Vocational training report on

THE COUNTRY'S LARGEST THERMAL POWER STATION

VINDHAYACHAL SUPER THERMAL POWER STATION(3260 MW)

Pankaj Baghel
B.Tech.
Mechanical Engineering
IIT Kanpur

Acknowledgement

With deep reverence and profound gratitude I express my sincere thanks to **Mr. A.K Singh, AGM (TMD)** for giving me an opportunity to do training at NTPC/VSTPP. I also would like to thank **Mr. Abhishek Rai, Supdt.(TMD)** 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 Mr. Arvind Baghel(MTP), Mr.Shiv Shankar Vyas. (EMD) for helping me throughout the trainingAt last I would like to convey my thanks to all the members of the staff of NTPC who have helped me at every stage of training.

Training Period: 15 May 2013 to 15 June 2013

Contents

INTRODUCTION

NTPC is the largest thermal power generating company of India. A Public sector Company wholly owned by government of India. It was incorporated in the year 1975 to accelerate power development in the country. Within a span of 30 years, NTPC has emerged as a truly national power company, with power generating facilities in all the major regions of the country. Contributing 28.5% of the country's entire power generation. NTPC today lights up every fourth bulb in the country.

With ambitious growth plans to become a 56000MW power company by 2017, NTPC the largest power utility of India has already diversified into hydro sector. 18 NTPC stations have already been accredited with the ISO 14001 certification. In keeping with its well focused environment protection policy, NTPC has set up a "Centre for Power Efficiency and Environmental Protection" (CENPEEP) which functions as a resource centre for development and dissemination of latest technologies in environmental management.

NTPC-Vindhyachal

STATION PROFILE

LOCATION:

Vindhyachal station of NTPC is located at Vindhyanagar in Sidhi District of MP state. The station is situated on the bank of Govind Vallabh Pant Sagar popularly known as Rihand reservoir. Distance of station from Varanasi in UP and Sidhi in MP is about 240 Kms. and 100 Kms. respectively.

CAPACITY:

Stage-I (Six units of 210 MW each)	1260 MW
Stage-II (Two units of 500 MW each)	1000 MW
Stage-III (Two units of 500 MW each)	1000 MW
Stage-IV(One unit of 1000 MW) (under construction)	1000 MW

Stage-I & Stage-II were totally declared commercial in Feb'92 and Oct'2000 respectively.

Stage-III – Unit-9 Synchronised on 27th July 2006 and unit became commercial from 1st December 2006.Unit -10 was synchronized on 8th March 2007 and unit became commercial from 15th July 2007

LAND:
Total land acquired is 6178 acres.

WATER:
Water for NTPC Vindhyachal is drawn from NTPC Singrauli station discharge channel which in turn takes it from Rihand reservoir. A total commitment of 190 cusecs of Make -up water is already available which covers requirement for Stage-I, II & III. Closed loop cooling water system using Cooling Towers has been adopted at Vindhyachal Station.

COAL:
The coal linkage for this station is from the Nigahi Coal Mines of NCL. From there, the coal is transported by Merry Go Round (MGR) transportation system (22 Kms length with double track) owned and operated by NTPC. The requirement of coal per year for use in stage- I, II and stage-III is around 17.1 million MT .

PROJECT COST:
The approved cost of Stage-I (6X210 MW) is Rs. 1460.37 crore with the part financing by erstwhile USSR assistance amounting to 303.66 Million rouble.

The approved cost of stage-II (2 X500 MW) is Rs. 2702 Crore. International assistance from IBRD time-slice loan of US $ 400 Million has been utilized for part financing of stage-II.
The approved cost of stage-III (2 X 500 MW) is Rs.4125.00 Cr.

STATION HIGHLIGHTS:

- The Stage-I (6 X 210 MW) has been implemented with Techno-economic assistance from erstwhile Soviet Union and its main equipments were supplied by Russia.
- Stage-II (2 X 500 MW) units incorporated latest technology for Instrumentation & Control. Main equipments have been supplied by M/s-BHEL.
- Vindhyachal 2260 MW Station dedicated to the Nation by then Union Power Minister Shri Suresh Prabhu on 13th July'2001
- Vindhyachal supplies power to the Western region grid.
- Vindhyachal is accredited with ESHQ (Environment Safety Health & Quality) for following Environment management systems, Safety & Occupational Health management systems & Quality management systems.
- Vindhyachal is accredited with '5 S' and SA 8000 Certification for work place Management.
- CII EXIM award for strong commitment for excellence.

ENVIRONMENT MANAGEMENT:

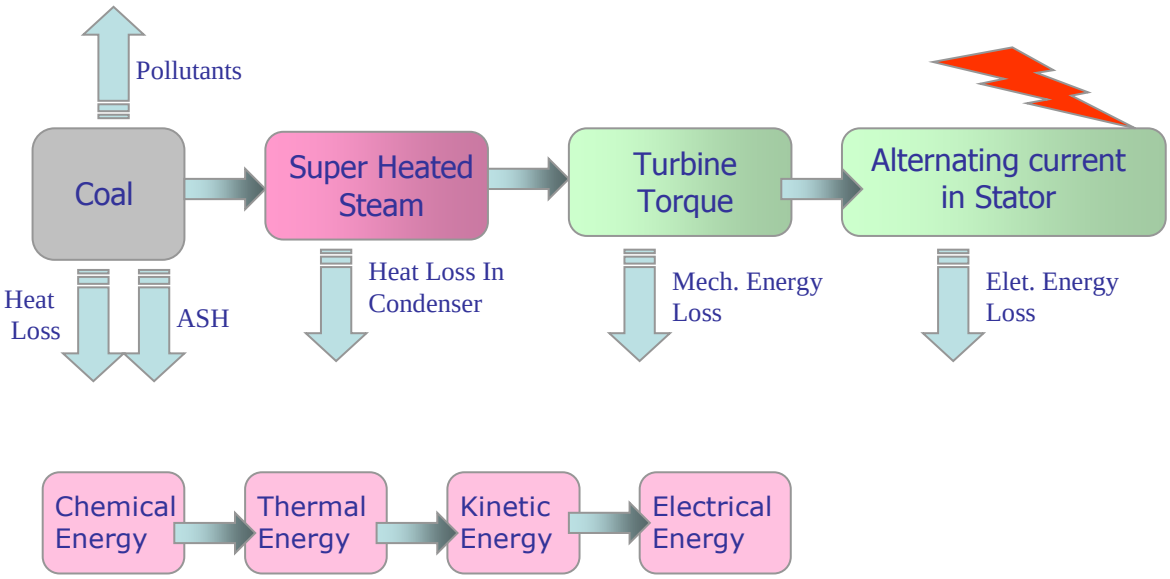
NTPC-Vindhyachal is ISO-14001 certified for adopting and implementing systems for Environment Management. Highlights of major work being done in this field and facilities available at Vindhyachal are given below-

