in the hot well, welded to the bottom of the condensers.

EJECTORS:

There are two 100% capacity ejectors of the steam eject type. The purpose of the ejector is to evacuate air and other non-condensation gases from the condensers and thus maintain the vacuum in the condensers. The ejector has three compartments. Steam is supplied generally at a pressure of 4.5 to 5 kg/cm² to the three nozzles in the three compartments. Steam expands in the nozzle thus giving a high-velocity eject which creates a low-pressure zone in the throat of the eject. Since the nozzle box of the ejector is connected to the air pipe from the condenser, the air and pressure zone. The working steam which has expanded in volume comes into contact with the cluster of tube bundles through which condensate is flowing and gets condensed thus after aiding the formation of vacuum. The non-condensing gases of air are further sucked with the next stage of the ejector by the second nozzle. The process repeats itself in the third stage also and finally the steam-air mixture is exhausted into the atmosphere through the outlet.

Deaerator :

The presence of certain gases, principally oxygen, carbon dioxide and ammonia, dissolved in water is generally considered harmful because of their corrosive attack on metals, particularly at elevated temperatures. One of the most important factors in the prevention of internal corrosion in modern boilers and associated plant therefore, is that the boiler feed water should be free as far as possible from all dissolved gases especially oxygen. This is achieved by embodying into the boiler feed system a deaerating unit, whose function is to remove

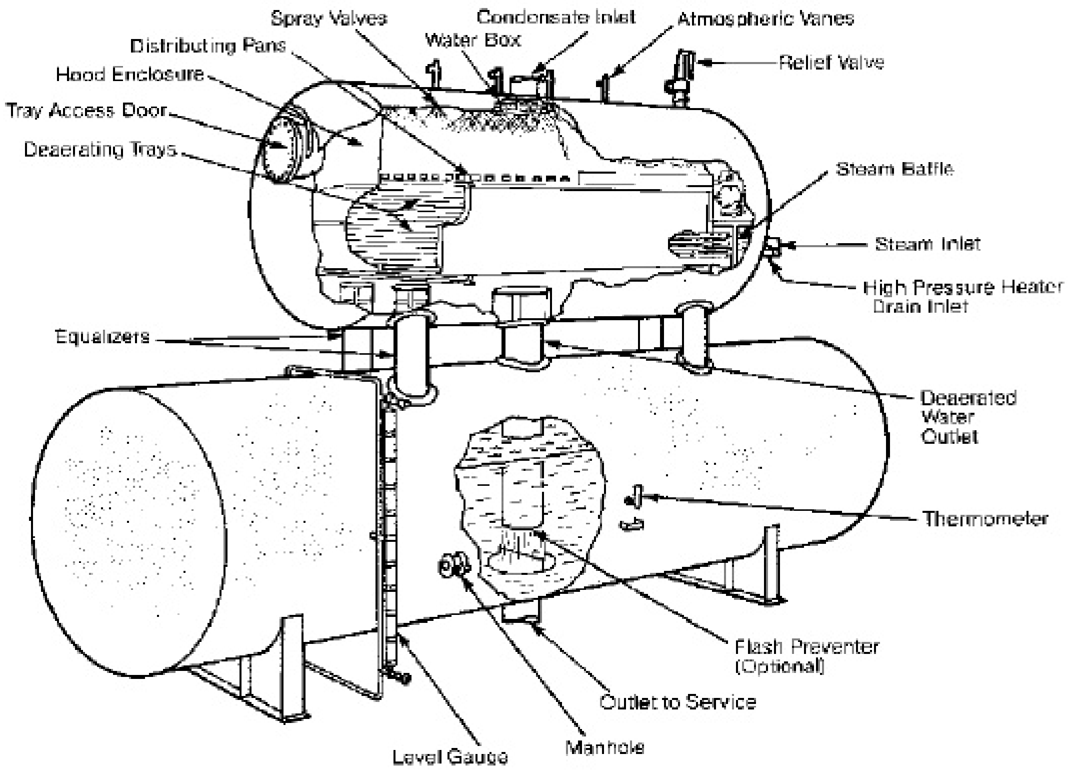

Figure 3.12 a Deaerator

PRINCIPAL OF DEAERATION:

It is based on following two laws.

- Henry's Law
- Solubility

The Deaerator comprises of two chambers:

- Deaerating column
- Feed storage tank

Boiler Feed Pump:

This pump is horizontal and of barrel design driven by an Electric motor through a hydraulic coupling. All the bearings of pump and motor are forced lubricated by a suitable oil lubricating system with adequate protection to trip the pump if the lubrication oil pressure falls below a preset value.

3.2.2 COAL HANDLING DEPARTMENT:

As coal is the prime fuel for thermal power plant, adequate emphasis should be given for its proper handling and storage. Also it is equally important to have a sustained flow of this fuel to maintain uninterrupted power generation. Coal is used as the fuel because of the following advantages

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Advantages of coal as fuel:

- Abundantly available in India
- Low Cost
- Technology for power generation well developed.

Easy to handle, transport, store and use.

Generator:

The generator that has been used her I of 200 MW , three phase horizontally mounted, 2 pole cylindrical rotor type, synchronous machine driven by steam turbine, here the stator is been cooled by demineralized water flowing through hollow conductor while the rotor is cooled by hydrogen gas maintained inside the machine, it is provided with both static thyristor controlled excitation system fed from terminal of machine and also with the pilot excitor system. Four hydrogen cooler are provided to cool the hydrogen gas provided inside the machine.

