



PROJECT HIGHLIGHTS

1.	Project	:	Yadadri Thermal Power Station
2.	Plant Capacity	:	4000 MW
3.	Plant Configuration	:	5x800 MW
4.	Location	:	Veerlapalem village, Damercherla mandal, Nalgonda District , Telengana State, India Latitude : 16.694138 N Longitude : 79.583531 E
5.	Nearest Town	:	Miryalaguda : 30 km
6.	State Highway	:	SH-2 (Narketpally -Addanki section) : 7 km
7.	Nearest Railway Station	:	Vishnupuram : 5 Km
8.	Nearest city	:	Hyderabad : 170 Km
9.	Nearest Airport	:	Hyderabad : 200 km
10.	Site elevation	:	227 meter above MSL
11.	Seismic Zone	:	Zone – III
12.	Land Available	:	4676.00 Acres already acquired & about 1000 acres land to be acquired.
13.	Land Requirement (acres)	:	Main Plant Area : 225.00
		:	BOP Area : 435.00
		:	Raw Water Reservoir : 100.00
		:	Coal Handling Plant : 415.00
		:	Ash Dyke Area : 900.00
		:	Green Belt Area : 1000.00
		:	Total : 3075.00
14.	Source of Water	:	River Krishna
15.	Water Requirement	:	12100 M ³ /hr





16.	Distance from water source	:	5 KM
17.	Cooling System	:	Closed cycle cooling system with Natural Draft Cooling Tower
18.	Primary Fuel & Source	:	Domestic Coal: Rudrampur Mines, SCCL Imported Coal
19.	Distance from Coal Source	:	Domestic : 300 kms Imported : 328 kms from Kakinada port
20.	Support Fuel & Source	:	HFO/LDO from nearest refinery/oil depots
21.	Fuel Requirement		
a)	50% domestic coal + 50% imported coal of GCV 4550 kcal/kg and heat rate 2109.4 kcal/kwh	:	1854.42 tph 13.81 mtpa
	100% imported coal) of GCV 5700 kcal/kg and heat rate 2109.4 kcal/kwh		1480.28 tph 11.02 mtpa
b)	Support fuel (HFO/LDO) 0.5 ml/kwh	:	17520 KL/Year (Average)
22.	Transportation:		
	i. Main Fuel Coal	:	By Rail system
	ii. Support fuel (HFO/LDO)	:	By Rail tankers
23.	Steam Turbine Generator	:	The steam turbine generator will be single shaft, two / three cylinders, tandem compound, reheat, regenerative, condensing unit directly coupled to AC Generator giving a continuous output at generator terminal of 800, 000 KW at 22~27 KV.
24.	Steam Generator	:	Semi outdoor type two pass single re-heat balanced draft, drumless unit designed for firing pulverized coal as main fuel.





25.	Control System	:	Distributed Digital Control and Management Information System (DDCMIS) with integrated, CRT/Key Board operation for Steam Generator, Turbine, Generator and auxiliaries from Central Control room.	
26.	Station Operation Philosophy	:	Base Load	
27.	Chimney	:	Two(2) twin flue and One(1) single flue chimney of 275 M high	
28.	Power Evacuation plan	:	400 KV transmission system	
29.	Project Commissioning Schedule	:	64 months from 'Zero Date' Unit – I & III : 52 Months Unit – II & IV : 58 Months Unit – V : 64 Months	
30.	Life of the Plant	:	25 years	
			<u>OPTION – I</u> (50% domestic coal + 50% imported coal)	<u>OPTION - II</u> (100% imported coal)
31.	Total Project Cost incl. IDC	:	Rs 25099.42 Crores	Rs 25099.42 Crores
32.	Cost per MW	:	Rs 6.27 Crores	Rs 6.27 Crores
33.	Levelised Tariff at 85% PLF	:	Rs 4.57/kwh	Rs 4.98/kwh





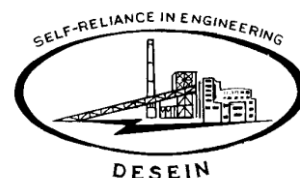
1.0.0 INTRODUCTION

1.1.0 Telangana State Power Generation Corporation Limited (TSGENCO) is one of the pivotal organizations of Telangana, engaged in the business of Power Generation. Apart from operation & maintenance of the power plants it has undertaken the execution of the ongoing & new power projects scheduled under capacity addition programme and is also taking up renovation & modernization works of the old power stations.

TSGENCO came into existence on 19.05.2014 and commenced operations from 02.06.2014. This was a sequel to Government's reforms in power sector to un-bundle the activities relating to generation, transmission and distribution of power. All the Generating Stations owned by erstwhile APSEB in Telangana area were transferred under the control of TSGENCO.

The installed capacity of TSGENCO as on 30.04.2015 was 4365.30 comprising of 2282.5 MW Thermal, 2081.80 MW Hydel and 1 MW from renewable energy sources thus contribute about 54% of the total energy requirement of Telangana. TSGENCO is the third largest power utility in the country.

1.2.0 The State of Telangana requires substantial addition to its power generating capacity to meet power demand of its rapidly growing industrial, agricultural and other sectors. A number of projects, including Yadadri Thermal Power Station (5x800 MW), have been identified by TSGENCO for augmentation of generating capacity.





1.3.0

TSGENCO has engaged the services of **DESEIN PRIVATE LIMITED**, Consulting Engineers, for the preparation of Detailed Project Report for 5x800 MW Yadadri Thermal Power Station, Besides bringing out broad equipment parameters, process flow inputs the Detailed Project Report represents cost estimates and financial analysis, in line with Govt. of India guidelines and CERC/SERC norms.