- Station is ISO –14001 certified
- Winner in environmental management in NTPC, under NTPC award scheme.
- Vindhyachal has four on line air quality monitoring stations
- Environment laboratory of Vindhyachal is approved by MP Pollution Control Board
- Regular monitoring of stack emission and ambient air is being done
- A central sewage treatment plant is in operation at Vindhyachal
- All environmental parameters are within prescribed limit
- Ash Water recycling and Liquid Waste Treatment Plant are in regular operation

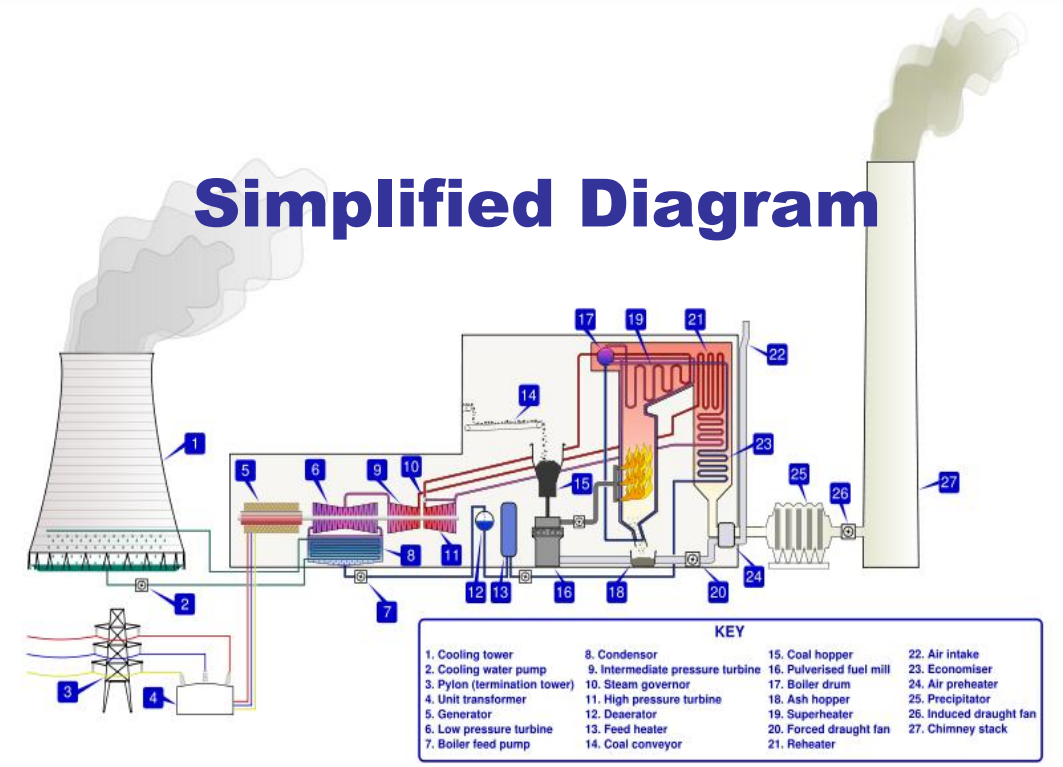
TREE PLANTATION:

Due emphasis has been given on Tree Plantation at NTPC-Vindhyachal. So far more than 17.38 lakh trees have been planted in and around the station. The work of tree plantation is being taken as one of the targets every year and is being monitored regularly.

Coal to Electricity ..... Basics



COMPLETE DESCRIPTION OF POWER PLANT



PA fan – **Primary Air fan**
FD fan- **Forced Draft fan**
ID fan- **Induced Draft fan**
ESP- **Electrostatic Precipitator**
CEP- **Condensate Extraction Pump**
BFP- **Boiler Feed Pump**
GSC- **Gland Steam Cooler**
LPH – **Low Pressure Heater**
DA- **Deaerator**
HPH- **High Pressure Heater**
OAC- **Open Approach Channel**
RAH- **Regenerative Air Heater**
DM water- **De-Mineralized water**

The coal from mines is received at track hopper in **CHP** through **BOBR Wagons**. The unloaded coal (max. size 250 mm^2) is scooped into conveyor by **Rotary Plough Feeders** & is passed through suspended magnet, magnetic separators, and metal detectors, to ensure that sized coal, free of foreign material is supplied. Then it is sent to Crusher House for further crushing to 25- mm^2 size. After crushing, the coal again screened for elimination of extraneous materials, weighed and sent to boiler bunkers. Excess coal, if any, is sent to coal yard for stacking. It then falls through a weigher into the Bowl Mill where it is pulverized. The mill usually consists of a round metal table on which large steel rollers or balls are positioned. The table revolves, forcing the coal under the rollers or balls which crush it. Air is drawn from the top of the boiler house by the **FD Fan** and passed through the **RAH**, and then send to boiler for burning of coal. **PA Fan** takes air from atmosphere and distributes them into 2 parts one send to **RAH** for heating and other fed directly to Mill blowing coal along pipes to boiler furnace.

The boiler consists of a large number of tubes extending the full height of the structure and the heat produced raises the temperature of the water circulating in them to form superheated steam which passes to the **Boiler drum**. The steam is fed through the outlet valve to the **HP Turbine**(High Pressure turbine) at around 540°C.After this, it is returned to the boiler and reheated before being passed through the **IP & LP Turbine**(Intermediate and Low Pressure Turbine).The water fed into boiler is DM water.

.

From the turbine the steam passes into **Condenser** to be turned back into water. This is pumped through CEP which sends water through **GSC, LPH, and HPH** for further heating and **BFP** then sends it to the **Economizer** where the temperature is raised sufficiently for the condensate to be returned to the lower half of the steam drum of the boiler.