The seal oil system is provided to prevent the leakage of hydrogen from generator housing. Ring type shell seals are provided at both end of the generator. During normal operation the ac seal oil pump draw the seal oil from the seal oil tank and feed it into the shaft seal via 2*100% capacity cooler and 2*100% capacity filter. The pressure is maintain at 1.3 kg/cm2 over the hydrogen pressure

Capability of the generator:

The generator can provide 247 MVA continuously at 15.75 kv terminal voltage and stator current 9050A , output of the generator at various lagging and leading power factor are as per generator capability curve. Generator can develop the rated power when the terminal voltage change within +- 5% of the rated voltage (approx. 14.96 KV to 16.54 KV) and stator current should within the limit of 8600 to 9500A.

The frequency of the generator must be within the limit of 47.5 to 53.5 Hz(+-5% deviation from 50 Hz)

Operation under unbalance load:

The turbo generator is capable of operating continuously on the unbalance system loading provided that continuously negative phase sequence current during this period shall not exceed 5% of the rated stator current. if the unbalance exceed the above the permissible limit, measure shall be taken immediately to eliminate or reduce the extent of unbalance within 3 to 5 minutes or the unit must be tripped down if time exceed.

Asynchronous operation

Asynchronous operation of the generator on the field failure is allowed depending upon the permissible degree of the voltage dip and acceptability of the system from the stability point of view. During field failure the field suppression shall be cut out from the circuit and active load on the generator shall be decreased to 60% of the rated value within 30 sec and 40% in the following 1.5 minutes. At this the generator can operate only op to 15 min from the exciatation failure, within this the step should be taken to estabilish the reason of field failure to normalcy or should be switch to reserve excitation.

Motoring action: motoring of the turbo generator is permissible within the limitation of the failure.

STATIC EXCITATION SYSTEM:

Excitation system is provided to supply the dc current to the field of the generator. For this the ac power is tapped from the generator terminal and step down and then rectified by fully controlled rectifier and then fed to the generator field as excitation power to control the generator output voltage. Any deviation in the generator terminal voltage is sensed by an error detector and cause the voltage regulator to advance or retard the firing angle of the thyristor thereby controlling the field excitation.

The static excitation system consist of:

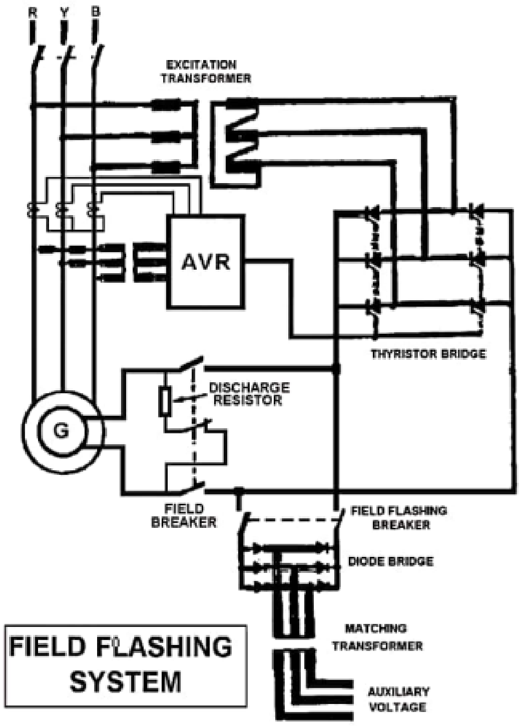
Rectifier transformer:

The transformer get the supply from the ac power and step down and secondary is connected to thyristor bridge to change it to dc and fed to the field of the generator.

Thyristor converter:

The converter is assembled in one or more no. depending on the no. of thyristor bridge is connected in parallel. It is so designed if one of the bridge fails during the operation the other have the capability to give the supply to the field of the generator.

Field flashing circuit



Since it is difficult to start the excitation system with the residual voltage at the nominal speed, a field flashing circuit is provided to overcome this problem.

Field breaker and field discharge equipment

For a rapid de excitation of synchronous and complete isolation of the field from the thyristor bridge, a field breaker is provided, in case of electric fault the field breaker is provides protection by isolating dc source from the field.

Automatic voltage converter

It is the main component of the motor, it contain the following things:

Error detector and amplifier:

The voltage after stepping down from the transformer fed into the AVRs, the ac then rectified and compared against a highly stabilized reference value and any difference in the value is amplified in different stage of amplification.

Grid control unit:

The output of the avr is fed to the grid control unit , it get its synchronous ac reference through a filter circuit and generated a row od pulse whose position depends on the dc input from the avr.

Pulse amplifier:

The pulse output of the grid control is amplified further at an intermediate stage of amplification , is also known as pulse coupling stage.

Pulse final stage:

The unit receive the pulse and transmit through the pulse transformer to the gate of the thyristor. The step pulse insure the simultaneous firing of the several thyristor in parallel.

Manual control channel :

There is a seprate manual control channel is provided where the controlling dc signal is taken from the stabilized dc voltage through a motor operated potentiometer. The dc signal is fed to a separate grid control unit whose output pulse after being amplified at an intermediate stage can be fed to the final pulse . when one channel is working the other channel is remained blocked.

