A

Report

of

Industrial Summer training

in

Electrical Maintenance Department,

NATIONAL THERMAL POWER CORPORATION

TANDA

Under the Supervision of

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Sr. Manager (O&D EMD, NTPC Tanda)

Submitted in Partial Fulfillment of
the Requirements
for the award of B. Tech. Degree
in

ELECTRICAL ENGINEERING

submitted
by

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NTPC
A Maharatna Company

NATIONAL THERMAL POWER CORPORATION
TANDA

CERTIFICATE

The undersigned certify that ***Mr. Shivraj Vishwakarma****, student of 3rd year, Electrical Engineering Department, Rajkiya Engineering College, Ambedkar Nagar has done the industrial summer training for B. Tech. Program in Electrical Engineering under my supervision.*

I hereby recommend that the industrial training report entitled, ***"EMD department at NTPC Tanda"*** *be accepted as the partial fulfillment of the requirements for evaluation and award of B.Tech. Degree.*

Date 11/07/2019

Place Tanda

Mr. Vishnu Pratap Mall

(Sr. MANAGER

O&M EMD DEPARTMENT

NATIONAL THERMAL POWER CORPORATION

TANDA)

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I hereby take this opportunity to thanks NTPC Tanda for giving us this opportunity to conduct our training in NTPC Tanda.

I am grateful to ***Mr. Yogesh Kumar Mandhyan (Sr. Manager (HR)), Er. Javed Akhtar (AGM, EMD), & Mr. M.S. Yadav (Dy. G.M., EMD)*** *for allowing us to conduct my training in the Electrical Maintenance Department, NTPC Tanda. We are heartily indebted our project guide Mr.* ***Vishnu Pratap Mall (Sr. Manager, O&M EMD)*** *for providing us with detailed in-depth knowledge and very useful information about the process and system used in the plant. His support was instrumental in our training being fruitful.*

I am also thankful to the entire officer and staff of NTPC Tanda for extending a helping hand whenever we need it.

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INTRODUCTION

1.1. Geographical location: -

The TANDA Thermal Power Project is located about 185kms from Lucknow. It is nearly 55kms from Faizabad. The nearest rail ahead is Akbarpur (now called as Ambedkar Nagar). The project lies in the Ambedkar Nagar district and is about 22kms from the nearest railway station.
The complete project is situated on the bank of Saryu River. The climate conditions are quite favourable with greenery all around.

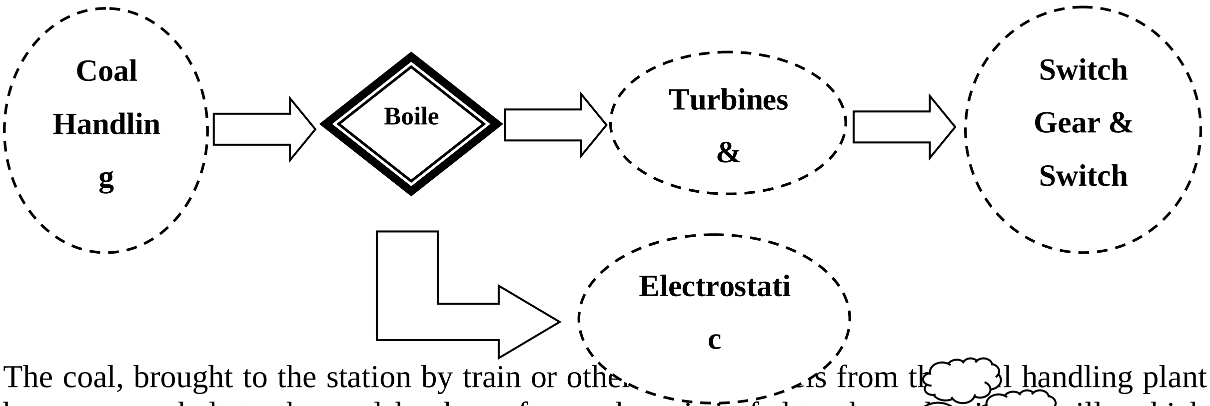
1.1.1 Features: -

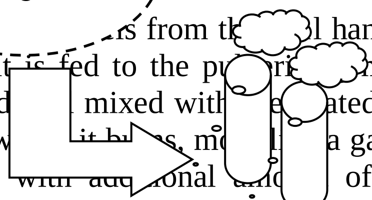
- NTPC Tanda is a coal-based power station a unit of NTPC limited which is a Maharatna Public Sector enterprise of Govt. of India.
- The total area is 1853 acres.
- NTPC took over the project from the UPSEB on Jan 14, 2000.
- The installed capacity is 4 X 110 MW

The water requirement of the station is met from the Saryu River through Mehripur pumping Station constructed for feeding Mehripur Pump Canal. The coal linkages for the station have been provided from North Karnpura & BCCL. The power generation is evacuated through 220kV feeders connected to Sultanpur (2 feeders), Basti & Gorakhpur (1 each)

PRODUCTION OF ELECTRICITY

The means and steps involved in the production of electricity in a coal-fired power station are described below.





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 preheated 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.

Meanwhile the heat released from the coal has been absorbed by the many kilometres of tubing which line the boiler walls. Inside the tubes 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.
Coupled to the end of the turbine is the rotor of the generator – a large cylindrical magnet, so that when the turbine rotates the rotor turns with it. The rotor is housed inside the stator having heavy coils of copper bars in which electricity is produced through the movement of the magnetic field created by the rotor. The electricity passes from the stator winding to the step-up transformer which increases its voltage so that it can be transmitted efficiently over the power lines of the grid.

The steam which has given up its heat energy is changed back into water in the condenser so that it is ready for re-use. The condenser contains many kilometres of tubing through which the colder is constantly pumped. The steam passing around the tubes loses the heat and is rapidly changed back to water. But the two lots of water (i.e. boiler feed water & cooling water) must NEVER MIX. The cooling water is drawn from the river, but the boiler feed water must be absolutely pure, far purer than the water we drink, if it is not to damage the boiler tubes. Chemistry at the power station is largely the chemistry of water.

To condense the large quantities of steam, huge and continuous volume of cooling water is essential. In most of the power stations the same water is to be used over and over again. So, the heat which the water extracts from the steam in the condenser is removed by pumping the water out to the cooling towers. The cooling towers are simply concrete shells acting as huge chimneys creating a draught (natural/mechanically assisted by fans) of air. The water is sprayed out at the top of towers and as it falls into the pond beneath it is cooled by the upward draught of air. The cold water in the pond is then circulated by pumps to the condensers. Inevitably, however, some of the water is drawn upwards as vapours by the draught and it is this which forms the familiar white clouds which emerge from the towers seen sometimes.