The flue gases produced in boiler are used to reheat the condensate in the **Economizer** and then passes through the ***RAH*** to the **ESP** where ash is collected. Finally, they are drawn by the **ID Fan** into the main flue and to the chimney.

From the boiler, a steam pipe conveys steam to the turbine through a stop valve (which can be used to shut off steam in an emergency) and through control valves that automatically regulate the supply of the steam to the turbine. The turbine shaft usually rotates at ***3000 RPM***. This speed is determined by the frequency of the electricity system and the number of poles of machine (2- pole machine here).

Cold water from ***OAC*** is circulated through the condenser tubes and as the steam from the turbine passes round them it is rapidly condensed into water. Water which gets heated up in condenser by cooling steam is sent to **Cooling tower** and then left into **OAC** from where it can be further used.

The electricity is produced in turbo generators and is fed through terminal connections to **Generator Transformer**, those steps up the voltage to **400kv**. From here conductors carry it to **Switchyard** from where it is sent for use.

Coal Handling Plant

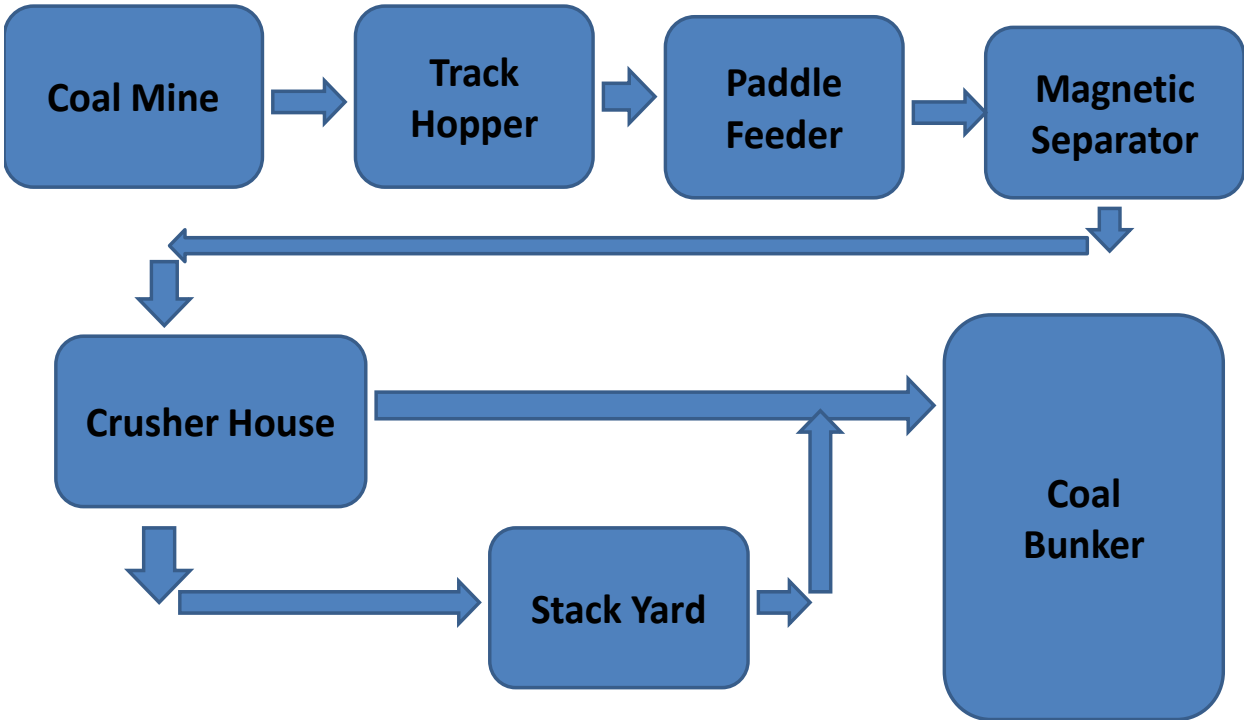
- Coal is the prime input for a thermal power plant, accounting for about 67% of the total energy consumption in the country .
- Coal is a combustible black or brownish-black sedimentary rocks.
- Each Thermal Power Project has been linked to a particular coal mine to meet its coal requirements.
- VSTPS meet its coal requirement from Dudhichuha and Nighahi Coal mine of NPCIL and also import coal from Indonesia .

Objectives of Coal Handling Plant are

- Transportation and Handling of Coal.
- Arrangement for transferring of coal from

  coal- wagons to coal-bunker or coal stock yard.
- Supply of Crushed coal to bunker

CHP: Overview



At power plant, coal is unloaded in track hoppers of length 200-250m normally. The unloading mechanism used in NTPC is Bottom Open Box type Rake (BOBR).

Paddle Feeder is used to used to feed coal to conveyor belt from track hopper.

After separation of magnetic particles from coal, it is carried to the Crusher House through conveyor belts and after that it is either stored at Stack Yard to be carried to coal bunker for burning.

BOILER

Boiler is device for generating steam for power processing or heating purposes. Boiler is designed to transmit heat from an external combustion source contained within the boiler itself.
Boilers may be classified on the basis of any of the following characteristics:

1. **Use:** The characteristics of the boiler vary according to the nature of service performed. Customarily Boilers are called either stationary or mobile.

2. **Pressure:** To provide safety control over construction features, all boilers must be constructed in accordance with the Boiler Codes which differentiates boilers as per their characteristics.

3. **Materials:** Selection of construction materials is controlled by boiler code material specifications.

4. **Size:** Rating core for boilers standardize the size and ratings of boilers based on heating surfaces. The same is verified by performance tests.

5. **Tube Contents:** In addition shell type of boiler, there are 2 general steel boiler classifications, the fire tube and water tube boilers.

6. **Firing:** The boiler may be a fired or unfired pressure vessel.

7. **Heat Source:** The heat may be derived from
    1. The combustion of fuel
    2. The hot gases of other chemical reactions

3. The utilization of nuclear energy

8. **Fuel:** Boilers are often designated with respect to the fuel burned.

9. **Fluid:** The general concept of a boiler is that of a vessel that is to generate a steam.