Follow up unit:

A pulse comparison unit detect any difference in the position of the pulse with the help of a follow up unit in actuate motor operated potentiometer on the manual channel to turn in direction so as to eliminate the difference.

Limit controller:

The following limit controller used in the static excitation system :

Stator current limiter

Rotor current limiter

Rotor angle limiter

EXCITATION SYSTEM PROTECTION:

Excitation system protection :

Excitation transformer protection:

The protection unit for the excitation transformer is normally mounted on the swing frame of the regulator cubicle. It consist two over current relay whith adjustable range. The current supply for the relay is made through dc converter. Which receive its input supply from the battery through the filter circuit.

Converter protection:

Fuses:

Each thyristor is connected to a fast acting semiconductor fuse to protect in case of over current .

Resistor / capacitor:

Network across to each thyristor for protection against hole storage affect.

Airflow monitoring

Since the converter are air cooled by fans the air flow is monitored by airflow relay.

Redundancy

The thyristor bridge are designed such that in case of failure of one . the remaining bridges will be adequate to provide full load output with field flashing.

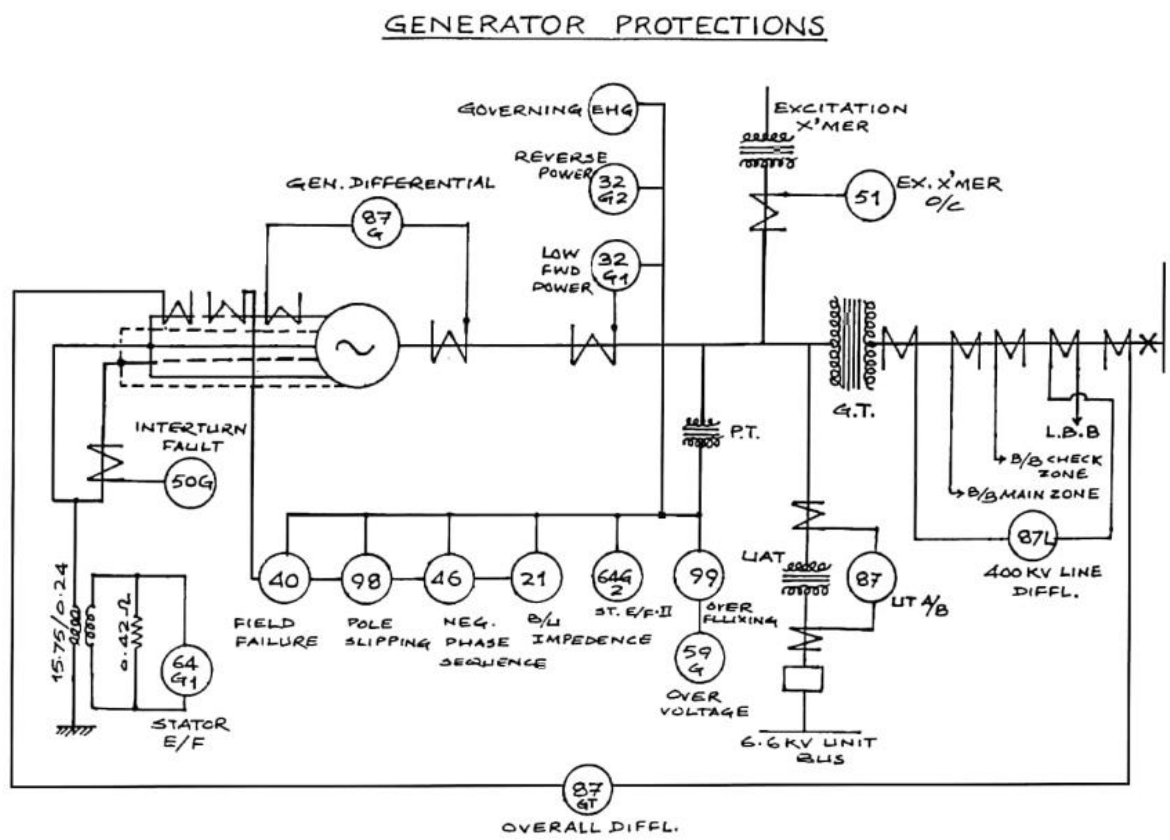
Isolator:

Isolator are provided on the input and output side of the converter to enable replacement of the defective thyristor under running load.

AVR protection :

All dc power supplies receives their input AC supply through miniature circuit breaker with thermal overload relay.

GENRATOR PROTECTION :



The core of the power plant is generator only, therefore to protect it there are several measure are taken during abnormal operating condition, during such condition the unit must be trip down immediately.

Task of the protective system:

Detect abnormal condition or defect.

Limit its scope by switching to isolate the defect.

Alarm the operating staff.

Unload and/or trip the machine immediately .

Type of protection:

Electrical protection

1: differential protection:

A: generator differential :

A direct short circuit between the different phases of thr winding causes fault and extensive damage, as a result there is distinct difference between the current at the neutral and terminal end of the winding. This difference is detected by differential relay.

The relay used is to designed 87G and is CAG 34.5 amp type. It is set to operate 10%(0.5 amp) relay current which corresponds to 1000 amp fault current.