2.0.0 JUSTIFICATION FOR THE PROJECT, POLICY FOR POWER GENERATION

2.1.0 Power Demand and Supply Analysis

Table-2.1 shows the details of peak load and energy requirement of State of Telangana (including Andhra Pradesh), Southern Region, Western Region and Northern Region as per 18th Electric Power Survey, a publication of CEA, upto the year 2031-32.

Table-2.1

Peak Load and Energy Requirement/Consumption in the State of Telangana (including Andhra Pradesh), Southern, Western & Northern Regions

YEAR	State of Telangana (including Andhra Pradesh)		Southern Region		Western Region		Northern Region	
	Peak Load (MW)	Energy Requirement (MUs)	Peak Load (MW)	Energy Requirement (MUs)	Peak Load (MW)	Energy Requirement (MUs)	Peak Load (MW)	Energy Requirement (MUs)
2011-12	14122	85358	36175	243912	39351	271453	37265	271301
2016-17	22445	129767	57221	357826	62015	394188	60934	422498
2021-22	33194	191912	82199	510786	86054	539310	86461	594000
2026-27	51601	284776	118764	727913	120620	75318	121979	840670
2031-32	74818	412903	165336	1017526	163222	1028974	164236	1135543

Source: 18th Electric Power Survey

The power scenario in the State of Telangana & Southern Region at April 2015 and from April 2014 to March 2015 is tabulated in **Table-2.2**.

Table – 2.2

	Unit	Telangana	
		By the end of 12 th Plan i.e., 2016-17	By the end of two years in 13 th Plan i.e., 2018-19
Anticipated Peak Demand	MW	11210	13108
Anticipated Base Demand (80% of peak demand)	MW	8968	10487
Installed capacity as on 31.03.2015	MW	8871	8871
Deficit against anticipated Peak Demand	MW	(-) 2339	(-) 4237
Deficit against anticipated Peak Demand	%	(-) 20.86	(-) 32.32

According to Table-2.2, the State of Telangana will have the peaking shortage of 2339 MW (20.86%) by the end of 12th Plan i.e., 31.03.2017 and 4237 MW (32.32%) by the end of first two years of 13th Plan i.e., 31.03.2019.

Installed capacity of State of Telangana including Andhra Pradesh, Southern Region and All India level as on 30.04.2015 is given in **Table-2.3**.

Table-2.3

Telangana (including Andhra Pradesh)

(Figures in MW)

Sector	Thermal				Nuclear	Hydro	RES (MNRE)	Total
	Coal	Gas	Diesel	Total				
State	3606.59	0.00	0.00	3606.59	0.00	2012.54	0.00	5619.13
Private	270.00	1697.75	19.83	1987.58	0.00	0.00	61.25	2048.83
Central	1653.28	0.00	0.00	1653.28	148.62	0.00	0.00	1801.90
Total	5529.87	1697.75	19.83	7247.45	148.62	2012.54	61.25	9469.86



Southern Region

Sector	Thermal				Nuclear	Hydro	RES (MNRE)	Total
	Coal	Gas	Diesel	Total				
State	14182.50	555.70	362.52	15100.72	11398.03	11398.03	473.45	26972.20
Private	4770.00	4047.50	576.80	9394.30	0.00	0.00	14643.75	24038.05
Central	11390.00	359.58	0.00	11749.58	0.00	0.00	0.00	14069.58
Total	30342.50	4962.78	939.32	36244.60	2320.00	11398.03	15117.20	65079.83

All India

Sector	Thermal				Nuclear	Hydro	RES (MNRE)	Total
	Coal	Gas	Diesel	Total				
State	58100.50	6974.42	602.61	65677.53	0.00	27482.00	1919.31	95078.84
Private	59005.38	8568.00	597.14	68170.52	0.00	2859.00	33857.65	104887.17
Central	48130.00	7519.73	0.00	55649.73	5780.00	11291.43	0.00	72721.16
Total	165235.88	23062.15	1199.75	189497.78	5780.00	41632.43	35776.96	22687.17

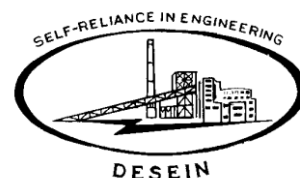
Source: CEA Website

The capacity addition envisaged by TSGENCO in Telangana State is given in **Table-2.4.**

Table 2.4

Capacity Addition Envisaged by TSGENCO

S. No.	Project	MW
1	Kothagudem TPS Unit # 12 (1x800 MW)	800
2	Manuguru TPP (4x270 MW)	1080
3	Yadadri TPP (5x800 MW)	4000
	Capacity Addition Programmed	5880





2.2

Need for the Power Generation Facility

As per 18th Electric Power Survey (EPS), the Peak load (MW) and Energy requirement (MU) at the end of 11th, 12th, 13th, 14th & 15th plan period are shown in **Table-2.1**. The peak load in Telangana State (including Andhra Pradesh) at the end of 11th plan will be 14122 MW, 22445 MW by end of 12th plan, 33194 MW by the end of 13th plan, 51601 MW by the end of 14th plan and 74818 MW by the end of 15th plan. Considering the utilization factor of 70%, Telangana State (including Andhra Pradesh) will require about 9886 MW by the end of 11th plan, 15712 MW by the end of 12th plan, 23236 MW by the end of 13th plan, 36122 MW by the end of 14th plan and 52373 MW by the end of 15th plan. During the above periods, Southern Region will require 36175 MW, 57221 MW, 82199 MW, 118764 MW and 165336 MW respectively.

Table-2.2 indicates the extent of shortfall in peaking requirement and peaking requirement in the state of Telangana, Southern Region.

The water requirement for agriculture in Telangana area is mostly met through bore wells. Thus agriculture in Telangana is heavily dependent on electrical power. To meet the present and future agricultural power demand as well as other developmental activities in the state, the need for setting up of the proposed 5x800 MW Yadadri Thermal Power Station is fully justified.