10. **Circulation:** The majority operate with natural circulation. Some utilize positive circulation in which the operative fluid may be forced 'once through' or controlled with partial circulation.
11. **Furnace position:** The boiler is an external combustion device in that the combustion takes place outside the region of boiling water. The relative location of the furnace to the boiler is indicated by the description of the furnace as being internally or externally fired. The furnace is internally fired if the furnace region is completely surrounded by water cooled surfaces. The furnace is externally fired if the furnace is auxiliary to the boiler.

Boiler accessories:-

Boiler 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 can be isolated and confined so that the reaction remains a controlled force. It provides support or enclosure for the firing equipments

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

Economizer: The purpose of the economizer is to preheat the boiler feed water before it is introduced into the steel drum by recovering the heat from the fuel gases leaving the boiler. The economizer in the boiler rear gas passes below the rear horizontal super heater.

Super Heater: There are 3 stages of super heater besides the side walls and extended side walls. The first stage consists of horizontal super heater of convection mixed flow type with upper and lower banks located above economizer assembly in the rear pass. The 2^{nd} stage super heater consists of pendant platen which is of radiant parallel flow type. The 3^{rd} stage super heater pendant spaced is of convection parallel flow type the outlet temperature and pressure of the steam coming out form the super heater is 540 **ºC** and 157 kg/cm^2.

Preheater: The function of preheater is to reheat the steam coming out from high pressure turbine to a temperature of 540 **ºC.**
Burners: there are total 24 pulverized coal burners for corner fired C.E. type boilers and 12 oil burners provided each in between 2 pulverized fuel burners.

Igniters: There are 12 side Eddy plate oil/ H.E.A igniters per boiler. The atomizing air for igniters is taken from plant air compressor at 7 kg/cm^2. There are 2 igniter air fans supply air for combustion of igniter oil. Mainly 2 types of igniters are used:-

1. eddy plate igniter
2. high energy arc type igniter.

Boiler Feed Pump

BFP is multistage centrifugal pump meant to supply boiler with required feed water at high pressure.

It comprises of impeller and diffuser arrangement to simultaneously increase velocity and pressure.

TECHNICAL SPECIFICATION OF BFP
of Stage-1

- No. of BFP - 3 (2 running + 1 Stand by)
- CAPACITY (M^3/HR) - 380
- DELIVERY HEAD - 2320 M
- PERMISSIBLE +VE SUC. HEAD - 10 kg/cm2
- FEED WATER TEMP.(^{0}C) - 165
- NO. OF PUMP STAGES - 11
- PUMP I/L TEMP.(^{0}C) MAX. - 165
- NOMINAL SPEED (RPM) - 2890
- Power - 4 MW
- FLOW RATE THROUGH R/C(M^3/HR) - 130

STEAM TURBINE

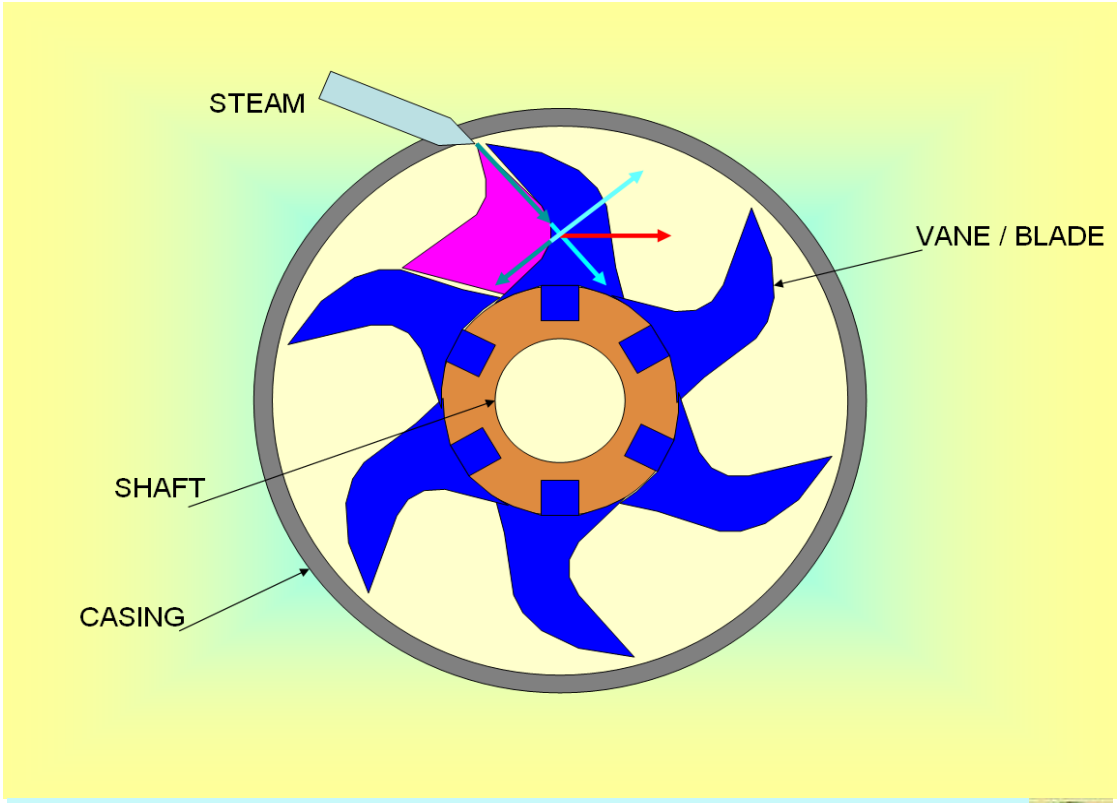
A **steam turbine** is a mechanical device that extracts thermal energy from pressurized steam, and converts it into useful mechanical work.

Three turbines, HP turbine, IP turbine and LP turbine, are synchronized together with a common shaft connected to the generator. HP and IP turbines have single flow unit while LP turbine has double flow unit so as to accommodate the increase in volume of steam due to the drop in pressure.