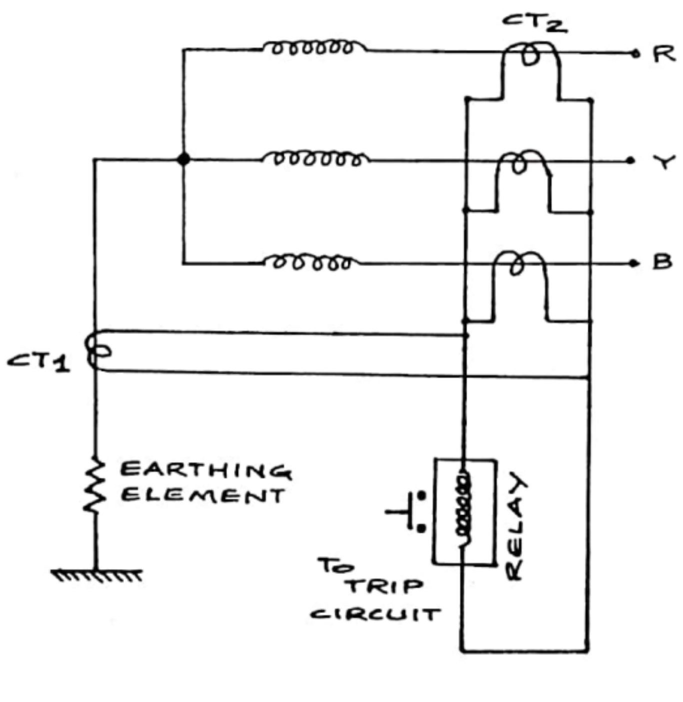
B: UATS differential :

Since UAT are connected directly to the stator windings. It has been provided with biased differential protection in a similar circulating scheme. The relay are designed 87UAT and 87UTB are DTH 31 type.

C: G.T. overhead line differential:

The 400 KV bushing of generator transformer are connected to switch yard double moose conductor overhead lines. Any fault in these lines are detected by overhead linedifferential protection.

GT restricted earth fault



GT RESTRICTED EARTH FAULT

The HV windings of the generator transformer is star connected and the neutral is solidity earthed. This meant for complete protection of the hv winding of the transformer . the delta side of the transformer is considered to be the part of the generator and it s earth fault would cause the fault current to flow toward the generator neutral and be detected as generator earth fault.

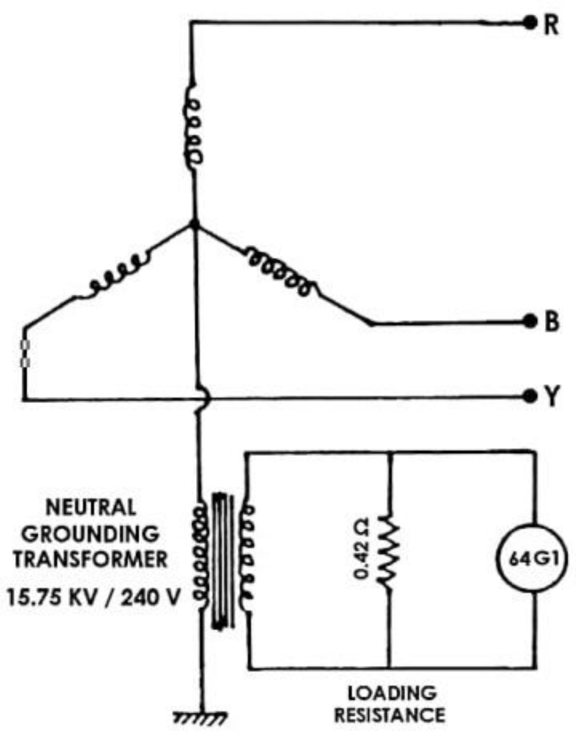
The relay is used for this purpose us 64 GT and is CAG 14 type.

GT overall differential :

Since generator transformer is directly connected to the stator winding it would be proper to include the transformer windings associated bus ducts including thos for UAT HV side and conductor in a similar circulating current protection scheme.

EARTH FAULT PROTECTION :

Stator earth fault:



Stator Earth Fault (Main)

The generator neutral earthed through primary winding of neutral grounding transformer of the rating 50KVA 15.75/0.24KV ratio. The secondary windings of the transformer is shorted through loading resistance of 0.42 ohm. For an earth fault in the generator the E/F current flows in the primary of the neutral grounding transformer, as result a voltage across the resistor is developed which activate stator E/F sensing relay.

The reason for this kind of protection is due to mechanical damage resulting from the insulation fatigue, creepage of the conductor bases, vibration of the conductor or other fitting of the cooling system.

Stator standby earth fault:

The relay is connected across an open delta of the generator PT secondary windings, when there is no E/F, the sum of the phase voltage of the generator and hence the voltage across the relay is zero, the voltage across the point a and b will assume a positive value when one phase voltage of the generator drop because of earth fault on that phase.

Rotor earth fault:

Ground leakage in the rotor circuit of the generator does not adversely affect operation, if it occur only at one point, danger arises if a second fault occurs causing the current to be deliveredin part at least from interventing turns , which can burn the conductor causing serve damage to the rotor , if large portion of winding is sorted , the field flux pattern may change causing flux concentration at one pole and wide dispensation at the other.

The rotor E/F protection is provided by monitoring the IR value of the rotor winding IR value < 5.5 kilo ohm.

