4. VIJAYAWADA THERMAL POWER STATION

Vijayawada Thermal Power Station is located at about 10 Kms from Vijayawada city and adjacent to Ibrahimpatnam and Kondapalli settlements. About four to five kilometer away from the power station the fly ash disposal pond is located. Water is supplied to the thermal power station from the Krishna river reservoir at Vijayawada by CW intake canal.

The Vijayawada Thermal Power Station has three stages. Each stage comprises of two units of 210 Mega Watt i.e. 3 stages x 210 mega Watts to make the total installed capacity 1260 Mega Watt. Table No. 4.1 shows the dates of establishments and installed capacity of different units.

Table No. 4.1 Dates of establishments of units and their installed capacities

<table>
<thead>
<tr>
<th>Stage I</th>
<th>Unit 1</th>
<th>Unit 2</th>
<th>1/11/1979</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>210 MW</td>
<td>210 MW</td>
<td>10/10/1980</td>
</tr>
<tr>
<td>Stage II</td>
<td>Unit 3</td>
<td>Unit 4</td>
<td>5/10/1989</td>
</tr>
<tr>
<td></td>
<td>210 MW</td>
<td>210 MW</td>
<td>23/8/1990</td>
</tr>
<tr>
<td>Stage III</td>
<td>Unit 5</td>
<td>Unit 6</td>
<td>31/3/1994</td>
</tr>
<tr>
<td></td>
<td>210 MW</td>
<td>210 MW</td>
<td>24/12/1995</td>
</tr>
<tr>
<td>Total Installed Capacity</td>
<td>1260 MW</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.1 GENERAL LAYOUT OF V.T.P.S.

V.T.P.S. establishment can be divided into three parts (a) VTPS Plant Complex (b) Fly ash pond (c) Residential colony

4.1.1 V.T.P.S. PLANT COMPLEX

The plant area is located at a distance of about one Kilometre from Vijayawada – Hyderabad National Highway, road branches off from highway leading to power station.
The total V.T.P.S. plant area is 566.95 acres. The main plant generating unit is centrally located in the area. On the west of the main plant building, Electrostatic precipitator are placed which caters the removal of fly ash from the gaseous effluents.

Adjacent to the generating unit is demineralisation plant (D.M. plant). This plant removes the salts from the water to be used in the boiler to make free from salts and mineral free. The process of dimineralization is necessary to prevent the formation of scales in the boiler in turn increasing its life.

On the north of the power generating unit is the coal handling unit. Railway line off shoot comes to this unit from the main railway line passing nearby.

On the east of the generating unit are two canals. One is the coolant water (cw) intake canal and other is Budameru canal into which the coolant water is discharged. On the south of the plant is power evacuation unit. Adjacent to the main plant are two chimneys 180 mts tall.

A. Generating Unit:
Generating unit consists of six units, each having a generation capacity of 210 MW. Each unit comprising of one boiler and a generator. Boiler produces super heated steam using dimineralised water produced from D.M. plant and pulverised coal as fuel. This super heated stream spins the turbines of generators to produce electricity. Effluents released are air pollutants and ash.

B. Fuel oil system
Fuel oil system is for handling following processes:
(a) Boiler startup
(b) Flame Stabilisation during low load operation with or without coal firing
Two types of fuel oils are used in this system (i) Light Diesel Oil (LDO) and (ii) Heavy Fuel Oil (HFO) for low load operation and flame stabilization.

C. Electrostatic Precipitators:
Each steam generating unit is provided with an electrostatic precipitator i.e. six electrostatic precipitator are present, one each for each unit. Each precipitator has two parallel gas paths, any of which can be isolated for maintenance when required keeping the other path in operation. Each path comprises of seven fields in series for collection of fly ash, of which six fields are in service and other one is a standby. The ESPS are known to have an efficiency of about 98%. The effluent released here is ash slurry.