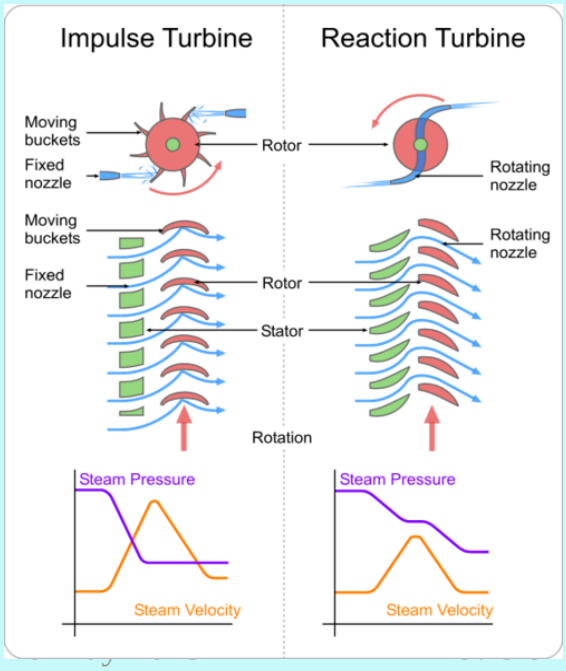
High pressure steam enters the HP turbine at 170 Kg/cm^2 and 540^o C temperature. The steam leaves the HP turbine at a pressure of 30 Kg/cm^2 and is carried to re-heaters which heats it up to a temperature of 540^o C while maintaining its pressure at 30 Kg/cm^2. This steam is carried to IP turbine after which it is directly send to LP turbin. The steam reaches to LP turbine at a pressure of 1.5 Kg/cm^2.

The steam is also carried from turbines to LP heaters and HP heaters to heat the water entering the boiler. After loosing its pressure and temperature steam is taken to the condenser.

Power output is proportional to the steam pressure drop in the turbine



एनटीपीसी
NTPC



Impulse and reaction Turbine

Turbine Auxiliaries

Regenerative Heaters

- The regenerative heaters are used to heat the Condensate from the condenser to the boiler inlet.
- This makes the mean temperature of heat addition in boiler high resulting in high efficiency.
- The heating is done by steam bled from different stages of HP, IP and LP turbines.
- The heaters are non mixing type.
- The drip formed is cascaded to lower heaters in the line and finally to deaerator(for HP heaters) and condenser (for LP heaters)
- The heaters before BFP are called Low Pressure Heaters (LPH) and those after BFP are called High pressure heaters (HPH).
- The Deaerator is the only mixing type heater in the power plant.
- In some design drip pumps are used to pump the drip from LPHs to the main condensate line.

Ejector

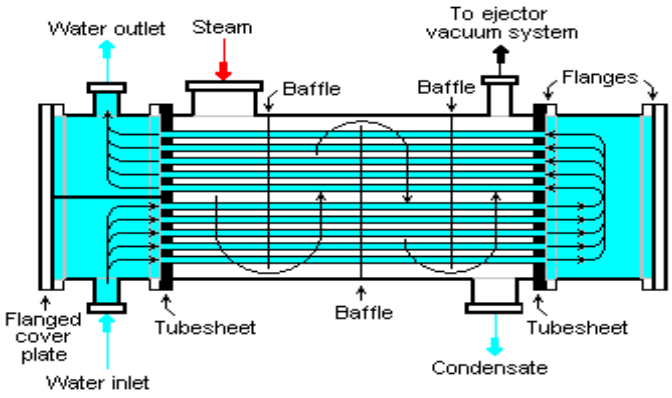
- The ejector is used to remove air from the condenser steam space so that proper cooling and thus vacuum can be maintained.
- The ejector uses steam and expands it in the nozzles of the ejector to create vacuum which sucks the air steam mixture. This is then expanded in the diffuser and pressure is increased.
- A 3 stage ejector is used to eject the air from the condenser to the atmosphere.
- Some designs use vacuum pumps to suck air.

Barring gear:

When turbine is shut down cooling of its internal elements continue for many hours.if rotor is allowed to stand still during this period distortion comes immediately.this distortion is caused due to flow of hot vapours to the upper part of the casing resulting in upper half at higher temp than lower half.hemce it causes distortion.

COOLING WATER CYCLE:

Condenser:



Condenser is basically a heat exchanger which condenses a steam and converted into water. After expansion of steam in LP turbine it enters in the condenser. In condenser there are many water tubes are provided to condensate the steam.

- It is provided to expand the working steam below the atmospheric pressure.
- It also converts the steam water mixture to water by condensation. This water can be easily transported (than the steam) to the boiler.
- There are tubes which carry the clarified water.
- On the shell side the steam condenses.
- For a 210 MW LMZ turbine the number of condenser tubes is 16760. For a 500 MW KWU m/c the number is about 25000.
- These tubes can be made of alloys of Cu & Ni, SS.
- During overhauling the tubes are cleaned by special bullets which are triggered by pressurized water. This cleaning removes deposits from the tube inner surface.
- After overhauling it is important to detect the leaking tubes by carrying out “FLOOD TEST”.

Cooling Tower

The hot water from condenser outlet reaches to cooling tower. Cooling towers are evaporative coolers to remove the heat of water so that water can be recirculating & can be reused. This heat of water is rejected to the atmosphere by evaporation. In NTPC modern types cooling tower uses in which cooling fan (suction) is required to remove the heat of water.

TURBOGENERATOR:

This Turbo generator is basically a Synchronous Alternator. The stator houses the armature windings and the rotor houses the field windings. D.C. voltage is applied to the field windings through the slip rings or brushless excitation system. When the rotor is rotated the lines of magnetic flux cut through the stator windings. This induces an e.m.f. in the stator windings.

The rotor is rotated at 3000 rpm by the turbines and a frequency of 50 Hz is required, by the formula f=nP/2, we see that it is a 2 pole machine. The generator used in NTPC has YY configuration in the stator. This is done to distribute the amount of generated current among the two circuits in order to increase the amount of output current by reducing the branch impedance since voltage induced remains constant.

Generator Components:

1. **Rotor:** The rotor is a cast steel ingot and it is further forged and machined. The rotor is to be designed very accurately as it has to work on speeds such as 3000 rpm. Also a fairly high current is to be carried by the rotor windings to generate the necessary magnetic field.

2. **Rotor winding:** Silver bearing copper is used for the winding with mica as the insulation between conductors. A mechanically strong insulator such as micanite is used for lining the slots. When rotating at high speeds centrifugal force tries to lift the windings out of the slots, so they are screwed to the rotor body. The two ends of the windings are connected to slip rings, usually made of forged steel.