Why bother to change stem from the turbine back into water if it has to be heated up again immediately? The answer lies in the law of physics which states that the boiling point of water is related to pressure. The lower the pressure, the lower the temperature at which water boils. The turbine designer wants as low boiling point of water as possible because he can only utilize the energy of the steam – when the steam changes back into water he can get NO more work out of it. So, a condenser is built, which by rapidly changing the steam back into water creates a vacuum. This vacuum results in a much lower boiling point which, in turns, means he can continue getting work out of the stem well below 100 degree Celsius at which it would normally change into water.

VARIOUS DEPARTMENTS IN NTPC

- **Water Treatment Plant (WTP):**
  This division separates the physical and chemical impurities of water.

- **Coal Handling Division (CHD):**
  This division takes care of efficient supply of coal and oil fuel to the power plant.
- **Boiler Maintenance Division (BMD):**

This division looks after the efficient working and performance of boiler, its mounting, its accessories, feed pump, milling system etc.

- **Turbine Maintenance Division (TMD):**
  This division looks after the efficient working of turbine and its accessories.

- **Electrical Maintenance Division (EMD):**
  This division takes care of the electrical networks and its elements in the power station.

- **Control and Instrumentation Division (C & I):**
  This division takes care of various instruments fitted in the power plants for controlling the generation of electricity.

- **Civil Maintenance Division:**
  This division looks after the construction and maintenance of various structures in the power plant.

- **Operation General Division:**
  This division takes care of the sanitation and cleaning etc of the power plant and management of the power station. It deals with the salaries of employees, recording and sending data related to the performance of the power plant to the Head Office.

- **Store and Purchase Division:**
  This division deals with the storage and supply of various spare parts requires in the power house along with their purchase.

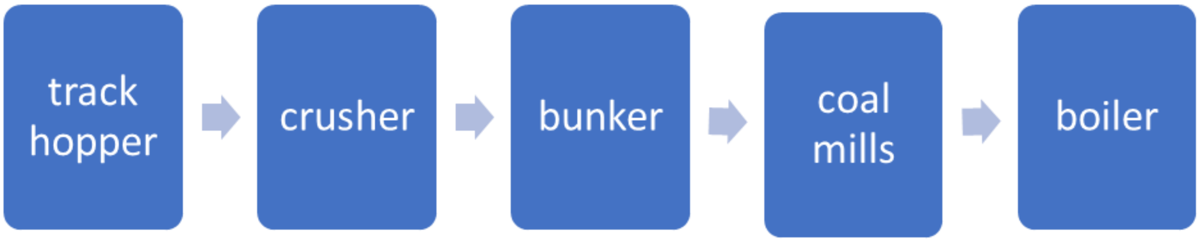
- **Transportation Division:**
  This division looks after the transportation of coal.

3.1. Coal Handling Division (CHD)

Coal is a prime fuel for a thermal power plant. Adequate emphasis needs to 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.

Each NTPC project has been linked to a particular coal mine to meet its coal requirement. Railway is the only means of transport of coal to this power station. Annual coal requirement for 4X110 MW units is estimated to be approximately 13.70 lakh mega tonnes. The coal yard in the layout is adequate for about 30 days storage with two coal stock piles and considering 3800 MT of coal requirement daily.

Coal is unloaded from the coal wagons in CHP, with the help of *wagon trippler*. Unloading operation of 60 ton per load wagon takes about 20-30 seconds. This coal is received in the track hopper and normally has size of 200 mm. The 200 mm coal received at the track hopper is fed to the crusher house through a series of conveyor belts. A series of parallel conveyors thereafter are designed to carry crushed coal directly to the bunkers or to divert it to the stockyard. To feed coal into bunkers, mobile trippers have been provided over bunker conveyors. Coal is fed to mills from bunkers via feeders. At mill the pulverization of the fed coal occurs, and finally the coal is converted into powder form.



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.

3.1.1 Equipments Involved in Coal Handling

Main equipments involved in coal handling are conveyor belts, drive unit, take ups, idlers, skirt board, scrappers, crusher, vibrating screen, magnetic separator, metal detectors. Their functions are described in the following sections.

a) Conveyor Belt:

Conveyor belt is used to transfer coal to various units. It consists of layers or piles of fabric duck, impregnated with rubber and protected by a rubber cover on both sides and edges. Fabric duck supplies necessary strength to withstand the tension created in carrying the load, while the cover protects the fabric carcass. Heat resistant belting is always recommended for handling materials at temperature over 66 deg. C.

b) Drive Unit:

Drive unit comprises of motor coupled to reduction gear box with the help of flexible coupling. For inclined conveyors, bold backs are incorporated in the gear boxes to prevent running back of the conveyor under loaded condition. The motor starts under no load conditions and conveyor moves only when the motor reaches its full speed. This also eliminates the starting shock on the conveyor components.

c) Skirt Board:

Skirt boards are used in conjunction with chutes at the trail end. They guide the materials centrally on the belt while loading, until it has settled down on the belt.

d) Scrappers

Conveyors are provided with scrappers at the discharge pulley in order to clean the carrying side of the belt by holding the scrapper against the belt with sufficient pressure without causing damage to the belt due to excessive force exerted by wiper.

e) Crusher:

The role of crusher is to crush the coal from 200mm to 20 mm, received from vibrating screen. The coal enters the top of the crusher and is crushed between rotating granulators and fluid cage path. Normally these crushers have capacity of 600tons per hour.

f) **Vibrating Screen:**

The function of vibrating screen is to send the coal having size of less than 20 mm to belt feeder through the bypass chute bypassing the crusher and to send the coal of size more than 20 mm to crusher.

g) Magnetic Separator:

There is an electro magnet placed above the conveyor to attract the magnetic materials. Over this magnet there is one conveyor to transfer these materials to chute provided for dumping at ground level. Because of this continuous removal is possible and also it is not necessary to stop the electric supply to the magnetic separators for removal of separated material.

With the help of above major equipments the coal is fed to the boiler, where it is fired and transmits the energy released through the tubes of boiler to the water.

3.2. Water Treatment Plant (WTP)

Working fluid used for the production of power in a steam power plant is water i.e. it is used for steam generation. As for as the water requirement for steam generation is concerned, problem is not of quantity but is of quality and hence water is first purified before it is fed to boiler. Water requirement in steam cycle is 3 to 4 tons/hr/MW and make up quantity is 2 to 3% of the same.

For Tanda thermal power station this need of water is being fulfilled by river SARYU, as the plant is situated on the bank of river Saryu.

The objective of water treatment is to produce a boiler feed water so that there shall be

(1) No scale formation causing resistance to passage of heat and burning of tube leading to the failure of the tube.
(2) No corrosion problem
(3) No priming or foaming problems.

This will ensure that steam generated shall be clean and the boiler plant will provide trouble free uninterrupted service. Various steps involved in the chemical treatment of water and its flow to the boiler are described in the following sections.