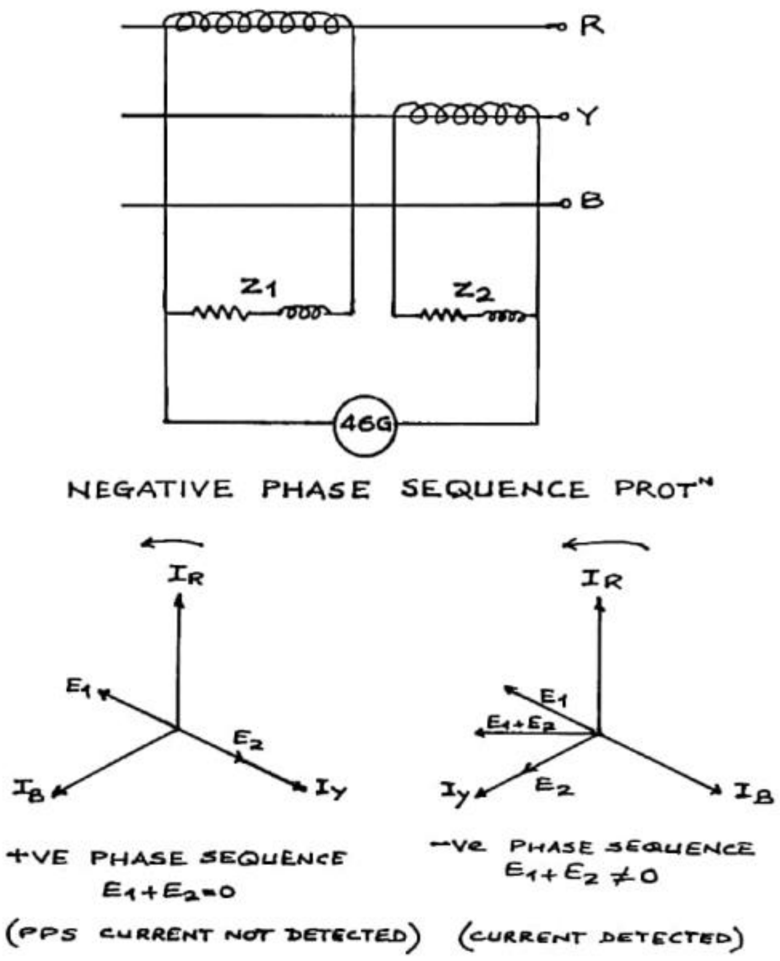
Stator inter turn fault:

When leakage occur between the turns in the same phase of the winding the induced voltage is reduce and there will be a voltage difference between the center of the terminal voltage triangle and the neutral of the machine , therefore in a generator having one winding per phase, a voltae transformer is connected between each phase terminal and the neutral of the winding , the secondary transformer leads beings connected to open delta, when inter turn leakage occur at the end of the open delta , it is detected by the polarised voltage relay.

For generator having several parallel windings per phase, the neutral end are connected together to form , as many as neutral as there are parallel windings per phase. These neutral are then then joined through a current transformer to current relays, or through voltage transformer to voltage relay, if inter turn fault occur in the machine, the current transformer carries a transient current or alternatively, voltage transformer produce a voltage thereby picking up relay and tripping the generator.

The relay is designated 50GI, and is cag 14 type 5 amp attached armature.

NEGATIVE PHASE SEQUENCE:



A three phase balance load produce a reaction field , which is constant and rotates synchronously with rotor field system. Any unbalance condition could resolved into a positive, negative or zero sequence component do not produce armature reaction. The positive sequence component is similar to balance load, the zero sequence component do not produce armature reaction. The negative sequence component is similar to that of the positive sequence but the resulting reaction field rotates in the opposite direction . hence the flux produced by negative phase sequence component is similar to that of the positive sequence but resulting reaction field rotates in the opposite direction. Hence the flux produced by negative sequence current cut the rotor at double seed, so produce double frequency current. This result in severe heating of the rotor windings.

The relay is used is designated 45 and is of solid state design and CTNM type.

GENERATOR BACKUP IMPEDANCE PROTECTION:

Three-phase zone impedance is provided for the backup protection of the generator against external three phases and phase-to-phase fault in 400 KV system. The zone of impedance relay should be extended beyond 400kv switchyard and it should be connected to trip the generator after a time delay of 1 to 1.5 second so that the generator is tripped only when 400kv protection had not cleared the fault even in the second zone. The relay used is designated 21G.

LOSS OF EXCITATION :

Failure of the field system leads to losing of synchronism and resulting in running in running above synchronism speed. It act as an induction generator. The main flux being produced by wattless stator current drawn from the system. Operation as induction generator necessitates the flow of slip frequency current in the rotor, damper winding and slot wedge, excitation under these condition require a large reactive component which approaches the value rated output of the machine. Since rotor would get over heated due to slip frequency current, the machine should not run more than few second without excitation , also it could overload the grid, which may not be able to supply the required excitation MVAR. When loss of excitation is accompanied by under voltage it will initiate class a trip. Otherwise class B trip if the grid is able to sustain the voltage dip.

Pole slipping:

The asynchronous operation of the machine while the excitation is still intact unlike loss of excitation causes sever shock to both machine and grid due to violent oscillations in both active and reactive power. Because of this the machine may fall out of step or usually known as pole slipping trip. The oscillation may disappear in the few second, in that case it is not desirable to trip the machine.

the swing curve can be detected by an impedance relay. The relay can be set to be in operation for swing up to +- 90 degree corresponding to the stability limit of the unit. The relay used is 98G and is of solid state design of ZTO type.