3. **Stator core:** The stator is the heaviest load to be transported. The major part of this load is stator core. This comprises of an inner frame and outer frame. The outer frame is a rigid fabricated structure of welded steel plates, within this shell is a fixed cage of girder built circular and axial ribs. The ribs divide the yoke into compartments. The inner cage is usually fixed to the yoke by an arrangement of springs to dampen the double frequency vibrations.

   The stator core is built from a large number of punchings or sections on thin steel plates. The use of **CRGO** can contribute to reduction in weight of stator core.

4. **Stator windings:** Each stator conductor must be capable of carrying the rated current without overheating. The insulation must be sufficient to prevent leakage currents flowing between the phases to earth. Windings for the stator are made up from copper strips wound with insulated tape which is impregnated with varnish, dried under vacuum and hot pressed to form a solid insulation bar. These bars are then placed in stator slots and held in with wedges to form the complete winding. The end turns are rigidly braced and packed with blocks to withstand the heavy forces.

Generator Cooling:-

Rotor Cooling System: The rotor is cooled by means of gap pick up cooling, wherein the hydrogen gas in the air gap is sucked through the scoops on the rotor wedges and is directed to flow along the ventilating canals milled on the sides of the rotor coil, to the bottom of the slot where it takes a turn and comes out on the similar canal milled on the other side of the rotor coil to the hot zone of the rotor. Due to rotation of the rotor, a positive suction as well as discharge is created due to which a certain quantity of gas flows and cools the rotor.

The conductors used in the rotor windings are hollow which is done to have internal cooling of the rotor.

Hydrogen Cooling System: Hydrogen is used as a cooling medium due to its high heat carrying capacity and low density. But it can also form an explosive, or escape out of the generator casing which may result into many catastrophic results. So the pressure of H_2 should be maintained properly. The filling in and **purging of H_2** is to be done safely without bringing in contact with air. To fill H_2 inside generator first CO_2 is filled through generator and then H_2 is passed since H_2 has no reaction with CO_2 and while taking H_2 out of generator first H_2 is taken out then CO_2 is passed through generator and then air is allowed to enter.

To stop the hydrogen from escaping the generator casing oil sealing is done. The shaft of the rotor has many blades connected at the end of the shaft. Each of the blades rotates in the slot engraved in the generator casing. Now these slots are filled with oil up to a certain level, so that the ends of the blades rotate in an oil medium which is separated among them. So when the H_2 tries to escape and comes near the end of the shaft it passes through the blade that is through the oil in the slot, due to which a major part of it gets obstructed and the left out gas proceeds to the next slot. Now at the end there is almost no or negligible amount of gas leakage.

Stator Cooling System: The stator is cooled by distillate which is fed from one end of the machine by Teflon tube and flows through the upper bar and returns back through the lower bar of another slot. The stator winding is cooled in this system by circulating DM water through hollow conductors. The DM water should be at 40°C. As it is a closed loop the water that comes out of the generator is again cooled and demineralized. Water passes through lower bars along the length to the other end returns through the upper bars of another slot and drain into drain header.

RATINGS OF TURBO GENERATOR

Stage-I

Rated Voltage:	15.75 kV
Rated Power:	210 MW
Rated KVA :	247 MVA
Stator Current:	9067 A
Rotor Current:	2640 A
Frequency:	50 Hz
Connection:	YY (DOUBLE -STAR)
Power Factor:	0.85 LAG
Rated H_2 Pressure:	4KgF/cm^2
Operational Duty:	S_1
Class of Insulation:	B

Stage-II

Rated Power:	500 MVA
Rated KVA :	588MVA
Stator Voltage:	21 kV
Stator Current:	16200A
Rotor current:	4040A
Rotor voltage:	340V
Rated H_2 pressure:	3.5 bar(g)
Power factor:	0.85 lag
Stator winding cooling:	Direct water cooling(DM water)
Stator core and rotor Cooling:	Direct H_2 cooling
Rated Speed:	3000 rpm
Frequency:	50 Hz

Connection: YY
Class of Insulation: B

TRANSFORMER

The transformers used in a power station have its sides abbreviated as Low Voltage (LV) and High Voltage (HV) rather than primary and secondary.

Major transformers in a power station:

1) Generator transformer: The generator is connected to this transformer by means of isolated bus duct. This transformer is used to step up the generating voltage of 15.75 KV or 21 KV (depending on the generator) to grid voltage normally 400 kV. This transformer is generally provided with OFAF cooling.

2) Unit Auxiliary Transformer (UAT):

The UAT draws its input from the main bus duct connecting generator to the generator transformer. It is used for the working of large devices such as boilers, heavy motors etc. The total kVA capacity of UAT required can be determined by assuming 0.85 power factor and 0.9 efficiency for total auxiliary motor load. For large units, it has become necessary to use more than one auxiliary transformer. It uses the generated 15.75kV to covert into 6.6 kV in stage I and 21kv into 11kv & 6.6kv in stage II & stage III.
The maximum short circuit currents on auxiliary bus should be limited with in the maximum switch gear rating available. The maximum permissible voltage dip while starting the largest single auxiliary motor, usually boiler feed pump, shall remain within acceptable limits.

3) Station Transformer: The station transformer is used to feed the power to the auxiliaries during the start ups. This transformer normally rated for the initial auxiliary load requirements of unit. In

physical cases this load is of order of 60% of the load at full generating capacity. It is also provided with on load tap changer to cater to the fluctuating voltage of the grid.

4) ICT (Inter Connecting Transformer): It connects 400KV substation to 132 KV substations.

5) CPT (Construction Power Transformer): This is the transformer which gives the output for construction in which the voltage required is 220 V.

Cooling of transformer:

Heat is produced in the winding due to the current flowing in the conductors (I^2R) and in the core on account of eddy currents and hysteresis losses. In small dry type transformer heat is dissipated directly to the atmosphere. In oil immersed transformer heat is dissipated by **THERMO SIPHON ACTION**.

The purpose of using oil is:-

1. **Cooling:** Provides a better cooling and helps in exchanging heat
2. **Insulation:** A non conductor of electricity so good insulator.

The oil used is such that its flash point is pretty high so that it doesn't have any possibility to catch fire.