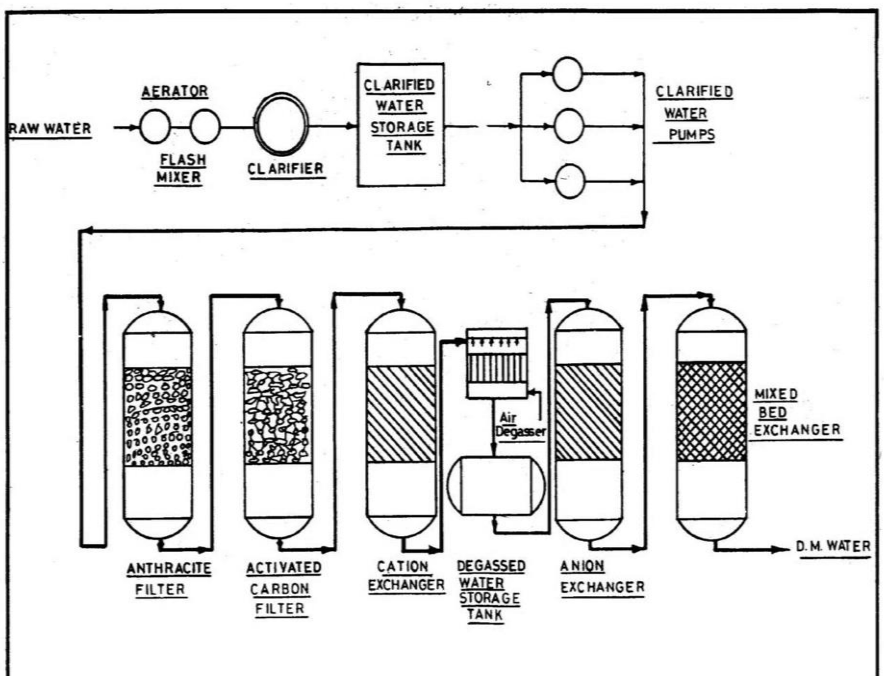


Fig No - 90 ***Raw Water to Demineralise Water***

3.2.1. Pre-treatment Section

Pretreatment plant removes the suspended solids such as clay, silt, organic and inorganic matter, plants and other microscopic organism. The turbidity may be taken as of two types of suspended solids in water. Firstly, the separable solids and secondly the non-separable solids

(colloids). The coarse components, such as sand, silt etc, can be removed from the water by simple sedimentation. Finer particles however, will not settle in any reasonable time and must be floculated to produce the large particles which are settle able. Long term ability to remain suspended in water is basically a function of both size and specific gravity. The settling rate of the colloidal and finely divided (approximately 0.01 to 1 micron) suspended matter is so slow that removing them from water by plain sedimentation is tanks having ordinary dimensions is impossible. Settling velocity of finely divided and colloidal particles under gravity also is so small that ordinary sedimentation is not possible. It is necessary, therefore, to use procedure which agglomerate the small particles into larger aggregates, which have practical settling velocities.
The term " Coagulation" and "flocculation" have been used indiscriminately to describe process of turbidity removal. "Coagulation" means to bring together the suspended particles. The process describes the effect produced by the addition of a chemical Aluminum hyposulphite to a colloidal dispersion resulting in particle destabilization by a reduction of force tending to keep particles apart. Rapid mixing is important at this stage to obtain uniform dispersion of the chemical and to increase opportunity for particles to particle contact. This operation is done by flash mixer in the clarifloculator. Second stage of formation of settle able particles from destabilized colloidal sized particles is termed a "flocculation". Here coagulated particles grow in size by attaching to each other. In contrast to coagulation where the primary force is electrostatic or inter ionic, "flocculation" occurs by chemical bridging. Flocculation is obtained by gentle and prolonged mixing which converts the sub microscopic coagulated particle into discrete, visible & suspended particles. At this stage particles are large enough to settle rapidly under the influence of gravity and may be removed.

If pre-treatment of the water is not done efficiently then consequences are as follows:

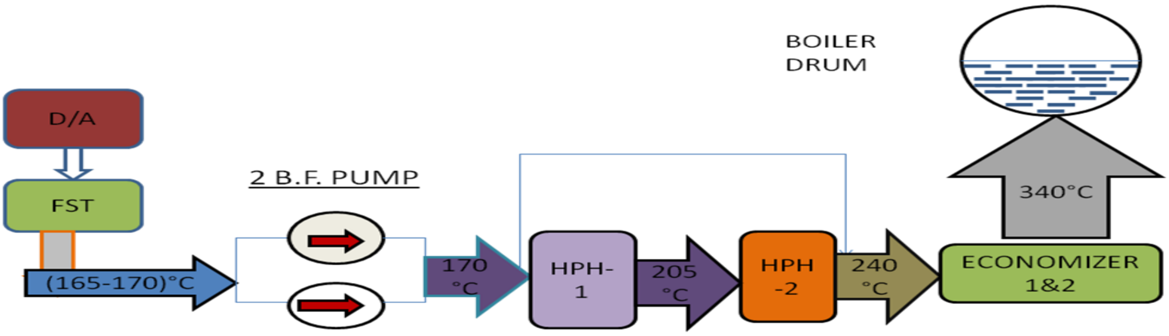
a) SiO2 may escape with water which will increase the anion loading.
b) Organic matter may escape which may cause organic fouling in the anion exchanger beds. In the pre -treatment plant chlorine addition provision is normally made to com bat organic contamination.
c) Cation loading may unnecessary increase due to addition of Ca (OH)2 in excess of calculated amount for raising the pH of the water for maximum floe formation. If less than calculated amount of Ca(OH), is added, proper pH flocculation will not be obtained and silica escape to demineralisation section will occur, thereby increasing load on anion bed.

3.2.2. <u>Demineralised Section</u>

Water obtained after pre-treatment is used for demineralising purpose and is fed to cation exchanger bed, but enrooted being first dechlorinated, which is either done by passing through activated carbon filter or injecting along the flow of water, an equivalent amount of sodium sulphite through some stroke pumps. The residual chlorine which is maintained in clarification plant to remove organic matter from raw water is now detrimental to cation resin and must be eliminated before its entry to this bed. Normally, the typical scheme of demineralisation is three bed system with a provision of removing gaseous carbon dioxide from water before feeding to Anion Exchanger.

Resins are manufactured in such a way that these have the ability to exchange one ion for another, hold it temporarily in chemical combination and give it to a strong electrolytic solution. Suitable treatment is so given to them in such a way that a particular resin absorbs only a particular group of ions. Resins, releasing cationic portion of dissolved salts, is called cation exchanger resin and when removing anionic portion is called anion exchanger resin.

The present trend is of employing strongly acidic cation exchanger resin and strongly basic anion exchanger resin in a DM Plant of modern thermal power station.



FEED WATER CYCLE

3.2.3. Deaerator

As the D.M. Water has a good affinity to absorb carbon dioxide and oxygen, and both are extremely harmful to metal surfaces for their destruction like corrosion, these have to be removed before it is fed to boiler. This is being done in de-aerator.