Over voltage:

The generator winding is rated for 15.75KV at the terminal, sustained over voltage would unduly stress the winding insulation and may lead to failure, to protect the over voltage relay is set to operate 10% rise in the terminal voltage.

G.T. over fluxing:

The iron core of the generator transformer carries the flux flux to produce required emf. If the flux increases unduly, the magnetic circuit of the generator and G.T. become over saturated resulting in high magnetising current. This leads to more iron losses, which in turn increases the temperature. The condition of over fluxing could arise in case the voltage at the machine terminal rises or its frequency drops or both occurring simultaneously. the relay used is 99 GT and GTT21 type which senses v/f ratio at the secondary of the bus duct P.T. and gives alarm and trip signal at different time delay.

Low forward power protection:

When a generator, synchronised with the grid , loses its driving force the generator remain in synchronism. The generator should be isolated from the grid after the steam flow ceases and the flow of power to grid reduce to minimum, i.e. the generator start to act like motor. When the load on the generator drop to less than 0.5 percent, generator low forward power relay get energised and with turbine or stop valve closed, trip the generator with a time delay of 2 seconds.

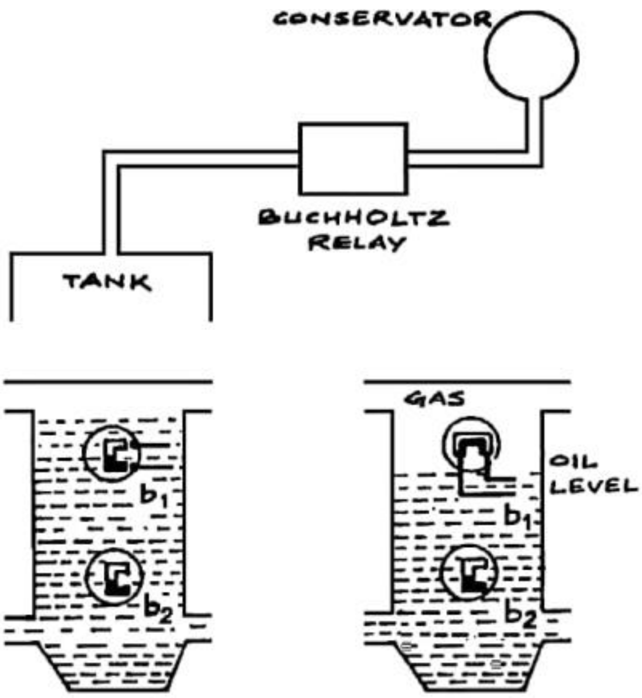
Reverse power protection :

The generator must be disconnected from the grid as soon as turbine stop/ control valve have closed, completely shutting off the steam. Continued full speed turbine rotating causes lot of turbulence of the trapped steam, which result in increase of temperature. Thus turbine wil be subjected to excessive thermal overstress, vibration and distortion. So there is a back up arrangement to trip the generator if it does not trip within 2 second i.e. on LPF protection. This is known as reverse power protection which act in two stage.

1st stage reverse power relay operate after 5 seconds time delay and includes stop valve closing/turbine trip 2nd stage reverse power relay act after 60 seconds time delay which trip generator irrespective of either stop valve closing or turbine trip. This acts as a final backup to L.F.P. protection.

GENERATOR TRANSFORMER PROTECTIONS:

G.T. Buchholz operation:



Any internal fault in generator transformer will result into rapid increase in the winding temperature resulting in vaporisation of oil (dissociation of oil) accompanied by generation of gas. The generator gas is utilised for relay operation.

The relay is gas operated device arranged in the pipeline between the transformer tank and separate oil conservator. The vessel is full of oil, it contain two float b1 and b2 which are to be hinged and to be pressed by their buoyancy against two stop. If gas bubble are generated in the transformer due to fault, they will rise and get trapped in the upper part of the relay chamber there by displacing the oil and lowering the float b1. This sink and eventually closes an external contact, which operate an alarm.

Thermal overload protection:

Vapour pressure thermometer or resistance temperature detector are used for this purpose. The transformer winding temperature and the oil temperature are continuously monitored, when the temperature reaches the certain value it will give indication , then load of the transformer is reduced, if the temp. rises further tripping will take place.

Fire protection:

Sprinkler system is utilised to protect the transformer from fire hazards. Sprinkler installation comprising of a system of inter connected pipes into which sprinkler head are fitted on a definite basis of distribution. Sprinkler head are so constructed that the heat arising will cause them to repture and the compressed water line sprinkle water to the transformer.

BUS BAR PROTECTION :

This is the protection in 400 kv which trip all the feeders connected to the faulted bus zone. It trip only the faulted bus section(zone). And not operate for external faults. The current differential senses the fault through high impedance voltage relay to reduce chances of maloperation on external fault duct to ct saturation. All CT in the particular zone are parallel with proper polarity to obtain the current differential, which is fed to the relay, it is made through isolator contact status relay.