There various types of cooling:-

1. AN – Air Natural
2. ON – Oil Natural
3. AF – Air forced
4. OF – Oil forced
5. ONAF – Oil natural Air forced
6. OFAN - Oil forced Air natural
7. OFAF – Oil forced Air forced

The oil serves as the medium for transferring the heat produced inside the transformer to the outside transformer. **Thermo siphon action** refers to the circulating currents set up in a liquid because of temperature difference between one part of the container and other.
When oil gets heated up the oil with greater temp, goes to the upper side of the transformer. Now if it is Oil natural it is cooled in it as it is whereas in Oil Forced a radiator is being constructed and a pump is being attached to it to pull the oil from the upper part of the transformer.

Now this oil in the chamber gets cooled either by direct heat exchanging through the atmosphere which is called Air Natural or by forced air draft cooling by a radiator with many electric fans which are automatically switched on and off depending upon the loading of transformer which is known as Air Forced cooling.
As the oil gets cooled it becomes heavier and sinks to the bottom.

Transformer accessories:

Conservator: With the variation of temperature there is corresponding variation in the oil volume. To account for this an expansion vessel called conservator is added to the transformer with a connecting pipe to the main tank. It is also used to store the oil and make up of the oil in case of leakage.

Breather: In conservator the moisture from the oil is excluded from the oil through breather it is a silica gel column, which absorbs the moisture in air before it enters the conservator air surface.

Radiator: This a chamber connected to the transformer to provide cooling of the oil. It has got fans attached to it to provide better cooling.

Stage –1

GENERATOR TRANSFORMERS *6 Nos (one for each unit)*

Rating: 250 MVA
No load voltage : 420/15.75 kV
Current : 343.66/9164.29 A
Cooling : OFAF
Vector group: Ynd11
Phase : 3
Freq.: 50HZ
Make : BHEL

UNIT AUXILIARY TRANSFORMERS (UAT) *6 Nos (one for each unit)*

Rating : 32 MVA
Transformation ratio: 15.75 ± 12% / 6.9-0-6.9
Vector group: d/ d-d 11-11

STATION TRANSFORMERS *2 Nos*

Rating : 63 MVA
Transformation ratio: 132 ± 12% / 6.9-0-6.9 kV
Vector group: Yo/ d-d 11-11
Make: RUSSIA

Stage –II & stage-III

GENERATOR TRANSFORMERS *4Nos (one for each unit)*

Rating:	200MVA
No load voltage :	420/sqrt(3)/21kV
Current :	824.79/9523.8
Cooling :	OFAF
Vector group:	Ynd11*
Phase :	1
Freq.:	50HZ
Manufacturer :	BHEL

*after 3 phase bank formation.

UNIT AUXILIARY TRANSFORMERS (UAT) 4 *Nos (one for each unit)*

Rating :	32 MVA
Transformation ratio:	15.75 ± 12% / 6.9-0-6.9
Vector group:	d/ d-d 11-11

STATION TRANSFORMERS *2 Nos*

Rating :	63 MVA
Transformation ratio:	132 ± 12% / 6.9-0-6.9 kV
Vector group:	Yo/ d-d 11-11
Make:	RUSSIA

The transformers used in **Stage 2** are single phase transformers that mean 3 single phase transformers are totally used for power transmission. The rating there is 600 MVA out of which the real power output is 500 MW. The input in this case is 21 kV. The reason for using 3 different transformers in this case is due to the high power rating.

To reduce the losses the core is made up of a special type of material which is **CRGO (Cold Rolled Grain Oriented)** steel which is further laminated to reduce the eddy current losses.

SWITCHYARD

It is a switching station which has the following credits:
(i) Main link between Generating plant and Transmission system, which has a large influence on the security of the supply.
(ii) Step-up and/or Step-down the voltage levels depending upon the Network Node.
(iii) Switching ON/OFF Reactive Power Control devices, which has effect on Quality of power.

SWITCHYARD EQUIPMENTS

Transformers:
Transformer transforms the voltage levels from higher to lower level or vice versa, keeping the power constant.
Inter connecting transformer (ICT) are used to connect 400KV switchyard to 132KV switchyard.

Circuit breakers:
Circuit breakers makes or automatically breaks the electrical circuits under loaded condition.

Isolators:
Opens or closes the electrical circuits under No-load conditions.

Instrument transformers :

Instrument transformers are used for stepping-down the electrical parameter (Voltage or Current) to a lower and safe value for Metering and Protection logics.

CTs are single phase oil immersed type.secondary current is generally 1A, but also 5A in certain cases.

The CVTS are used at 220KV & above. For lower voltages electromagnetic type transformers are mostly used. The secondary voltage is 110/sqrt(3).

Earth switch:

Earth switches are device which are normally used to earth a particular system to avoid accident, which may happen due to induction on account of live adjoining circuits. These don't handle any appreciable current at all.

Lightning arrestors: station type "lightening arresters" are provided at the terminals of the transformers for protection against lightening or any surges developing in the system, the practice is also to install lightening arresters at the incoming terminals of the line. Shielding of substation from direct lightening stroke is provided through earth wires located at structures 'peaks'. Recently masts are also used for the purpose of shielding substation.

Overhead earth wire:

It protects the O/H transmission line from Lightning strokes.

.

SWITCHGEAR

Switchgear is one which makes or breaks an electric circuit. The equipments which normally fall in this category are:-

- **Isolators**
- **Switching Isolators**
- **Circuit Breakers**
- **Load Break Switches**
- **Earth Switches**

Isolators can break an electric circuit when the circuit is to be switched on no-load only. These are normally used in various circuits for the purpose of isolating a certain portion when required for maintenance etc.

Switching isolators are capable of

1. Interrupting transformer magnetized currents
2. Interrupting line charging current and
3. Load transfer switching

Its main application is in connection with transformer feeders as the unit makes it possible to switch out one transformer while the other is still on load.