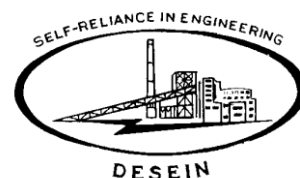


Table-2.5

Peak load and Energy Requirement at Station Bus Bar

YEAR	Southern Region		Northern Region		Eastern Region	
	Peak Load (MW)	Energy Requirement (MUs)	Peak Load (MW)	Energy Requirement (MUs)	Peak Load (MW)	Energy Requirement (MUs)
2011-12	36175	243912	37265	271301	15122	106086
2016-17	57221	357826	60934	422498	24303	163790
2021-22	82199	510786	86461	594000	35928	236952
2026-27	118764	727913	121979	840670	53053	349412
2031-32	165336	1017526	164236	1135543	72874	480046

Source: 18th electric power survey

From the Table-2.5 it will be seen that peak load requirement will be on a rising trend. Considering Utilization factor of 70%, Southern Region will require 57540 by the year 2021-22, 83135 MW by the year 2026-27 and 115736 MW by the year 2031-32.

Northern Region will require 60523 MW by the year 2021-22, 85386 MW by the year 2026-27 and 114966 MW by the year 2031-32. Eastern Region will require 25150 MW by the year 2021-22, 37138 MW by the year 2026-27 and 51012 MW by the year 2031-32.

2.3 Government Policy for Power Generation/Requirement of Input/Clearance

2.3.1 Government Policy

The Electricity Act 2003 has come in force from May 2004. As per Electricity Act 2003, clause 7 "Any Generating Company may establish, operate and



maintain a generating station without obtaining licence under this act if it complies with technical standards relating to connectivity with the grid.

2.3.2 Requirement of Input/Clearances & Status

Electricity Act 2003 do not indicate special requirement like clearances from the concerned statutory or non-statutory authorities for setting up thermal power plant. However clause 10 (3) stipulates that generating company will:-

- a. Submit technical details regarding its generating stations to appropriate commission (i.e. CERC/SERC) and the Authority (i.e. CEA).
- b. Co-ordinate with central transmission utility or state transmission utility as the case may be for transmission of electricity generated by it.

2.3.3 Relevant Requirements & Status thereof are furnished as under:

	Particulars	Status
1.	Land availability	3075 Acres of land is available for Main Plant building, Water facilities, Raw water reservoir, switchyard, Coal handling system, Ash dyke & development of green belt etc.
2.	Water requirements and its Availability	The water requirement for the proposed 5x800 MW unit has been worked out about 12100 m ³ /hr.
3.	Coal availability & Transportation	Coal requirement for proposed unit is about 13.81 MTPA (50% imported coal + 50% Indian coal) and 11.02 MTPA (100% imported coal). The coal will be transported through Railway system.





4.	Environmental & Forest Clearance from ministry of environment and forest / State Environment Deptt.	As per MoEF notification, the project falls under category 'A'. As such environment impact assessment Authority of MoEF will be approached for ToR for conducting EIA studies for environmental clearance.
5.	Airport Authority clearance for chimney height	AAI clearance for chimney height of 275 meters will be obtained.
7.	Power Absorption & Evacuation Plan	Power generated from the plant will be procured by State Electricity Boards/ Electricity Distribution Companies/State Electricity Utilities as per the allocation by Ministry of Power. Power will be evacuated at 400 KV voltage levels.
8.	Ash Utilization Plan	Ash utilization plan will be drawn as per MOEF guidelines. In the vicinity of the proposed power project, 22 cement plants are already set up at a radius of 10 Km. The fly ash generated by the proposed power project will be fully utilised for manufacture of Pozzolona cement.





3.0 BASIC REQUIREMENTS

3.1 Infrastructure Requirements

A power station requires a number of basic inputs such as land, fuel, water etc. Setting up of power station is primarily governed by the following basic considerations:

- a) Availability of land
- b) Rail/road accessibility
- c) Availability of fuel and proximity to source
- d) Availability of water and proximity to source
- e) Load demand / Power absorption plan
- f) Environmental consideration

The most important criteria for selection of site for TPS is availability of land with least R&R issues & forest land, fuel availability and its transportation, water availability and acceptability from environmental considerations.

3.2 Site Selection and Features of the Site

The basic requirement for establishing the project was studied in the backdrop of available infrastructural facilities and the requirement of developing of facilities to ensure compatibility and adequacy of system by TSGENCO for setting up power plant.

Site selection team comprising officials from TSGENCO and State Government visited the potential sites in Telangana state for identifying the most suitable site for setting up Super Critical Thermal Power Station of 5x800 MW capacity to be set up by TSGENCO. Brief description of each site is given below:

**Site-I**

This site is located in village punukudu chelka of Kothagudem mandal, Khammam district. The land availability is 8800 acres. This land falls under kinnarasani wild life sanctuary and the area falls under eco-sensitive zone. Hence this site is not considered.

Site-II

This site is located in Pandurangapuram village, Palavanha mandal, Khammam district. The site is very close to the existing operating Kothagudem Thermal Power station and also falls under ecosensitive zone under Kinnerasani wild life sanctuary. The land available is only 1200 acres. Hence this site is not considered.

Site-III

This site is located in near Veerlapalem villages, Damercherla mandal, Nalgonda district. The land available in Veerlapalem is approximately 4676 acres.

The nearest town is Miryalaguda which is about 30 km from the site. The nearest railway station is Vishnupuram which is 5 km away from the plant. Nearest airport is Hyderabad which is about 200 km away from site. Water requirement for this project is planned to be drawn from Krishna river which is located at a distance of about 5 KM.

Based on the site selection team assessment, the **site-III** is preferable for implementation of the thermal power Station. This location involves reserve forest (10380 acres) out of which 1027 acres is patta land. This



patta land is a single crop agricultural land and revenue land. Adequate land is available which can be optimised for setting up of Yadadri Thermal Power station (5x800 MW) by TSGENCO.