D. Dimineralization Plant:
Dimineralization (DM) plant is used to remove the mineral content of the water. Water is first filtered through pressure filters and activated carbon filter units, all installed within the DM plant building. Filtered water is passed through cation resin beds, degassifier towers, anion resinbeds and mixed bed exchangers and deminirelised water is stored in the DM water storage tanks. The capacity of these storage tanks is $2 \times 1000 \text{ m}^3$.

E. Coal Handling System:
Rake of coal wagons, either side discharge type or bottom discharge type, will come over existing track hopper for unloading. For reclaiming coal from track hopper paddle feeders are used to feed two take out conveyors below the track hopper. From track hopper coal is taken to crusher house for pulverisation of coal from crusher house coal is transported through conveyor depending on the demand to either directly to bunkers or to the stockyard. Bunkers, within the power house are suitably sized to store coal of about 24 hours of boiler operation.
From stock-pile coal can be reclaimed by reversible stackers-reclaimer through conveyor for onward transport to boiler bunkers. Emergency reclaim hoppers are provided for reclaiming coal for pile through bulldozers in case of emergency.

Precaution are taken for pollution control by providing dust extraction and dust suppression system in different transfer points and stock pile area and ventilation systems in underground tunnels. Roof extraction fans are provided in crushers house and boiler bunkers floors. Water sprinkling is done before and during coal crushing to reduce the coal dust.

F. Chimney

Two 180 metre high chimneys are present which have three independent flues each. In the first chimney two flumes are connected to the 210 MW units of Stage – I and third is connected to another 210 MW unit of Stage–II.

Another chimney has one flue connected to second 210 MW unit of Stage – II and two 210 MW units of Stage – III. One of these chimneys cattering to the Stage – II and Stage – III effluent is provided with automatic smoke density monitoring systems for measurement of particulate matter emission. However both the chimneys have a facility to periodically monitor the effluent gas quality. Since each chimney catters to a cumulative 630 MW of power generating units the height of these should have been more than 275 m as prescribed height of CPCB.

G. Condensation Water Intake and Discharge

Water for condensation and ash slurry is drawn from coolant water (cw) intake canal. The cooling water is drawn from the Prakasam barrage by a 12 Km long concrete lined canal with capacity of 2000 Cusecs, to meet the ultimate requirement of entire power station. Out of this about 1400 Cusecs is used for condensor cooling and the rest for DM plant, fly ash disposal and domestic requirement.
The hot return water from condenser it let into the Budameru canal to join the river Krishna at about 10 Kilometres upstream of Prakasam barrage. River Krishna has a perennial discharge which is let out from Nagarjuna Sagar Dam. Thus the availability of water round the year is ensured.

The characteristics of Prakasam Barrage and CW intake canal are presented in table 4.2

Table No. 4.2 Salient Features of Prakasam Barrage and CW Intake Canal

<table>
<thead>
<tr>
<th>SI.No.</th>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Prakasam Barrage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Crest level of barrage</td>
<td>13.73 Metres</td>
</tr>
<tr>
<td>2.</td>
<td>Pond level of barrage</td>
<td>17.39 Metres</td>
</tr>
<tr>
<td>3.</td>
<td>Minimum water level in the river Krishna at barrage</td>
<td>13.42 Metres</td>
</tr>
<tr>
<td>4.</td>
<td>High flood level u/s of barrage</td>
<td>22.174 Metres</td>
</tr>
<tr>
<td>5.</td>
<td>Maximum flood discharge</td>
<td>18.48 lakhs cusecs</td>
</tr>
<tr>
<td>B. CW Intake Canal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Length</td>
<td>12 Kilometres</td>
</tr>
<tr>
<td>2.</td>
<td>Discharge</td>
<td>56.64 Cubic metres/sec</td>
</tr>
<tr>
<td>3.</td>
<td>Full supply depth</td>
<td>2.5 Metres</td>
</tr>
<tr>
<td>4.</td>
<td>Free Board</td>
<td>0.5 Metre</td>
</tr>
<tr>
<td>5.</td>
<td>Velocity</td>
<td>1.22 Metre/Sec.</td>
</tr>
</tbody>
</table>

1. **Power Evacuation**

Power from four units of 210 MW of Stage - I and Stage - II are evacuated from the 220 KV switch yard of the power station under Stage - I, which is connected to 220 KV grid of APSEB.
The power evacuation of the two 210 MW units of Stage – III is from 400 KV switchyard. This 400 KV switchyard is connected to the 400 KV transmission lines of APSEB. A tie connection is also established between 400 KV switchyard and 220 KV switchyard through two transformers, so that if required complete generation of Stage – III units may be evacuated through 220 KV systems.