It works on two principles: Henry law and solubility law.

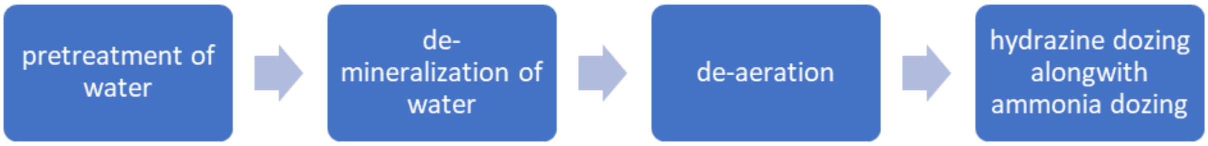
- Solubility law: solubility of gases decreases with increase in pressure and /or decrease in temperature.
- Henry law: the mass of gas with definite mass of liquid will dissolve at the given temperature and is directly proportional to the partial pressure of the gas in contact to liquid.

Still the residual oxygen which is remaining in the water is neutralized by a suitable *doze of hydrazine*, at the point after de-aerator.

3.2.4. Ammonia Dosing

To have further minimum corrosion, the pH of feed water is to be maintained at around 9.0 for

which purpose ammonia in suitable doze is added to this make up water at a point along with hydrazine as stated above.



3.2.5. <u>Feeding of DM Water to Boiler</u>

a) <u>**Feed water cycle**:</u> -

This cycle deals with the flow of water to boiler feed pump from feed storage tank, which is later fed to the boiler drum passing through high pressure heater and economize.

This system plays an important role in the supply of feed water to the boiler at requisite pressure and steam/water ratio. This system starts from boiler feed pump to feed regulating station via HP heaters

b) <u>**Boiler Feed Pump:**</u>

This pump is horizontal and barrel design driven by an electric motor through a hydraulic coupling. All the bearings of the pump and motor are forced lubricated by oil lubricating system. The feed pump consists of pump barrel into which is mounted the inside starter, together with rotor. Water cooling and oil lubricating are provided with their accessories. The brackets of the radial bearing of the suction side and the radial and thrust bearing of the discharged side are fixed to low pressure.

3.3. <u>Steam Generation Unit (Boiler)</u>

The heat released from the coal has been absorbed by the many kilometres of tubing which line the boiler walls. Inside the tubes 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

The illustration given in figure below shows a symbolic arrangement of various accessories of a 200/210 MW Boiler. These accessories include: Economizer, Boiler drum, Down Comers, Water walls, Water wall platen (used for Low Pressure Boilers), Primary super heater, Platen super heater, Final super heater, Re-heater, Burner, Igniters. Functions of some major auxiliaries are described below.

3.3.1 <u>Coal Bunker:</u>

These are in process storage silos used for storing crushed coal from the coal handling system. Generally, these are made up of welded steel plates.' Normally, there are six such bunkers supplying coal of the corresponding mills. These are located on top of the mills so as to aid in gravity feeding of coal.

3.3.2 Coal Feeders:

Each mill is provided with a drag link chain/rotary/gravametric feeder to transport raw coal from the bunker to the inlet chute, leading to mill at a desired rate. Mills: There are six mills

(25% capacity each), for every 200 MW unit, located adjacent to the furnace at '0' M level. These mills pulverize coal to the desired fineness to be fed to the furnace for combustion.

3.3.3 Air Pre- Heater:

Air pre - heater transfer heat from flue gases to cold primary and/ or second ary air by means of rotating heating surface elements.

3.3.4 Furnace:

A boiler furnace is that space under or adjacent to a boiler in which fuel is burned and from which the combustion products pass into the boiler proper. It provides a chamber in which the combustion reaction can be isolated and confined so that the reaction remains a controlled force. In addition, it provides support or enclosure for the firing equipment.

3.3.5 Water Wall: -

These are membrane walls, no. of tubes are joined. Vertical tubes connected at the top and bottom of the Headers. Receives water from the boiler drum by down –comers.

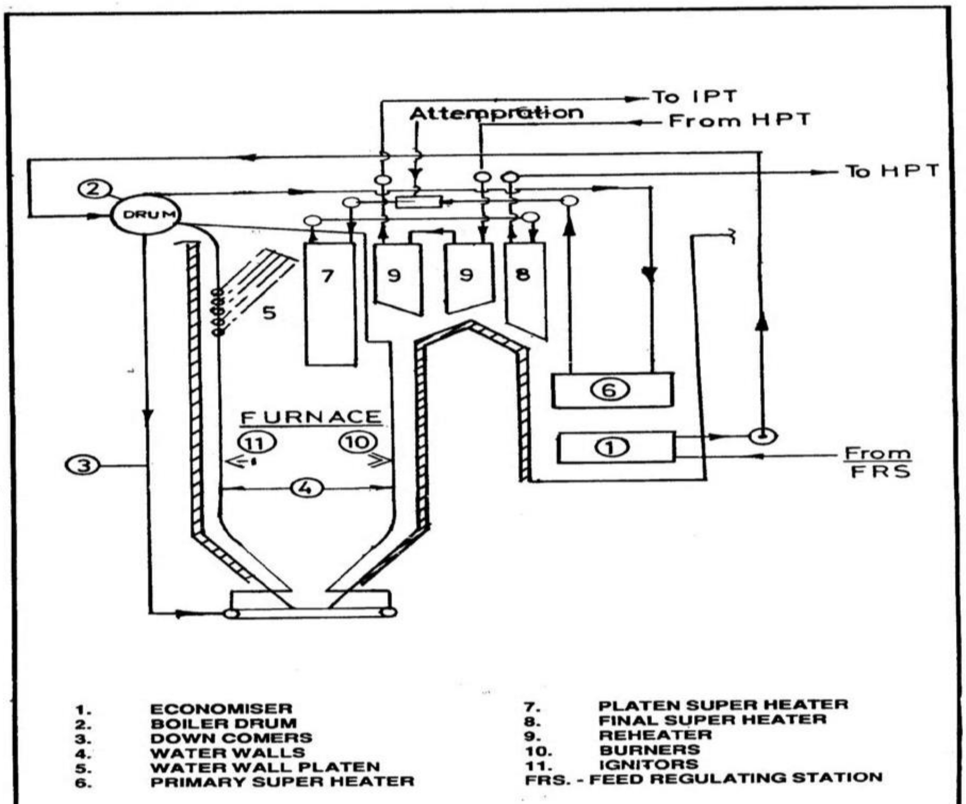


Fig No.-4 Arrangement of Boiler Accessories

3.3.6 Boiler Drum:

The function of steam drum is to separate the water from the steam generated in the furnace walls and to reduce the dissolved solid contents of the steam to below the prescribed limit of 1 ppm. The drum is located on the upper front of boiler.