Details of Proposed Site

This site is located near Veerlapalem village, Damercherla mandal, Nalgonda district. Available land is approx. 4676 acres. Out of this land, the land required for setting up the power project will be 3075 acres. This includes ash disposal area and colony for the thermal power project. The nearest town is Miryalaguda which is about 30 km from the site. The nearest railway station is Vishnupuram railway station which is 3 km from the plant. Nearest domestic and international airport is Hyderabad which is about 200 km away from project site. Water requirement for this project will be drawn from river Krishna. The coordinates of the site at Veerlapalem village is 16.694138 North and 79.583531 East.

Location map is as per **Annexure-3.1**.

Climatological data of nearest station Nalgonda is as follows:

Annual mean daily max. ambient temperature	26.7°C (max.)
Annual mean daily min. ambient temperature	23.7°C (min.)
Extreme highest temperature	46.3°C
Extreme lowest temperature	12.6°C
Annual minimum relative humidity	63%
Highest relative humidity	82%
Annual mean rainfall	696.8 mm
No. of rainy days in a year	32.5 days

Climatological data at Nalgonda (nearest observatory) is as per **Annexure-3.2**.



a) **Land**

The proposed site is mostly reserved forest, semi-agricultural and partly revenue land with isolated pockets of habitation. There are no historic places in the vicinity.

3075 Acres land is available for proposed 5x800 MW Yadadri Thermal Power Station.

Breakup of land required for the proposed power plant is as below:

Land area break-up

Sl. No.	Details	Area in Acres
(A)	Inside Power Plant boundary	
i.	Main Plant Area	225.00
ii.	BOP Area	435.00
ii.	Raw Water Reservoir	100.00
iv.	Coal Handling Plant	415.00
v.	Ash Dyke Area	900.00
vi.	Green Belt Area	1000.00
	Total	3075.00

The Soil in the District is mostly consisting of clay sand with Rock Strata. The fertile black cotton soil forms only 9% and occurs on the banks of Krishna and isolated patches here and there. Among the red soils 47% is dubba soil (Loamy sands), which has a very low moisture retaining capacity, and the rest is chalka soil, forming 44%. Suitability of foundations designs will be based on soil investigation results.



**b) Rail/Road Accessibility**

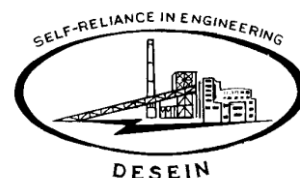
A railway line is available between Secunderabad and Nadikudi junction (on Secunderabad – Guntur BG line). The nearest railway station is Vishnupuram which is 5 km from project site. The rail line will be used for transportation of heavy equipment to the site in consultation with Indian Railways for permissible weight & height of consignments during construction period and subsequently for transportation of coal & fuel oil during operation & maintenance.

Site is approachable from Narketpally on NH 65 via Miryalaguda (80 KM) or via Addanki on SH 2 (100 KM). State Highway No. 2 connecting Hyderabad and Addanki which is about 7 Km from the project site. Approach to site is possible through the district road network. Transportation of heavy equipment from manufacturer's works to site shall be by road and by railway network.

c) Fuel Availability & Transportation

The coal requirement for the proposed power project based on station heat rate of 2109.4 kcal/kwh, GCV of coal as 4550 kcal/kg and 85% PLF is estimated as 13.81 mtpa.

Imported coal and Indian coal will be blended in 50:50 ratio and will be fired in the steam generators. The source of coal will be as per coal linkage by the Ministry of Coal. For the purpose of this study, domestic coal and imported coal in 50:50 ratio is considered.





Primary Fuel (Coal)

The coal will be transported to power station from coal mines through Indian Railways. The nearest port is Kakinada which is about 328 KM from the project site.

Secondary Fuel (HFO/LDO)

Secondary fuel LDO & HFO for start-up of boilers and to use as support fuel will be brought to site in railway tankers through Indian Railways.

d) Availability of Water

In line with the MOEF guidelines for new Thermal Power Projects, it is proposed to adopt closed circuit cooling water system deploying cooling towers and draw only make up water requirement from the source.

The makeup and consumptive water requirement of 5x800 MW thermal power station is assessed as 12100 m³/Hr. the source of water is Krishna River is 5 km from proposed project site.

e) Power Absorption

The power from the plant will be evacuated at 400 KV voltage level. TSGENCO will take necessary steps in consultation with TSTRANSCO/ POWER GRID for evacuation of power. It is envisaged that the power generated will be absorbed within the State.





f) **Environmental Aspects**

The Power Plant will be developed based on the guidelines of the State Environmental Authorities and that of MoEF. Suitable provisions will be incorporated in the design of buildings, structures, and selection of equipment so that there are no adverse effect of emissions, noise, and contamination of soil, water and air. Two (2) Nos. twin flue stacks and One (1) No. single flue stack of 275 metres height will be provided for the generating units as per the guidelines.

In the vicinity of the proposed power station, 22 cement plants are already set up at a radius of 10KM. The fly ash generated by the proposed power station will be fully utilised for manufacture of Pozzolona cement.

The necessary Terms of Reference (TOR) will be obtained for conducting EIA studies for installing 5x800 MW capacity unit. The recommendations and environmental stipulation of MoEF will be followed during implementation phase of the project.