I. Fly ash and its Disposal

Vijayawada Thermal Power Station in its maximum capacity of six units functioning produces ash in the order of 10,000 metric tonnes per day, of which 80% is the fly ash and 20% is the bottom ash. The quantum of total ash produced in 1994-95, when unit – 2 of Stage – III has not been installed was 23,67,647 metric tonnes. This increased to 34,73,006 metric tonnes in 1995-96 after installation of unit – 2 of Stage – III. Ash is collected in ESPs and disposed to ash pond by ash handling system.

(1) Ash Handling Systems

The ash handling system serves the purpose of extracting the fly ash, as also furnace bottom ash from the unit and disposing off the same to the ash disposal area through slurry pumping facility. The system meant for fly ash removal is designed as “hydro-sluicing system” in which fly ash is sluiced to a sump for further disposal to the ash dump area through slurry pumps in the ratio of 1:10 water and ash respectively. The system is designed for complete removal of all ash generated continuously round the clock. Apart from the hydro-sluicing system which is the main and basic system for the plant, additional and parallel pneumatic cleaning facility is also provided for collection of dry ash from the unit as and when required. The bottom ash system is for intermittent removal of bottom ash via. outlet pumps and slurry pumping facility.
(2) **Furnace Bottom Ash System**

Dry ash from furnace bottom is collected in the water impounded bottom ash hopper located below and would get quenched. The hoppers have storage capacity of at least ten hours. Once in a shift, the ash collected in the hopper is conveyed to the ash slurry sump through clinker grinder, jet pump and pipe line assembly for further transportation to the ash disposal area through the slurry disposal system.

(3) **Fly Ash System**

Fly ash is separated from the gas and collected in exhaust hoppers electrostatic precipitator hopper and stalk hopper. The ash thus collected is allowed to fall continuously into the respective "flushing apparatus" provided below each hopper where fly ash is mixed with water. The resultant slurry thus formed is discharged into the sluice trench running below and is conveyed to ash slurry sump by gravity aided by pressurised water jet at strategic locations. The slurry thus received into the slurry sump is pumped to the ash pond.

In addition to the "hydro-sluicing system" parallel facility for collection of dry ash from the Electrostatic precipitator (ESP) hoppers at a suitable rate (about 40 T/hr) is provided so that dry fly ash as and when required may be extracted and collected through the above facility. The system envisaged for extraction and collection of dry fly ash from the ESP hoppers is designed as "hydro-pneumatic Vacuum System". In this system fly ash from the hoppers is pneumatically conveyed to the ash storage site via dust collector assembly. The pneumatic conveyance of fly ash is achieved by creation of vacuum into the conveying line by means of either i) Vacuum blowers or ii) Hydraulic exhausters.

(4) **Ash Slurry Disposal System**

The ash slurry disposal system is common for bottom ash and fly ash units. This system is composed of slurry sump – slurry pump – valves and disposal pipe line
assembly and serves to transport the incoming bottom ash and fly ash slurry from the sump up to the disposal pond located at a distance of about 5 KM. The ash slurry disposal system is designed to work continuously round-the-clock.

Thus both bottom ash from the furnace hoppers and the fly ash from the dust collecting hoppers are sluiced to the ash disposal pond about 5 Kilometres from the plant. Ash get settled in the pond effluent water is decanted out of the and ash pond which comes through the natural drainage stream present near Zupudi village and finally released into river Krishna about 20 Km. up the stream of Krishna barrage.