3.3.7 Economizer:

The purpose of economizer is to preheat the boiler feed water before it is introduced into the steam drum by recovering heat from the flue gases leaving the boiler. The economizer is located in the boiler rear gas pass below the rear horizontal super heater. The economizer is continuous unfinned loop type and water flows in upward direction and gas in the downward direction. It reduces the exhaust gas temperature and saves the fuel.

3.3.8 Super Heater:

Since the superheated steam is to be supplied to the turbine, steam is super-heated in the super heater. There are three stages of superheater. The outlet temperature and pressure of the steam coming out from the super heater is 540^{o}C and 157 Kg/Cm^{2} respectively for H.P. units

3.3.9 Reheater:

The function of re-heater is to reheat the steam coming out from high pressure turbine to a temperature of 540oC.

3.4. Turbine Maintenance Department (TMD)

The main works of this department are maintenance of turbine and look after all the things related with turbine. The steam turbine has been used predominantly as mover in all thermal power stations. It is not likely to be replaced in the future. Turbines are mainly divided into three groups:

- Impulsive turbines
- Reaction turbines
- Impulsive-reaction turbines

In both types of turbine, first the heat energy of the steam at high pressure is converted into kinetic energy passing through the nozzles. The turbines are classified as impulsive in impulsive turbinate steam coming at a very high velocity through the fixed nozzle impinges on the blade fixed on the periphery of the rotor. In the reaction turbine the high-pressure steam boiler is passed through the nozzle. When the steam comes out through these nozzles, the velocity of steam increases relative to rotation and this resulting force of steam on the nozzles give the rotating motion to the disc and shaft. The shaft rotates in opposite direction of steam jet. In an impulsive reaction turbine, the steam expands both in fixed and in moving blades continuously as it passes over them. Therefore, the pressure drop occurs gradually and continuously over both moving and fixed blades. For e.g. Parson’s turbine.

3.4.1 Compounding of The Steam Turbines

If the entire pressure drop from boiler pressure to condenser pressure is carried out in a single stage nozzle, then the velocity of the steam entering into the turbine could be very high of the order of 1500 m/s. The turbine rotor velocity (blade velocity) will be very high of the order of 3000 rpm as it is directly proportional to the steam entering velocity. Such high rpm of turbine is not useful for practical purpose and a reduction gear is necessary between the turbine and external equipment (generator driven by the turbine). There is also a danger of structure failure of the blade due to excessive centrifugal stresses. Therefore, the velocity of the blades is limited to 400 m/s. The velocity of the steam at the exit of the turbine is sufficiently high when single stage blades are used. This gives a considerable loss of kinetic energy (about 10-20 %). The compounding can solve the above-mentioned difficulties associated with the single stage turbine. The combinations of the stages are known as compounding. There are three types of compounding which are generally done.

a. **Velocity compounding:**
   In this type of compounding there is only one set of nozzles and two or more rows of moving blades. There is also a row of fixed blades in between the moving blades. The function of the fixed blades is only to direct the steam coming out from first moving row to the next moving row without altering pressure and velocity of the steam. The heat energy drop takes place only in the nozzle at the first stage and it converts into kinetic energy. The kinetic energy of the steam gained in the nozzles is successively used by rows of moving blades and finally exhausted from the last row of the blades on the turbine rotor. A turbine working on this principle is known as velocity compounded impulse turbine. For e.g. Curtis turbine.
b. **Pressure compounding:**
   A number of simple impulse turbine sets arranged in series is known as pressure compounding. In this arrangement, the turbine is provided with one row of the fixed blades at the entry of each row of the fixed blades, which work as nozzle. For e.g. Rateau turbine.

3.4.2 Governing System of Turbine

1. Speed range is 2850 rpm to 3360 rpm corresponding to primary oil pressure of 2.17 to 2.99 atmosphere at oil temperature of 50^{o} C (3000 rpm corresponds to 2.38 atm primary oil pressure.)
2. The non-uniform changer (NUC) enables the exchanging of non-uniformity continuously in the range of 3.5 to 5 %.
3. Before start of increase of secondary oil pressure, safe oil pressure can be achieved by limiter only when the main relay is in engaged position.
4. During the starting of machine up to 2730 rpm, safe oil pressure is regulated by limiter.
5. When the turbine has taken over the regulation function, the limiter works as by-pass valve on the secondary oil system.

3.4.3 Turbine Protection Testing

The following protection parameters of turbine have to checked & recovered in log book:

1. Primary oil pressure should be 3.05 kg/cm^2
2. Control gear pressure should be 7.00 kg/cm^2 (regulation oil pressure)

3.4.4 Turbine Oil Pressure Regulating System

1. Reset the supply turbine.
2. Reduce the turbine oil from turbine local panel as described in T.G. set manual.
3. Further reduce the turbine oil pressure by procedure given above and watch so that E.O.P. (A.C.) starts at 0.8 kg/cm^2. Now further reduce the pressure & water so that E.O.P. (D.C.) gets started automatically at 0.7 kg/cm ^{2}.

4. Mechanical shift tripping.
5. Low vacuum tripping.

3.4.5 Specifications Of 110 Mw Turbine

Rated output at generator terminals	: 110 MW
Rated speed	: 3000 rpm
Rated steam pressure just before stop valve	: 130 kg/sq. cm
Maximum steam pressure just before stop valve	: 146 kg/sq. cm
Rated temperature just before stop valve	: 540
Reheated steam pressure	: 27.4 kg/sq. cm
Maximum steam pressure before MP casing	: 36 kg/sq. cm

3.4.6 Important Features of Turbine

No. of regulated extractions	: 8
No. of wheels in HP rotors	: 2 row Curtis, 8 HP (impulse)
No. of wheels in MP rotors	: 12 impulse
No. of wheels in LP rotors	: 4 impulse of double flow design
No. of high pressure control valves	: 4
No. of interceptor valves	: 2
Range of critical speed	: 1200 to 2500
Weight of HP rotor	: 5.5 Tonnes
Weight of MP rotor	: 11 Tonnes
Weight of LP rotor	: 24 Tonnes
Direction of rotation	: Clockwise from front bearing stand
Material construction	: special cast steel
HP MP outer casing	: Casting of chromium vanadium steel
HP MP Inner casing	: Casting of chromium vanadium molybdenum carbon steel

3.5. Control & Instrumentation Division

This is the backbone of a thermal power plant. Various parameters in various auxiliaries are controlled from here. The equipments are very sensitive and can even pick up minute disturbances. Automatic control comparator compares the actual value of the plant output with the desired value, determined the deviation and produces control signal which will reduce the deviation to zero or a small value. The industrial automatic controllers that are employed in the control and instrumentation section are as follows:

1. Two position or on-off controllers
2. Proportional controllers
3. integral controllers
4. Proportionally-integral controllers (PI)
5. Derivative controllers
6. Proportionally-integral-derivative controllers (PID)

3.5.1 Various instruments of the C&I department

a) **Boiler Drum:** There are numerous red and green lights in the control room. The light continuously indicates the boiler drum steam and water level. When the level goes in the danger region, on alarm is activated.

b) **Feeding Desk:** On this panel the knobs are available for the operations. Steam dust collectors are measured in these stages. The boiler pressure is indicated by corresponding dial. When the boiler steam reaches the super-heated and attains a temperature of 485^o C. This steam is released to turbines. A temperature higher than the allowed value is indicated by an alarm. A control panel also indicates pressure in the boiler tube. There is also a coal burner control. For initial firing we require coal temperature of 800-1000^o C. The primary air fan controls the pressure of air.

c) **Pulverised coal feeding desk:** When vapor is fully open, the pulverized coal feeder will start otherwise pipe line will be heated.

d) **Furnace draft control desk:** by this vacuum and air quantity is maintained quick closing valve are opened.