4.0 TECHNOLOGY & UNIT RATING

4.1 Adoption of Supercritical Technology

The proposed 800 MW units will have super critical steam parameters to achieve higher efficiency and hence, lower cost of generation. Steam parameters of supercritical technology are as follow:

Pressure : 247 kg/cm² (a)

Main Steam Temperature : 565°C

Reheat Steam Temperature : 593°C

The main advantages of adopting higher unit size of 800 MW with supercritical parameters are brought out below:

i. From Plant Performance Point of View:

- Reduction in coal consumption.
- Reduction in ash generation.
- Reduction in effluent gasses to atmosphere.
- Reduction in suspended particulate matters to environment.
- Better performance during off-design operation due to variable “Evaporate End Point”.

ii. From Operation Point of View

- Better heat rate at full load as well as partial load.
- Lesser percentage of auxiliary consumption, hence increase in net power export.



- Lesser startup time and hence less consumption of startup fuel and power.
- Quicker load following capabilities i.e. better response to load rise / fall.
- Lesser consumption of cooling water.
- Boiler drum is eliminated hence no need of level control.
- More favourable for frequent start / stop even for two-shift operation.
- Lesser requirement of service like compressed air; water etc. because of reduction in number of units.

iii. From Plant Upkeep Point of View

- Lesser requirement of manpower for the operation & maintenance.
- Lesser number of equipments to maintain, hence lesser *inventory*.
- Increase in cost due to expensive materials to withstand higher pressure and temperature is off-set for reduction in size of balance of plant as well as number of units.

Super Critical Pressure power plant is envisaged in view of above indicated benefits.



5.0 TECHNICAL FEATURE OF THE BOILER & TG PLANT

5.1 General

The Super-critical technology is being adopted by number of Independent Power Producers & Utilities in India with 660 MW & 800 MW unit sizes.

Steam Generator, Design Considerations

1. Furnace Type

(i) Two Path / Tower Type

Furnace configuration is derived from each equipment manufacturer's specialty. Two path types is mainly adopted in Japan and tower type is typical in Europe.

No significant difference is observed in the applicability to kind of coal. It is because boiler design can be adjusted in accordance with coal characteristics such as abrasion of ash.

(ii) Spiral (plain/bare tube) Wall and Vertical (rifled/ribbed tube) Wall Type

The principal concern with a variable-pressure super critical-pressure design is the requirement for once-through operation. The mass flow in the furnace-wall tubes must be sufficiently high to avoid overheating or Departure from Nucleate Boiling (DNB) while generating steam at sub-critical pressures and to avoid excessive metal temperatures and uneven steam outlet temperatures when operating at super critical pressure at higher boiler loads.



To accomplish these objectives, the spiral-wall design is used for the unit. The principle of the spiral or helical-wall furnace is to increase the mass flow per tube by reducing the number of tubes needed to envelope the furnace without increasing the spacing between the tubes. This is done by arranging the tubes at an angle and spiraling them around the furnace. For instance, the number of tubes required to cover the furnace wall can be reduced to one half by putting the tubes at a 30 degree angle. The centerline spacing or pitch (P) is made the same as on a vertical wall to prevent fin overheating. Additionally, by spiraling around the furnace, every tube is part of all the walls, which means that each tube acts as a heat integrator around the four walls of the combustion chamber.

The spiral-wall concept thus addresses two major challenges of the full variable pressure super critical pressure boiler.

- Achieving the required mass flow to avoid overheating and excessive metal temperature by reducing the number of tube circuits.
- Minimizing difference in tube to tube heat absorption by exposing each tube to all four furnace walls.

Spiral-wall furnaces have been in operation in Europe and Japan for many years and have given satisfactory performance.





As an alternative to the spiral-wall design for larger-size steam generators, a certain manufacturers offer a tangentially fired unit with vertical walls consisting of rifled tubes for ease of fabrication, erection, and maintenance. A stable fireball is formed in the center of the furnace with tangential firing, with essentially equal distribution of the lateral heat absorption on all furnace walls. Unbalances are minimized and lateral heat-absorption patterns are predictable over the entire load range.

Rifled tubing is used in the furnace walls to avoid overheating or DNB at sub-critical pressures.

(iii) UP Type / Benson Type

UP type is applied to constant pressure once through boiler and Benson type is applied to variable pressure once through boiler. Variable pressure Benson type boiler is suitable to improve plant efficiency at partial load and flexible operability.

2. Startup System

In the case of UP type (constant pressure) boiler, it is necessary to keep the super critical pressure at boiler and the minimum water flow rate at water wall from the early stage of unit starting in order to prevent the water wall from tube burning-out, while the turbine needs low pressure superheated steam at starting. For these purposes, UP type boiler usually has flash tank drainage start up system and uses de-pressurized steam from flash tank for starting turbine. This start up system requires so-called ramping operation





which means switching operation from starting system to main system during load increasing operation, because this start up system capacity is only around 10% of turbine TMCR. This ramping operation is so complicated operation under the large different pressure that some valves are required with enough durability.

On the other hand, Benson type boiler can start from under the low pressure condition because Benson type boiler has availability of variable pressure operation owing to spiral structure of water wall tubes (or rifled tubes used for vertical water walls), and circulation system with Boiler Circulation Pump (BCP) can be applied to this type of boiler. This system can shorten the start up time and heat loss during start up period.

3. **Minimum Load with Dry Range / Control Range**

Changing point (Benson Point) or dry/wet condition is about 30% TMCR load. Minimum control range is set at 40% TMCR load with consideration of undershoot during load reducing, turn-down of pulverizers, ignition stability, etc. There is no difference in spiral water wall and vertical tube water wall in minimum load requirement.

4. **Material Selection**

The materials for the range of steam temperature to the level of 566°C are already proven. There is no difficulty in technical aspects in material selection.

On the other hand, the applicable materials will be selected considering the combination of applied temperature and pressure levels.

Table below shows the typical material selection in boiler pressure parts. This material application just shows the general concept and each manufacturer has his criteria considering his design concept. Judging from Indian sub-critical plants, 9% Cr steel and austenitic materials have already used for high temperature zones, therefore, for super critical plants, 580⁰C temperature for main steam and 600⁰C for reheat steam, no new materials are required as the material basket used in sub-critical plant is adequate. Only a shift in quantum of superior material is there due to higher parameters.