4.1.2. FLY ASH POND

Fly ash pond is located at about five kilometres from the power station on the foot of Kondapalli hill range and reserve forest. Ash ponds are in three stages. The areas of each ash pond stage is given in Table No. 4.3.

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Stage</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Stage − I</td>
<td>200.48 Acres</td>
</tr>
<tr>
<td>2.</td>
<td>Stage − II</td>
<td>679.93 Acres</td>
</tr>
<tr>
<td>3.</td>
<td>Stage − III</td>
<td>388.64 Acres</td>
</tr>
</tbody>
</table>

Among the three stages of ash pond first stage is abandoned on 31/3/92. Since and 1/4/92 second stage has been operationalised. Simultaneously third stage became operational on 1/4/95. Thus at present the available pond area is 1068.57 Acres out of the total 1269.05 Acres of pond area. A study considered by done by V.T.P.S. indicates that as per the present rate of fly ash disposal and the volume of the available ash ponds of ash pond of Stage − II and Stage − III the total life of these stages would be 33 years.
A rehabilitation work in Stage – I of fly ash pond is taken up and about 40,000 plants are planted till now. Plant species of subabul, Teak, Felto forum, Cherry, Ashoka, Acasia Neem, Susher Ganuga, Tinkona, Eucaliptus plants are planted.

4.1.3. RESIDENTIAL COLONY

Residential colony is located adjacent to the thermal power station in between the national highway connecting Hyderabad and Vijayawada. The colonies are named as A, B and C. These colonies occupy an area of 181.03 Acres, 96.32 Acres and 54.07 Acres respectively. These colonies cater to a employ population of about 1000.

4.2 RAW MATERIAL REQUIREMENT

Raw material required for any typical coal based thermal power stations are:

(a) Coal - This is the base fuel for thermal power generation
(b) Fuel Oil - Heavy fuel oil (HFD) and Light Diesel Oil (LDO)
(c) Water - Condenser cooling, Dimineralisation plant and backwash, Ash Slurry, Coal wash and Domestic input requirement

4.2.1 COAL REQUIREMENT

Vijayawada Thermal Power Station has a coal requirement of 3500 metric tonnes per unit (210 MW) per day. That is a total of 21,000 metric tonnes of coal per day of the whole six units of power plant. Out of the total coal requirement 85% is met from Talcher coal fields, Orissa and 15% from Singareni Coalaries, A.P.

Talchar coal is better in quality than the coal from Singareni coalaries. Talchar which has a ash content of about 45% whereas Singareni coalaries coal has more than 45% ash. Singareni coalaries are about 100 to 300 Kilometres from Vijayawada Thermal Power Station, whereas, Talcher coal is about 600 to 700 Kilometres in Orissa. Therefore coal is either brought by conventional railway
wagons or by bottom discharge wagons owned be either Indian Railways or by APSEB.

The averages of coal consumption per unit of electricity produced is given in the Table No. 4.4

Table No. 4.4 Coal Consumption per unit of Electricity

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Year</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1994-95</td>
<td>0.719 Kg/unit</td>
</tr>
<tr>
<td>2.</td>
<td>1995-96</td>
<td>0.734 Kg/unit</td>
</tr>
<tr>
<td>3.</td>
<td>1996-97</td>
<td>0.730 Kg/unit</td>
</tr>
</tbody>
</table>

4.2.2 FUEL OIL

Fuel oil used are Light Diesel Oil (LDO) and Heavy Fuel Oil. These are necessary for the following purposes:

(1) Boiler startup
(2) Flame stablisation during low load operation with or without coal firing
(3) Mill cutting out operation

The daily requirement of fuel oil is about 400 tonnes. The consumption of different fuel oils per unit electricity produced is given in table No. 4.5. Fuel oil is supplied from Indian oil storage facility on Vijayawada – Guntur Highway.