SWITCH YARD:

The switchyard shall generally comprise of the following equipment’s:

1: BUS BARS:

The outdoor bus bars shall be of strain flexible and/ or rigid type. The overhead conductors shall be strain/ flexible type, which are strung between supporting structure and strain/ tension type insulators. The bundle conductor bus bars may be considered for 220kv and above system to optimise the steel structure. In the rigid type, pipe are used for bus bars and also for making connections to various equipment, wherever required. The bus bar and the connection are supported on the pedestal-mounted post insulators.

2: clamps and connectors:

Clamps and conductor(for connecting to equipment terminal and conductors) shall be of aluminum alloy casting type A6, in case of copper terminals, the clamps and connectors shall be of 2mm thick bi-metallic liner /strip, clamps and connectors for connecting to shield wires shall be of galvanized mild steel.

3: insulator string and hardware:

Disc/ long rod type porcelain or composite type insulator shall be provided for tension and suspension string assembly for overhead bus conductor.

4: circuit breaker:

A **circuit breaker** is an electrical safety device designed to protect an electrical circuit from damage caused by an overcurrent or short circuit. Its basic function is to interrupt current flow to protect equipment and to prevent the risk of fire. Unlike a fuse, which operates once and then must be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation.

Circuit breaker shall be of sf6, outdoor type. Here in ntpc they have sf6 , oil pressure, vacuum type also.

Circuit breaker shall be of live tank or dead type. In case of dead tank type **CB**, conventional outdoor CTs as describe elsewhere shall not be required; however, bushing type CTs shall be provided on either side of CB.

5: controlled switching device:

The control relay shall have facility to record and monitor the switching operations. It shall be positive to make adjustment behaviour as necessary. It shall be provided with self-diagnostic facilities, alarm and downloading and display facility for the setting and measured values. The controller shall be PC compatible.

In case of breaker to be operated manually, controller shall also get manual command from remote. The controller shall be able to analyse the current and voltage available through the signal from the secondaries of CTs and CVT for purpose of calculation of optimum moment of switching the circuit breaker and issue command to circuit breaker to operate.

6: disconnectors(isolators) and earth switches

Disconnectors shall be of outdoor horizontal centre break/ double break/ pantograph type/ vertical break/ knee-type with/ without earth switch.

a disconnector, disconnect switch or isolator switch is used to ensure that an electrical circuit is completely de-energized for service or maintenance. They are only used for breaking the circuit and are often found in electrical distribution and industrial applications, where machinery must have its source of driving power removed for adjustment or repair. Disconnectors can be manual or motor operated and may be paired with an earthing switch to ground the portion that has been isolated from the system for ensuring the safety of equipment and the personnel working on it.

7: current transformer :

A current transformer (CT) is a type of transformer that is used to reduce or multiply an alternating current (AC). It produces a current in its secondary which is proportional to the current in its primary. Current transformers are used extensively for measuring current and monitoring the operation of the power grid.

Current transformer shall be single phase, oil immersed, sf6 gas filled and self cooled, it shall be of dead tank or live tank type. The secondary terminal shall be brought out at the bottom to terminal box.

8: voltage transformer:

Potential transformer or **voltage transformer** gets used in electrical power system for stepping down the system voltage to a safe value which can be fed to low ratings meters and relays. Commercially available relay and meters used for protection and metering, are designed for low voltage.

Voltage transformer shall be capacitor voltage divider type(CVT)/ electromagnetic type, it should be of single phase , oil immersed / sf6 gas filled and self cooled.

9: surge arrestor :

A surge arrester is a device to protect electrical equipment from over-voltage transients caused by external (lightning) or internal (switching) events. Also called a surge protection device (SPD) or transient voltage surge suppressor (TVSS), this class of device is used to protect equipment in power transmission and distribution systems. To protect a unit of equipment from transients occurring on an attached conductor, a surge arrester is connected to the conductor just before it enters the equipment. The surge arrester is also connected to ground and functions by routing energy from an over-voltage transient to ground if one occurs, while isolating the conductor from ground at normal operating voltages. This is usually achieved through use of a varistor, which has substantially different resistances at different voltages.

Surge arrester in general, shall be of heavy duty, station class and metal oxide gapless type without any series or shunt gap. SA shall be single pole, hermitically sealed with non linear block of metal oxide material.

10: Power transformer :

A: inter connecting auto transformer:

The function of the interconnecting transformer-as the name suggests to interconnect two systems at different voltages. Normally, they will be either 400KV/132KV or 220KV/110KV, of say about 315 MVA. They are bidirectional .During the plant start-up, they import power from grid either at 400KV or 220KV and step down to132KV or 110KV to supply the station auxillaries. Once the plant is started and synchronized to the grid, the same transformer can now be used to export power to the grid. They are normally auto-transformers and they will have a delta connected teritiary winding of about 33KV rating, for providing a circulating path for the Zero sequence currents. Then the Transformer rating will be 400/220/33KV, 315 MVA.

All the auto transformer shall be running in parallel and their tap changer shall be controlled by keeping any of them as master and other as follower. The 33KV tertiary winding shall be unloaded or loaded or loaded with shunt reactor/ capacitor as per system requirement / application.

B: shunt and neutral reactors:

A shunt reactor is an absorber of reactive power, thus, increasing the energy efficiency of the system. It is the most compact device commonly used for reactive power compensation in long high-voltage transmission lines and in cable systems. The shunt reactor can be directly connected to the power line or to a tertiary winding of a three-winding transformer.

Neutral Earthing (Grounding) Reactors are single-phase reactors generally connected between ground and neutral of transformers or generators in order to control single line-to-ground faults at a desired level. They achieve this by resisting current flow through inductive elements.