3.5.2 Turbo Supervisory Equipment's

The turbo equipments observe the following parameters:

a) **Vibration:** Vibratory picks up are to pick up the vibrations and then amplified scientific pick-ups are used to pick up displacement of even or few micrometres.

b) **M.P. Expansion:** Differential expansion of stator frame is observed at turbo supervisory equipment because if the more than, they break up. Maximum and minimum allowable expansions in different sections are shown below:

	Minimum	Maximum
High-pressure	1.5 mm	3.5 mm
Medium-pressure	1.5 mm	3.5 mm
Low-pressure	2.0 mm	4.0 mm

c) **Eccentricity:** Since the rotor moves at a very high speed of about 2900 rpm to 3000 rpm, due to impinging of steam at high temperature, the expansion of rotor takes place. This is called eccentricity.

d) **Bearing Temperature:** Bearings are made of those metals, which melt at 100^o C. Therefore, allowable temperature is 7.5^o C. Platinum resistance thermometers are used. The oil pressure is maintained at 35 kg/cm ^{2} at the header and a pressure of 15.8 kg/cm ^{2} at ball bearing.

3.5.3. Generator: -

The generator is directly coupled with its respective turbine normally rated for 110 MW at 0.88 power factor (i.e. 125 MVA), 11kV, 3 phases, 50Hz. The hydrogen cooling mechanism is used for the generator. The neutral point of the generator is earthed through a single-phase Distribution Transformer, the secondary of which is shunted through a suitable resistance.

The excitation system consists of high frequency AC mains and pilot exciters directly driven from the main shaft, silicon rectifying unit and associated control gears.

3.5.4 Generator Transformer: -

The generation voltage of 11kV is stepped up to 220kV by generator-transformer (in short GT) whose low voltages side is directly connected with the generator through an isolated phase bus duct. The rating of generator-transformer is 125MVA, 11/220kV, 3 phase, 50 Hz having an ON/OFF cooling. The high voltage side of the transformer is connected to the 220kV system in 220kV switchyard.

3.5.5 <u>Unit Transformer</u>: -

The bus-duct leading from the generator to the GT is tapped off conveniently for connection to high voltage side of Unit Auxiliary Transformer used for stepping down the voltage to 6.6kV for supplying power to the unit auxiliary loads of the power station. The rating of the UAT is 15MVA, 11/6.6kV, 3-phase, 50 Hz.

3.5.6 <u>Start-up cum Reserve Transformer</u>: -

Each of the four units draw its start-up power from the 220kV system through two/three windings common start-up cum reserve transformer rated for 30/10/20 MVA, 220/33/6.6 kV, 3 Phase, 50Hz. The transformer supplies the 33kV load requirements. This transformer also meets the requirement of station loads like coal & ash handling, compressed air and water treatment plant, station lightening and other common services as well as act as a standby source of power to unit auxiliaries.

3.5.7 <u>L. T Auxiliary Transformer</u>: -

For further step down of 6.6kV power from the reserve system for utilization at medium voltage 16 nos. 1000kVA, 6.6kV/415V, 3-phase, 50Hz transformers have been envisaged. The actual requirement is assessed after detail design of the system.

Power for station illumination, unit wise is provided by five 300kVA, 6.6kV/415V, 3-phase, 4 wire transformers.

3.5.8 <u>DC Supply System</u>: -

A station battery unit, complete with battery charger and control & distribution system is installed as required for supply to all loads either for normal operation or during any emergency conditions.

Exact rating is however determined after the detail study of all loads and their durations.

Tanda Thermal power station has four units for generation. Each unit has a separate transformer. Transformer rating depends on the generating capacity of each unit. Units 1,2,3 and 4 generate power at 11 KV.

3.5.9 <u>Rating of Transformers of Each Unit: -</u>

KVA	H.V.	87500/12500
	L.V.	87500/12500
No Load Volts	H.V.	220000
	L.V.	11000
Winding Temperature		30 ^{0}C
Amperes	H.V.	298
	L.V.	656
Phase	H.V.	3
	L.V.	3
Types of cooling		ON/OFF
Frequency		50 Hz
Impedance Volts		12.15%
Vector group symbol		Y d 1 1
Core winding weight		104000 kg
Weight of oil		34700 kg

Total weight	187000 kg
Oil	38550 litres
Oil circulation	2 x 1800 litres/min
Air circulation	24 x 50 m^3/min
Type of circuit breaker	A.B.C.B.

The ratings of major electrical equipments such as all transformers, for 110 MW units are as follows:

Power rating of generating transformer	: 125 MVA
Power rating of unit auxiliary transformer (UAT)	: 16 MVA
Voltage transformation ratio of generating transformer	: 11/220 KV
Voltage transformation ratio of UAT	: 11/6.6 KV
Voltage transformation ratio of reserve transformer	: 132/6.6 KV

In TTPS, the generation of electrical power is done at 11 KV. The generated power at this voltage goes to the bus bar through transformer which step-up the voltage. Then power is ready for transmission and is fed into transmission network.

After the generating transformer, the current transformer and the potential transformer are located. After the CT and PT, two circuit breakers are connected. One of the circuit breakers is manual while the other is automatic. The automatic circuit breaker is air blast circuit breaker (ABCB). When excessive current or over voltage or sudden dip in voltage occurs then the circuit breaker disconnects the line.

3.5.10 Current Transformer (C.T.): -

At this substation a number of current transformers are used. These current transformers are used with low ammeters to measure high current in high voltage A.C. circuit where it is not practical to connect instruments or ammeters directly from high voltage lines. In addition to insulate the instrument from high voltage it steps down the current in known ratio.

The current transformer has a primary coil of very few turns of thick wire connected in series with the line whose current is to be measured. The secondary consists of a large number of turns of thin wire and it is connected across the ammeter terminals.
At required voltage the current transformer is of step-up type. But it is sure that the current will be step down. Thus, if the current transformer has primary to secondary ratio of 100:5, then it step-ups the voltage 20 times whereas it step-downs the current to 1/20 times of it.