Component	250 Kg/Cm² (g) 580⁰C / 600⁰C
Super heater tubes	1-2% CrMo Steels
Reheater tubes	1-2% CrMo Steels Austenitic steels
Main steam pipes, headers, valve bodies	2-1/4 CrMo Steels
High temperature reheater pipes	9% Cr steels

5.2 Description of Steam Generator

The steam generator will be supercritical, technology designed for firing coal as primary fuel, balanced draft furnace suitable for semi-outdoor installation. Boiler including auxiliaries will be designed for operation with 100% Imported coal and with a coal blending of imported coal and indigenous coal in the ratio of 50:50.

The steam generator will be capable of operating on sliding parameter. The load charge for sliding parameter will be from 40% SGMCR to 100%



TGMCR. However, it will be possible to operate the steam generator with modified pressure sliding mode with constant pressure mode operating between 90% TGMCR to 100% SGMCR. Steam generator will be designed to meet the Indian Boiler Regulation (IBR) requirement. Wherever IBR is not specific, ASME or equivalent reputed international code will be used.

Steam and water system will essentially comprise of steam separator, separator storage tanks evaporator down comers, water walls, superheater, reheater, desuperheater, economizer, valves, fittings, piping, insulation, supporting hanger's instrumentation etc.

The furnace will be designed to withstand pressure regimes without permanent deformations and will be made of gas tight welded membrane walls design required for openings of wall blowers, observation ports, access doors and instruments.

The furnace walls will either be spiral wound and vertical tubes or vertical rifle tubes as per the manufacturer's design. The furnace will have hopper bottom with stainless steel seal plates suitable for connection to an ash hopper. A suitable sealing arrangement shall be provided for connecting to water impounded wet type bottom ash hopper.

The water / steam separators will be arranged at the evaporator outlet and will be so sized to ensure adequate steam separation. The water / steam mixture will be fed into the separators by connecting pipe work which will enter around the circumference at an inclined angle to ensure mixture moving spirally downwards and the water / steam separation is done by means of applied centrifugal force. The water will be led downwards to the collecting vessel and the steam escapes centrally upwards to the connections towards the first superheater stage.





The water received in the separators will be re-circulated to the economizer inlet via 1x100% startup water re-circulation pump. At higher loads the re-circulation pump will not be in operation and the entire flow from the evaporator is directed to the superheater. It will also be possible to start the steam generator without the re-circulation pump.

The superheater and reheater will be designed to maintain superheat and reheat steam temperatures at superheater and reheater outlet over the entire steam temperature control range.

The attemperators are to be of spray type fitted with an inner removable lining. RH temperature control is by means of damper control of the flue gases or gas recirculation.

The economizer will be of non-steaming and bare tube type. The tube banks will be of inline arrangement.

5.2.1 Air and Flue Gas Draft System

(1) Draft System

The Draft system will comprise of two (2) sets of FD fans each set rated for 60% of BMCR capacity. The FD fans will be axial reaction variable pitch control. Two (2) Nos. axial type induced draft (ID) fans each rated at 60% of BMCR flow will be axial radial reaction single stage, with variable blade pitch control.

Boiler unit will be equipped with two (2) Nos. 60% capacity primary air fans. Primary air fans will be axial reaction two stages and variable pitch blade control. Cold primary air system will be provided.



The fans will be complete with lube oil, hydraulic regulations and all other accessories required for continuous operation and will be suitable for outdoor installation. 2x100% seal air fans will be radial type.

(2) **Air Heater**

Secondary air and primary air will be preheated in two trisector or four bisector air preheater, two (2) each for secondary air and primary air separately.

Additionally, two steam heated air preheaters (SHAP) will be provided on upstream of the secondary section of regenerative air preheater.

(3) **Coal Feeding and Burning System**

Coal feeding and burning system will essentially comprise of gravimetric coal feeders, coal mills, coal pipes and coal burners.

For firing high ash content abrasive coal, medium speed vertical spindle of large capacity bowl mills will be provided having low power consumption; relatively high availability, low maintenance cost and fineness control. The mill size and numbers will be selected such that on an average two mills remain standby.

Considering the grinding fineness required, the mills will be equipped with rotating classifiers having speed adjustment to control grinding fineness. The firing system will employ latest "State of the Art" burners and will permit load variation from 40 to 100% BMCR without use of support fuel. The ratio of fuel and air flow will be controlled. Due to sufficient burner wall distance and the burner





swirl direction, operation with low excess air will be possible without the risk of wall damage.

Tilting Tangential Firing system in which injection of fuel and air from wind box in the furnace corner is envisaged.

(4) Coal Mill Rejects Handling System

The Mill Rejects Handling System will be provided for collection of the rejects from each mill of the boiler unit and to convey to storage bunker. Each mill will be provided with collection and transportation equipment comprising of one no. Pyrite Hopper with water spray arrangement plate valves at inlet and outlet and a transport vessel connected to storage bunker.

(5) Secondary Fuel Oil System

The fuel oil system will be provided for boiler start up; and for flame stabilization during low load operation with or without coal firing. Light Diesel Oil (LDO) for boiler start up (up to 7.5% of BMCR) and Heavy Fuel Oil (HFO) for low load operation and flame stabilization for minimum capacity of 30% of BMCR will be provided.

High Energy Arc (HEA) ignitors will be provided to ignite the fuel oil.

(6) Soot Blowing System

Soot blowing system will comprise of steam soot blowers in various heat transfer sections suitable for automatic and sequential control.



(7) **Electrostatic Precipitators**

The high efficiency electrostatic precipitators having collection efficiency of 99.89% will limit the outlet dust emission to 50 mg/Nm³ at ESP outlet with all fields in service while the boiler is operating at its BMCR, firing worst coal having maximum ash content in coal.