Table No. 4.5 Consumption of Fuel oil per unit of Electricity

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Year</th>
<th>H.F. Oil (ml/Unit)</th>
<th>H.S. Oil (ml/unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1994-95</td>
<td>3.322</td>
<td>0.173</td>
</tr>
<tr>
<td>2.</td>
<td>1995-96</td>
<td>0.960</td>
<td>0.099</td>
</tr>
<tr>
<td>3.</td>
<td>1996-97</td>
<td>0.453</td>
<td>0.060</td>
</tr>
</tbody>
</table>
4.2.3 WATER

Water is required for Vijayawada thermal power station for the following:

1. Condensor cooling.
3. Deminerilisation plant and Backwash.
4. Domestic inplant requirement
5. Coal wash

Out of these, major requirement of water is for condenser cooling and ash slurry. For condenser cooling the consumption of water is of the order of 33 lakh cubic metres per day, whereas fly ash slurry consumes about one lakh cubic meter of water per day which is mixed in the ratio of 1:10 ash versus water for easy transportation and disposal.

The requirement of dimeneralisation plant and coal wash is about 3000 cubic meter per day. The domestic, inplant requirement is 150 to 200 cubic meter per day which is negligible as compared to the total requirement.

Water requirement for different process of power generation for 95-96 and 96-97 is given in the Table 4.6.

Table No. 4.6 Annual Average of Daily Water Requirement for Different Process in V.T.P.S.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Process</th>
<th>95-96 (m³/day)</th>
<th>96-97 (m³/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Main Generation Process (D.M. Boiler)</td>
<td>3066</td>
<td>2657</td>
</tr>
<tr>
<td>2.</td>
<td>Condensor Cooling</td>
<td>3225079</td>
<td>32860000</td>
</tr>
<tr>
<td>3.</td>
<td>Domestic requirement</td>
<td>150</td>
<td>155</td>
</tr>
<tr>
<td>4.</td>
<td>Ash Slurry</td>
<td>76953</td>
<td>78847</td>
</tr>
<tr>
<td></td>
<td><strong>Total requirement</strong></td>
<td><strong>3305248</strong></td>
<td><strong>3367659</strong></td>
</tr>
</tbody>
</table>
Average water requirement for different processes of electricity generation per unit of electricity produced in different years is given in Table 4.7.

Table No. 4.7 Annual Average of Water Requirement per unit Electricity Produced

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Process</th>
<th>94-95 (Lt/unit)</th>
<th>95-96 (Lt/unit)</th>
<th>96-97 (Lt/unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Main generation Process (D.M., Boiler)</td>
<td>0.156</td>
<td>0.110</td>
<td>0.094</td>
</tr>
<tr>
<td>2.</td>
<td>Condensor Cooling</td>
<td>128.978</td>
<td>119.750</td>
<td>116.740</td>
</tr>
<tr>
<td>3.</td>
<td>Domestic</td>
<td>0.006</td>
<td>0.006</td>
<td>0.006</td>
</tr>
<tr>
<td>4.</td>
<td>Ash Slurry</td>
<td>4.876</td>
<td>2.857</td>
<td>2.801</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>134.016</strong></td>
<td><strong>122.723</strong></td>
<td><strong>119.641</strong></td>
</tr>
</tbody>
</table>

Water is drawn from Prakasam Barrage existant on Krishna river adjacent to Vijayawada city at a distance of 14 Kilometres from Vijayawada Thermal Power Station. The reservoir of Prakasam Barrage feeds the coolant water (cw) intake concrete lined canal with a capacity of 2000 Cusecs.

The hot return water from condenser which is $10^0c$ higher than the intake water is released into Budameru canal to join Krishna river at about 10 Kilometres upstream of Prakasam barrage. The one lakh cubic metres of water used for ash disposal is released into fly ash pond in the form of slurry. Ash settles down in the pond and the supernatant water is released out through filters into nearby drainage which leads into Krishna river about 14 Kilometres upstream to the Prakasam Barrage.
4.3 ENVIRONMENTAL PROBLEMS OF VTPS

The location Vijayawada Thermal Power Station is such that on its South flows river Krishna, on the East is Vijayawada city, on the West lies Kondapalli reserve forest and it is surrounded by fertile agricultural fields. It is located in one of the most fertile land of coastal Andhra Pradesh.