3.5.11 Potential Transformer (P.T.): -

The potential transformers are used to operate as voltmeters. The potential coil of wattmeter and relays form high lines. The primary winding of the potential transformer is connected across the line carrying the voltage to be measured and the voltage circuit is connected across the secondary winding; the design of a potential transformer is quite similar to that of a proper transformer but the loading of a P.T. is always small. The potential transformers are used to measure the high voltage. The potential transformer is also used for operating the relays in control circuit.

For safety the secondary winding it is completely insulated from the high voltage of primary side and grounded for boundary protection of the operators.

Three types of cooling techniques are employed for the transformers. These techniques are as follows:

a. Oil Natural Air Force
b. Oil Natural Air Natural
c. Oil Force Air Force

3.5.12 <u>Generator And Exciter: -</u>

The electric generator is most important part of the power station. The principal of electromagnetic induction is used to generate electric power with the help of synchronous generator. All modern type of AC generators essentially consists of fixed starter and revolution rotor. An alternating e.m.f. is induced when the shaft of the rotor is revolved with the help of a prime mover.

The rotor provides the magnetic flux to the machine. The winding of three generators may be connected either in delta or star arrangement. With star arrangement two voltages can be obtained as the line voltage or as the phase voltage. The neutral is connected to the earth and this helps in designing a protective system in order to keep the temperature rise of various parts from exceeding the respective maximum permissible values. Every generator requires continuous cooling during its operation. The system cooling adopted for the cooling purpose consists of a fan that circulates the air through the alternator and the warm air is cooled by the water coolers before being circulated again. This system gives good protection against fire in alternator due to restricted air supply. Carbon dioxide can also be easily injected to extinguish the fire.
The exciter provides the direct current mended to excite the rotor field magnets. The present on excitation must be absolutely reliable since their failures will shut down the alternators. The higher the total load and more the lagging power factor, the greater excitation is required.

3.6. <u>Electrical Maintenance Division (EMD):</u>

Switch gear in a broad sense covers a wide range of equipment’s connected with switching and protection. A circuit breaker is a switching (current interrupting or making) device in switch gear. The basic requirements of switching in power system practice are twofold:

1. To permit apparatus and circuits to be conveniently put into or taken out of service.
2. To permit appropriate and safe isolation of apparatus and circuits automatically, in a pre-determined time period when they develop faults.

3.6.1. <u>Devices Used For Circuit Breaking (Or Making):-</u>

a) <u>Fuse and Iron Clad Switches</u>

Fuse is an over-current switch in the sense that when the current exceeds a pre-assigned value in a circuit or device, it melts and causes current interruption. The supply is restored only when a healthy one replaces the damaged (melted) fuse in the line. To permit this without any danger of shock to the operator, fuses are connected on the load side of an iron clad switch.

b) <u>Isolators</u>

An isolator is a switch connected after a circuit breaker. When a circuit or a busbar is taken out of service by tripping the circuit breaker, the isolator is then open circuited and the isolated line is earthed through earth switch so that the trapped line charges are safely conducted to ground.

These devices are used to break or isolate the circuit. They are however, slower than circuit breakers in operation. They are used to locate and rectify faults in circuit elements and therefore they relieve the CB which may also be used for these operations. (However, it is not advisable to turn CB in off position for a long duration as this may damage its springs.) In general, two isolators are put in circuit, one each on both sides of CB, in order to facilitate repair of CB as well as circuit isolation and repair. Air pressure for isolators at Tanda thermal power station is 16 kg/cm^2.

c) <u>Circuit Breakers</u>

- Make or break both normal and abnormal currents.
- Appropriately manage the high-energy arc associated with current interruption. The problem has become more acute due to interconnection of power stations resulting in very high fault levels.
- Current interruption occurs only when it is called upon to do so by the relay circuits.
- In fact, they are required to trip for a minimum of the internal fault current and remain inoperative for a maximum of through fault current.
- Rapid and successive automatic breaking and making to aid stable system operation.
- 3-pole and single pole auto-reclosing arrangement.

In addition to these breaking and making capabilities, a circuit breaker is required to do so under the following typical conditions:

- Short-circuit interruption
- Interruption of small inductive currents
- Capacitor switching
- Interruption of short-line fault
- Asynchronous switching

3.6.2. <u>Principles of circuit breaking: -</u>

a. *DC circuit breaking:* effect of decreasing current and increasing arc length.

b. *AC circuit breaking:* It is performed by several techniques which are current-zero period, distortion of AC current wave by arc voltage recovery and restriking voltages, single frequency and double frequency transients, rate of rise of recovery voltage (RRRV), control of RRRV, Resistance switching.

Current chopping-interruption of low magnetizing currents-Opening resistors-capacitive current breaking-Switching of capacitor banks and unloaded lines-Interrupting terminal faults and short-line faults.

3.6.3. <u>Classification of Circuit Breakers: -</u>

A CB is used to make or break a circuit either manually or automatically under faulty conditions. The following types of CBs are used at Tanda Thermal Power Station:

a) Air Circuit Breaker (ACB):

Up to a certain medium range of voltage, ACB are widely used for the low voltage circuits as well as the highest transmission voltage. Simple ACB which do not corporate any air, control devices used for voltages below 1 KV.

These CB usually have two pair of contacts per phase. The main pair of contact handles the current under normal operating conditions and is made of copper. The additional pair actually becomes the arcing electrode as the CB is opened and is made of carbon because of the vaporizing of surface material of the contacts. The main contacts separate while the arcing pair is still in contact and the arc is initiated only when the arcing pair separates.

b) Air Blast circuit breaker:

These breakers employ a high-pressure blast as an arc quenching medium. The contacts are opened in a flow of air blast established by the opening of the blast valve. The air blast cools off the arc and sweeps away the arcing products to the atmosphere. This rapidly increases the dielectric strength of the medium contacts and therefore prevents the arc from re-establishing. Consequently, the arc is extinguished and flow of current is interrupted.

It has a major advantage that no fire risks are involved as opposed to OCB. At Tanda thermal power station, air pressure limit for ABCB are 33 kg/cm^2 to 40 kg/cm^2.

c) Oil Circuit Breaker:

In such CB, insulating oil is used as an arc quenching medium. The contacts are opened under oil and arc is struck between them. The heat of the arc evaporates the surrounding oil and dissociates its substantial volume of gaseous hydrogen at high pressure. It has the advantage of better and efficient arc quenching medium but on the negative side it involves risk of fire.

d) SF_6 CB:

In such circuit breakers SF_6 gas is used as the arc quenching medium. The SF_6 is an electronegative gas and has a strong tendency to absorb free electron. The contacts of the breakers are opened in a high-pressure medium of SF_6 gas and arc is struck between them. The conducting free electrons in the arc are rapidly captured by the gas to form relatively large, immobile negative ions. This loss of conducting electrons in the arc quickly builds up enough insulation strength to extinguish the arc. The SF_6 CB has been found to be very effective for high power and high voltage service.