For each unit, four electrostatic precipitators comprising of eight (8) bus sections in the direction of gas flow and two bus sections perpendicular to the gas flow will be provided. Electrostatic precipitators will be provided with microprocessor based programmable type rapper control system and ESP management system to ensure the safe and optimum operation of ESP. The dust collection hoppers at all strategic locations will have a minimum storage capacity of eight (8) hours.

(8) **Boiler Structures**

Boiler and auxiliaries will be complete with necessary piping, valves and fittings. Supporting structural steel, stairways, platforms and walkways, hand rails complete, weather covering interconnecting platforms, buck stay and tie bars for boiler, refractory & insulation etc. will be provided.

Space provision for the FGD system to be installed in future (if required), will be kept behind the chimney as per environmental stipulation. The design and layout of steam generator and its auxiliaries will be such that a wet/dry flue gas desulphurisation system can be installed, taking suction from duct after ID fan and



feeding the desulphurised flue gases back to the chimney with provision for bypassing the FGD system.

5.2.2 Technical Data

The data of steam generator & auxiliaries mentioned below is indicative and each supplier will offer data for the machine being offered:

Particulars	Unit	Parameters
Super heater outlet steam flow	tph	2600
Steam pressure at SH outlet (minimum)	Kg/cm ² (a)	256
Steam temperature at SH outlet	°C	565
Reheat steam flow	tph	2052
Steam temp. at RH inlet	°C	350
Steam temp. at RH outlet	°C	593
Steam pressure at RH inlet (minimum)	kg/cm ² (a)	61
Steam pressure at RH outlet	Kg/cm ² (a)	59
Feed water temperature entering Economiser	°C	307
Excess air (at 100% MCR)	%	20
Superheat temp control	-	By spray attemperation between stages of super heaters
Reheat temperature control	-	By burner tilt/flue gas recirculation and emergency spray attemperators
FD Fans	Nos./Type	2 Nos. axial reaction type, blade pitch control
PA Fans	Nos./Type	2 Nos. axial reaction type, blade pitch control
ID Fans	Nos./Type	2 Nos. Axial reaction, blade pitch control.
Soot blower	-	Wall blowers, retractable blowers, rotary blowers and APH blower as per requirement
Regenerative air pre-heaters	-	2 Nos. trisector APH or four



		bisector APH 2 Nos. steam heated air pre heater
Ambient air temperature for design (For Electrical equipment only)	°C	45
Burners	-	Low NOx pulverized coal burners

5.2.3

AUXILIARY BOILER

One number outdoor installation type, natural circulation, single / bi-drum, pressurized furnace, water tube Boiler suitable for firing LDO and having required steaming capacity but not less than 60 T/hr (Excluding steam requirement of Auxiliary Boiler) with operating steam parameters of 19 kg/sq.cm(g) pressure & 250 deg.C temperature at super-heater outlet. Output steam of the auxiliary boiler shall be connected to the low temperature station header.

Boiler and its supporting auxiliaries are capable to generate 110% MCR steaming capacity for half hour every shift of eight hours.

The steam temperature control range of Auxiliary boiler shall be from 60% to 100% load.

The design of Auxiliary Boiler shall meet (or exceed) all requirements of IBR. The Bidder shall be responsible to obtain necessary approval of Inspection Authority / Chief Inspector of Boiler on behalf of Customer as may be required for design & design calculation, manufacturing & erection procedures, testing etc as called for under IBR.





The auxiliary Boiler, including its interlock & protection system shall conform to NFPA – 85.

5.3 Steam Turbine and Auxiliaries

5.3.1 Steam Turbine Plant

The turbine component and its auxiliaries will be designed and selected to meet the stringent requirements in respect of superior thermal performance, excellent product reliability & operational flexibility.

The turbine will be designed based on modular design approach that divides the turbine into three main parts:

- High-pressure (HP) section
- Intermediate-pressure (IP) section and
- Low-pressure (LP) section

The turbine will have one single flow HP, one double flow IP and two double flow low-pressure cylinders exhausting downwards into condensers. All components will be selected based on long-proven records and standardized modules. The turbines will be of the tandem compound design. The individual shafts of the cylinders and the generator rotor shaft will be coupled rigidly together.

5.3.2 Gland Steam Sealing System

A fully automatic gland sealing steam supply system will be provided for the TG Set and the turbine drives of BFPs. HP & IP turbine shaft glands will be sealed to prevent escape of steam into the atmosphere and the LP turbine glands will be sealed for preventing leakage of atmospheric air



into the turbine. Steam will be used for sealing these spring backed labyrinth glands.

During start-up and low loads (say 40% load), seal steam will be supplied to the turbine glands from the auxiliary steam header or cold reheat line through a seal steam regulating valve. During normal operation (above 40% load), the HP and IP turbines will be of self-sealing type and under that condition the auxiliary / CRH steam source will be cut off and the leak-off steam from HP and IP glands will be used for sealing the LP glands. The excess leak-off steam will be led to the condenser.

A gland steam condenser will be provided to condense and return to the cycle, all gland leaks off steam including that from BFP turbines. 2x100% capacity vapour exhausters will be provided to remove non-condensable gases from the gland steam condenser.

5.3.3 Oil System

The oil system will supply oil for lubrication and cooling of turbine and generator bearings, driving the hydraulic shaft turning gear during start-up and shutdown, jacking the rotor shaft system at low speed. This system will be provided with AC & DC powered oil pumps.

A separate, self contained high-pressure fluid system with dedicated pumps will be provided for valve actuation. The system will specifically include the following:

- (a) Turbine shaft driven main oil pump will have the sufficient capacity to handle lube oil requirement of the bearings and emergency seal oil requirements during normal operation.