Neutral Grounding Reactors are used in order to limit line-to-ground fault current to a value that will not damage the equipment in the power system, yet allow sufficient flow of fault current to operate protective relays to clear the fault. If the circuit is balanced, current flow through the reactor will be zero, thus, there will be no losses.

Reactor shall be of oil immersed with natural cooling. The insulating oil shall be virgin high grade inhibit.

Shunt reactor shall be gapped core or magnetically shielded air core type of construction. In case of core less construction, a magnetic shield shall be provided around the coreless coils and non-magnetic material sheet shall form the central core to minimize the vibrations.

11: wave trap:

Wave trap is used to create a high impedance to the carrier wave high-frequency communication entering into unwanted destinations typically substation. Carrier wave communication uses up to 150kHz to 800kHz frequency to send all the communication. These high-frequency damages the power system components which are designed to operate 50 or 60 Hz. Wave traps are also called line traps.

Wave trap shall be out door type suitable for mounting on post insulators/ CVT /suspension type. It should be equipped with suitable bird barriers and shall be provided with suitable corona rings to meet corona and radio interference performance

12:Diesel generator :

Diesel generator are provide to charge the line and axillaries in case of unit or plant failure of loss of power source.

13: power line carrier communication(PLCC)

PLCC shall be used for communication link between 400/200/132 KV switchyard of thermal /hydro power plant and inter connecting sub-station through 400/ 200 /132KV transmission line .PLCC panel shall be located in control room in AC kiosks.

It contain following things:

- Coupling device
- Coupling filter
- High frequency cable
- Power line carrier terminals

- Private Automatic Exchange
- 48 V DC power supply equipment
- Wave trap for the above transmission lines

14: Auxiliary power supply for switchyard :

A: 415 AC system:

The 415KV AC system shall provided power supply to 415V switchgear, DC system, circuit breaker, disconnectors, lighting panels etc of the entire switchyard system.

B: LT transformers:

The 11/0.433 KV or 3.3/0.433KV (whichever Is applicable) LT transformer shall be provided with delta-connected primary and star-connected secondary with the star point brought out solidly earthed for 415 V system.

C: DC system:

The DC system comprising of adequate capacity of 220V DC battery and its charger shall be provided for protection and monitoring system of the various panel , circuit breaker, isolators , lighting etc. of entire switchyard system.

D: DC BATTERY:

The system parameter are of 220/110 DC system shall be as follows:

1) Nominal system voltage	V	220	110
2) Highest system voltage	V	242	121
3) Voltage variation	V	187-242	99-121
4) Ambient temperature	^{0}C	50	50
5) System earthing		Unearthed	Unearthed
6) Maximum system fault level	kA	25 (for1s)	25 (for 1s)

The DC system shall be ungrounded and comprise of 2*100% sets of either lead-acid plante or Nickel-Cadmium Battery banks each provided ith trickle an boost charger and 2 no. DC distribution boards for switchyard load.

Battery duty cycle:

Load	Duration	Type of Loads
1) Continuous load	3 hours	Relays/ IEDs, HMIs, CB spring charging, isolator interlocking load, miscellaneous permanently connected loads etc.
2) Emergency load	1 hour	Emergency lighting loads
3) Momentary load	1 minute	CB closing, tripping loads (considering simultaneous occurrence as per system)

Conclusion:

By doing all so extensive visit to all unit and understanding the working of plant, different machine used, their protection and cooling system, relay, we got the total understanding of the plant, its importance and how advance the system is, we have seen that how collectively all system collectively work in so efficient, precise and synchronised manner to make this plant work. Here all unit the offsite, water handling plant, fire control system, chp, boiler , generator , chemistry department ,management ,control unit, service building ,switchyard and switchgear work in so efficient and synchronised manner to make the production of electricity in efficient and at lo cost at the rate of 3 to 4 rupees per unit. The efficiency of the plant is about 34 %. Here the 5 unit are of critical type and the sixth is more advance and of super critical type, here all the valve are of nematic, manual and mostly of motorised type which can be remotely controlled form the control unit. Here the back up system are so advance that in any situation the plant equipment and axillary will get it power form the alternate sources and the unit will operate it maximum capacity in efficient manner. In switchgear they have 2 incomer connected by bus coupler and get supply from axillary transformer, in case of failure of any incomer the supply cand be continued from other incomer through bus coupler, in case both incomer fail the supply can be continued form the switchyard, and in case of grid failure, it power can be supplied from the dg set and battery unit. Similarly in switchyard in case failure of any bus or feeder the supply can be continued through transfer bus and in case of unit failure it can take power from grid also and supply to unit also. The technology of air pre heater and economiser increase the efficiency of the boiler at most, the esp system used her to collect ash is most advance and collect ash by attracting the negative charged ash on cathode and collect it in hopper and send it to silo to use as raw material in cement industry and the clinker collected at the bottom of the boiler is crushed and send to arkha by pressurised water, and flue gas is released in the atmosphere, the water used here in cooling tower and collection of ash is recycled and reused again. This all thing together shows how effectively the plant and management is working day and night to make this all possible. By having this opportunity of internship at NTPC Unchahar I have learnt a life long and precious lesson and deep thank to it staff and management to be so kind and informative to us and help in our training.

Thankyou.