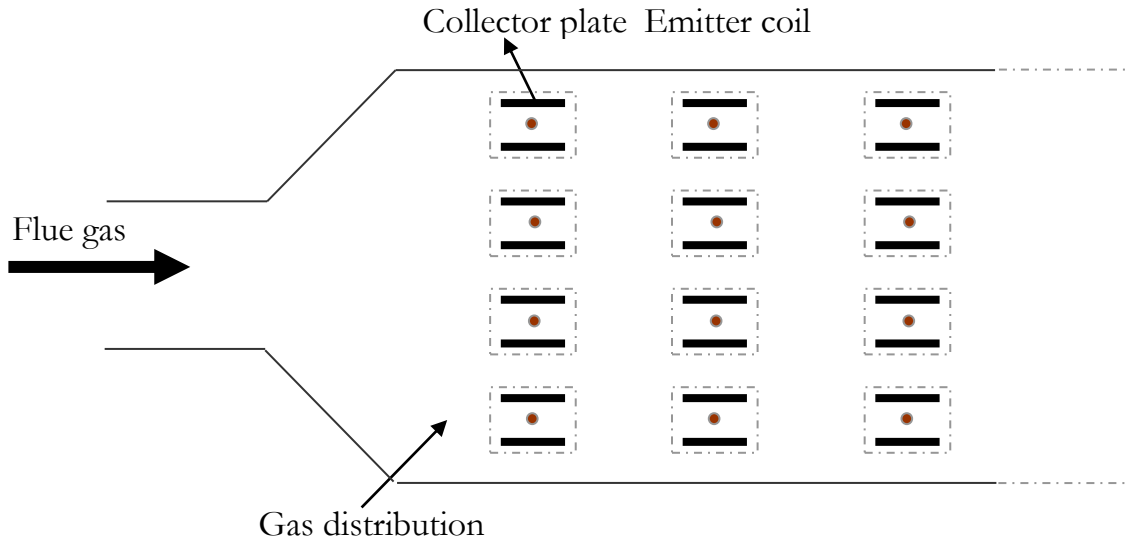
Circuit Breakers can break or make the circuit on load and even on faults. The equipment is most important and is heavy duty equipment mainly utilized for protection of the various circuits and operation at load. Normally circuit breakers are installed accompanied by isolators.

Load break switches are those interrupting devices which can make or break circuits at 8 times the rated current. These are normally installed on the same circuit or on the circuits which are backed up by circuit breakers.

Earth switches are devices which are normally used to earth a particular system to avoid accident, which may happen due to induction on account of live adjoin circuits. These do not handle any appreciable current at all.

ELECTROSTATIC PRECIPATATOR

It is a device which captures the dust particles from the flue gas thereby reducing the chimney emission. Precipitators function by electrostatically charging the dust particles in the gas stream. The charged particles are then attracted to and deposited on plates or other collection devices. When enough dust has accumulated, the collectors are shaken to dislodge the dust, causing it to fall with the force of gravity to hoppers below. The dust is then removed by a conveyor system for disposal or recycling.



ELECTROSTATIC PRECIPATATOR

Electrostatic precipitation removes particles from the exhaust gas stream of Boiler combustion process. Six activities typically take place:

- **Ionization** - Charging of particles
- **Migration** - Transporting the charged particles to the collecting surfaces

- **Collection** - Precipitation of the charged particles onto the collecting surfaces
- **Charge Dissipation** - Neutralizing the charged particles on the collecting surfaces
- **Particle Dislodging** - Removing the particles from the collecting surface to the hopper
- **Particle Removal** - Conveying the particles from the hopper to a disposal point

MOTOR

A 3-φ induction motor, stator connected 2 or 3φ supply produces a rotating magnetic field. Speed of rotation is proportional to the main frequency and inversely proportional to the no. of pair of poles. Stator can have single layer windings with each coil side occupying one stator slot. Many type of stator windings are encountered. 2 most common types are:-

1. **Single Layer winding** – Each winding is distributed over a number of stator slots.
2. **Double Layer winding** – Each stator slot contains sides of two separate coils.

Definition: Motor form the single largest prime mover found in power stations and are used for multipurpose.

Induction motor: There are various types and sizes of motors used in the power stations. These are used for various purposes as prime movers. Apart from the simple motor used in different areas, these HT motors used in the various heavy duty equipments. These are FD, ID, PA fans, boiler feed pumps, CW pumps, etc. These motors have certain special features like cooling, auto starting, inter locks and control. These are generally squirrel cage motors. The rotor never rotates at the synchronous speed. Off load, the induction motor has poor efficiency and power factor. On load we get an efficiency of 85% and 0.8 power factor.

Synchronous Motor: These are motors which always run at synchronous speed and speed of rotation depends upon the pair of poles. Synchronous motors do not start on their own they need an external exciting system which gives it an initial rotation. Generally an induction motor is used for this purpose. As the load increases, load angle increases and power drawn from the supply increases. With an excessive load, the rotor pulls out of

synchronism. When operating at synchronous speed the power factor can be changed by varying the degree of excitation.
The motors are generally started using **DOL (Direct Online Starters)**

Rating of Various motors attached to pumps and fans:

1) **BFP**-4000 kW, 6.6kV, 405A, p.f.-0.89, 2979 RPM. This is the biggest motor of power plant consuming a huge power and rotating at speed greater than that of turbine.

2) **CEP**-250 kW, 6.6kV,26A,1480 RPM

3) **Mill motors**-340 kW,6.6kV,41 A,991 RPM

4) **CWP**-2000 kW, 6.6 kV, 250 A, p.f.-0.74, 300RPM.This is also a big motor which needs to pump large quantity of water thereby reducing its speed.

5) **ID fan**-1250 kW, 6.6 kV, 147 A, 597 RPM

6) **PA fan**-420 kW, 6.6 kV, 45.9 A, 1490 RPM

7) **FD fan**-1st speed - 550 kW, 6.6 kV, 73 A, 597 RPM
2nd speed -1000kW, 6.6 kV, 114 A, 746 RPM

CONCLUSION

Industrial training being an integral part of engineering curriculum provides not only easier understanding but also helps acquaint an individual with technologies. It exposes an individual to practical aspect of all things which differ considerably from theoretical models. During my training, I gained a lot of practical knowledge which otherwise could have been exclusive to me. The practical exposure required here will pay rich dividends to me when I will set my foot as an Engineer.

The training at NTPC Vindhyachal was altogether an exotic experience, since work, culture and mutual cooperation was excellent here. Moreover fruitful result of adherence to quality control awareness of safety and employees were fare which is much evident here.

BIBLIOGRAPHY

- ANNUAL REPORTS OF NTPC

- IN HOUSE MAGAZINES OF NTPC

- WEBSITES VISITED :

  - WWW.GOOGLE.COM
  - WWW.NTPC.CO.IN
  - NTPC/ VSTPP (Intranet)
  - WWW.WIKIPEDIA.COM