4.3.1 AIR POLLUTION

V.T.P.S. has two chimneys which are 180 metres tall. These chimneys were good enough when they were catering two units of 210 MW each. But as the units kept adding up to the power station making a station of six units as on 1995, the volume of gaseous effluents released has increased three fold. The power station should have had a chimney of 275 m as prescribed by CPCB (for more than 500 MW power plant).

Adjacent to the Thermal Power plant are Kondapalli hill range with reserve forest. These forest have been heavily affected as a result of fumigation by the noxious gases released by VTPS chimneys.

Air born gaseous effluents are carried away to the mango plantations and crop lands etc., in the area effecting their productivity. In the past four to five years there has been a dramatic change in the land use pattern on the Southern banks of river Krishna, which had mango plantations as predominant land use. This has been changed to annuals and biennial crops like the annual Drum stick plantation, Plantain etc. Thus this in long run affects the stability of the river bank which was stable since past many decades. The air pollution has also reduced the productivity of the crops in the neighbouring areas which has not been quantified.

Among different effects the impact felt on the western part of the Vijayawada urban settlement, where the air pollution has caused respiratory disorders to the
located population is of serious concern.

4.3.2 WATER POLLUTION

Vijayawada Thermal Power station releases water effluent in the environment which are the bi-products of the following processes:

(a) Making of ash slurry and ash disposal
(b) Dimineralisation
(c) Condenser cooling

(a) Ash Slurry

Water is mixed with ash for making ash slurry and its disposal in fly ash pond. The supernitent water in ash pond is released into a stream through filters. Due to practical difficulties is filters get chocked and water overflows. Thus water effluent rich in ash flows through stream, and finally enters into river Krishna. All along its course of travel, ash pond effluent water keeps depositing the ash sediment, and finally sedimenting into the Krishna river reservoir at Prakasam barrage.

Ash water percolates in the ground causing:

(i) Heavy metal contamination in ground water
(ii) Raise of ground water table causing secondary problems of soil salinity, water logging etc.
(iii) Phytotoxicity by heavy metals to agricultural crops in the adjoining areas.
(iv) Bio-magnification and its impart of Human, cattle population.

(b) Deminaralisation plant effluent

D.M. plant releases effluent water into adjoining fields, the water quality of the effluent is at times highly acidic or basic thus causing land degradation and affecting and crop productivity.
(c) **Condensor cooling effluent**

The condenser cooling effluent releases huge quantities of water (1400 Cusecs) in Budameru canal and finally into river Krishna, at a temperature of $10^\circ$C above the ambient water temperature. This has caused thermal pollution though localised, but causing eutrophication all along the Budameru canal and in part of Krishna river reservoir.

### 4.3.3 SOLID WASTE DISPOSAL

Solid waste disposal is one of the biggest problems of any coal based thermal power stations. The problem is much more prominent in India since Indian non-cooking coal has an ash content of the order of 40 to 50%. Thus on an average the release of ash is 40% of the coal consumption.

In the case of V.T.P.S. the ash content is more than 45%. Hence the problem of ash disposal. The ash is released blocks at the orders of 1 acre per megawatt per year. The pond is located on the fertile agricultural land. Hence the loss is of a great value. *Moreover* the total loss is in the magnitude of about 1300 acres. Hence the input on the neighbouring acres is also equally significant.

Vijayawada Thermal Power Station produces ash in the order of 10,000 metric tons per day. This is about 45% and more of the total coal consumption. Out of the total ash 15 grade ash is collected in silo and used for cement and brick making. But the quality of 15 grade ash is just 5 to 10%. The rest has to be disposed off into the fly ash pond.

The ash produced requires in the order of 1 acre of land per mega watt of installed capacity. The V.T.P.S. ash pond which occupies an area of 1269 Acres of fertile lands. Thus the magnitude of problem.
Vijayawada Thermal Power Station, though a resource to the state, contributing a major share in the State’s Power Grid in the order of 1260 MW is a problem to be reckoned with in its near vicinity.