The advantages of SF_6 CBs are as follows:

1. Very short arcing time.
2. Can interrupt much larger current.
3. Noiseless operation.
4. No moisture problem.
5. No risk of fire.
6. Low maintenance cost.

The only disadvantage of SF_6 CB is that SF_6 is costly thereby increasing the cost of CB.

3.6.4. Types of indoor switchgears:

a. Stationary Cubicle type
b. Draw-out or Truck type
c. SF_6 filled switchgear
d. Fuse-switch units
e. Flame proof or Explosion proof switchgear
f. Cellular type
g. Corridor switchboard
h. Mimic diagram board
i. Metal-clad switchgear
j. Isolator and earthing switch-Vertical break isolator-Double break isolator

3.6.5. Thermal Relays: -

A thermal relay consists of a bimetallic strip which is heated by the means of a heating coil that is supplied through a current transformer. An insulated arm carrying contact is pivoted and is held in contact with the strip with the help of a spring. The tension of spring can be varied by rotating the sector shaped plate.

Under normal working conditions, the strip remains straight, but when the strip is heated it bends and the tension of the spring is released thus the relay contacts are closed which energises the trip circuit. The setting of relay can be achieved by varying the tension of the spring. The construction of bimetallic element consists of two nickel-alloyed strips and steel strips welded together. These strips have high heat resistivity and are free from thermal secondary effects and aging. Each of these strips is subjected to an artificial aging process and they are individually calibrated under currents. These relays assume a temperature higher than the surrounding parts and must have a short circuit capacity corresponding to the breaking capacity of circuit breaker itself. This is achieved by using the heat resisting bimetal material of suitable dimensions having large thermal time constant.

These over current tripping relays are used mostly for motor controls and their heating elements are designed to withstand short time overload up to seven times the full load current.

Only the smaller size of the indirect current heated bimetallic elements from 4A to 6.5A are used while 30A motor protective circuit breaker will call for the additional fuses for the protection of winding along with relays. The smallest thermal relays of 400A circuit breakers are short circuit proof up to 200 times their top current rating, i.e. up to 8 KA which is adequate.

3.6.5.1 Ratings of thermal relay are as follows:

With winding-temperature indication type R.B. form- H2AW74

Contact capacity for

(a) Cooker control	5A & 230V
(b) For all arms	0.2A & 125V (D.C.)
(c) For trip	0.2A & 125V (D.C.)
(d) Power supply	230V (A.C.)

Bushing	Sec. Thermal	Current Ratio	VA	Accuracy
A_6	$AS_1 + AS_2$	--	--	--
B_6	$BS_1 + BS_2$	400/1	60	5P20
C_6	$CS_1 + CS_2$	--	--	--
N	$N_1S_1 - N_1S_2$	400/1	60	5P20
N	$N_2S_1 - N_2S_2$	--	--	--

3.6.6. Wave Trap: -

This is used for communication by means of which, two grid substations may communicate and receive messages.

3.6.7. Switchyard: -

The air at high pressure required for ABCB is produced by the compressor. There are two compressors for this purpose at TTPS. Both the compressors are run by the diesel engines. This is to ensure that interruption of power supply does not affect the operation of CB. The compressor maintains the pressure of air in main air tank. The compressor starts

automatically when pressure of air in main tank falls below 33 kg/cm^2 and stops automatically when pressure in main tank has reached 40 kg/cm^2.
Each ABCB is provided with its own subsidiary air tank. This tank contains air at pressure of 23 kg/cm^2 which is the operating pressure of the ABCB. The subsidiary tank ensures that sufficient air is available for ABCB operation while its operation does not affect the main tank pressure. Similarly, subsidiary tank of isolation contain air at pressure of 16 kg/cm^2. Two sets of contact are provided for each phase of ABCB so that one of these may operate if the other fails.

3.6.8. Tracks for Transformer: -

Transformers are placed on the tracks (similar to railway tracks). This is done to aid the transportation, loading, unloading and installation of transformer. Using these tracks, transformer may be taken to the cranes which then lift and place the transformer on the vehicle. Similarly, cranes download these transformers which are then transported through the tracks to the site of installation.

3.6.9. Switchgear: -

The drives for auxiliary equipment rated 150kW and above are operated at 6.6kV and drives having a rating below 150kW are operated at 415V, 3-phase, and 4-wire system having a provision for single phase 230V. For starting up of these motors suitable switchgears/starters are provided.

a) **6.6 kV Switchgears**: 6.6 kV power received from either Unit Auxiliary Transformer or Reserve Transformer are connected to respectively 6.6 kV switchgear bank through suitable breakers for further distribution to motors and to transformers for further step down to 415V.

b) **415 V Switchgear**: The 415V supply from each 1000 kVA transformer are connected to a suitable 415V bus having its distribution for different motors and starters. Motors capacity above 90kW are controlled by a 415V breaker from respective bus and that of lower capacity by magnetic contractors grouped together in a sheet metal cubicle for a number of motors, termed MCC. Protection and control for individual motors is provided there.

c) **220kV Switch Yard:** Generator Transformer step-up the 11 kV voltage generated by the Generator to 220 kV. This voltage is used to charge the three buses in the Switch yard which follows Double Bus Bar with Transfer Bus Scheme.

Switch yard provides protection between generator transformer and transmission lines.

3..6.10. Major components of 220 kV Switch yard is: -

a) Power Transformer – 4.
b) Reverse Transformer - 2.
c) Buses (Bus #1, Bus #2 & Transfer Bus).
d) Isolators.
e) Circuit Breaker-
    1. Air blast circuit breaker
    2. Oil circuit breaker
f) Current Transformer (CT).
g) Capacitor Voltage Transformer (CVT).
h) Wave Tape.
i) Potential Transformer (PT).
j) Bays (4-Transmission line, 4-GT, 2-Station transformer, 1-Bus coupler, 1- Transfer Bus

CONCLUSION

It was worth an educational experience to see the working of various electrical and electronic devices in practical, which I had just read about in books.
The process of knowing about the various stages of thermal power generation (from coal) including the boiler & it's auxiliaries, the steam generating units & auxiliaries and the compounding, governing, protection testing & regulation of turbines was a great experience.
Observing the practical implementation of the various electronic devices like transducers, signal converters, transmitters & relays and the electrical equipments like current transformers, potential transformers, generators, exciters, switch gears, circuit breakers etc. added a lot to my knowledge.
To know about the various stages in a water treatment plant was a new experience.
And lastly, I would like to mention about the team work, co-ordination and time management which exists among the various departments of the unit. This has really helped me to learn about the job skills.

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