- (b) During start-up and shutdown, one of the electrically driven main oil pump will supply the lube oil to the bearings. Second main oil pump will be automatically put into operation by pressure switch when the oil pressure drops below the preset value.
- (c) 1x100% DC emergency oil pump for meeting lube oil requirements of bearings during emergency with automatic starting on low lube oil pressure preset value.
- (d) One (1) AC motor & one (1) DC motor jacking oil pumps will be provided to lift the rotor at the bearings during turning gear operation.
- (e) Each unit will be provided with an oil tank of sufficient capacity with 2x100% duty vapour extraction fans. 2x100% capacity oil coolers will be provided for oil cooling.
- (f) A lube oil purification unit will be installed for each unit for the total oil charge on a continuous basis.

5.3.4 Control Fluid System

Control fluid supply for hydraulic actuators will be provided by means of a common hydraulic supply unit. The system will comprise of:

- a) A control fluid reservoir of adequate capacity to ensure fluid supply.
- b) Oil purification unit for control fluid system.
- c) 2x100% AC motor driven pumps to pump the fire resistant fluid from the reservoir.
- d) 2x100% capacity control fluid cooling via blast air coolers designed for service with DM water.



- e) Required fluid conditions will be maintained by separate filtering lube with micro filters.

5.3.5 Governing Systems

The turbine will be equipped with multi-channel digital turbine governor control system ensuring stable operation under all operating conditions including grid disturbances and load throw off condition. The turbine governing system will be designed for high accuracy and high speed control tasks of steam turbine. It permits governed run up to rated speed of the turbine.

5.3.6 Turning Gear

Shaft turning gear will be provided to ensure uniform and rapid heating/cooling of casing during start up/trip conditions. The turning gear consists of hydraulic motor, overrunning clutch and intermediate shaft installed in the front bearing pedestal of the LP turbine. Oil supply to the shaft turning gear will be from the shaft jacking system.

Manual turning gear device with ratchet and liver arrangement will also be provided.

5.3.7 Turbine Protection System

Electronic protection system of turbine receives tripping signals from individual tripping criteria such as low condenser vacuum, lube oil pressure, high axial shift, high turbine bearing temperature, high HP exhaust steam temperatures, high absolute turbine vibration, high condenser level, low HPT proportional pressure, electrical generator protection, over speed protection and low vacuum trip etc.



5.3.8 HP-LP Bypass Station

60% HP / LP Turbine bypass station will be provided to act not only as a protection to the turbine during pressure rise resulting from sudden load throw-off but also to enable operation of the unit at loads lower than the control load. Further, HP/LP bypass will permit quick, repeated hot starts of the unit on its tripping.

The LP bypass station will be connected to the hot reheat line and discharges the steam into the condenser. The hot reheat steam will be desuperheated by means of condensate injection. The bypass system shall be in operation when the steam turbine is not able to receive the entire steam quantity, e.g. during start-up or in case of a load rejection.

5.3.9 Condensing System

The function of the condenser is to condense the steam exhausted from the LP cylinders and to produce and maintain as high a vacuum as possible in order to increase the enthalpy drop, which can be utilised in the turbine.

Twin condensers will be provided per unit with cooling water side of condenser in series. Condenser will be of box type construction with divided water box design which facilitate the operation of one half of condenser while the other half is under maintenance. The steam space will be of rectangular construction. The condenser will be provided with integral air cooling system from where air and non-condensable gas are drawn out with the help of air evacuation equipments.

Condenser tube will be of cupronickel or stainless steel. The layout of the tube will be of modular type having properly sized tube bundles.



5.3.10 Air Extraction

The unit will comprise of (2x100%) vacuum pumps for each condenser along with all accessories and instrumentation for condenser air evacuation. The vacuum pumps and accessories will be used to create vacuum by removing air and non-condensate gases from steam condenser during plant operation. Vacuum pumps will be of single/two stage liquid ring type with both stages (if two stage pump is selected) mounted on a common shaft. Vacuum pumps will be sized as per latest HEI requirements.

For quick initial start up, air will be extracted from the condenser using both vacuum pumps.

5.3.11 Condensate Extraction Pumps

Each unit will have 3x50% capacity motor driven condensate extraction pumps (two operating and one standby). The condensate pumps will be vertical barrel type, multistage, double section, diffuser pumps, centrifugal type designed for condensate extraction service having low suction head requirement. The pumps will be capable of handling the condensate from the condenser together with feed heater drains when the machine is operating at maximum unit output with HP heaters out with 3% make-up and discharging this quantity through the condensate polishing unit and the LP heaters to deaerator. The pump will have adequate margins on capacity and head to cater for most adverse conditions of operation such as:

- a) HP & LP bypass in operation.
- b) HP heaters out of service and unit operating at its maximum load during an under frequency operation.



5.3.12 Regenerative Feed Heating Cycle

Regenerative feed heating cycle will consist of LP heaters, drain cooler, deaerator and a parallel bank of HP heaters. The number of LP & HP heaters will however be based on the optimization of feed heating cycle.

Feed water will be heated by uncontrolled turbine extraction steam from turbine inter-stage tap-offs and cold reheat line in feed water heaters.

Spray-cum-tray type deaerator will consist of integral vent condenser, deaerating header and feed storage tank. The deaerator will be capable of deaerating the dissolved oxygen and carbon dioxide in condensate & HP Heater drains. The minimum capacity of the deaerator will be 6 minutes between normal operating level and low level with a filling factor of 0.66. The deaerator will be normally operating by taking extraction steam from IP turbine except during low load operation and start up when the steam is drawn from the auxiliary steam header.

5.3.13 Boiler Feed Pumps (BFP)

The unit will comprise of 2x50% turbine driven boiler feed pumps and 1x50 % electric motor driven boiler feed pump per unit with boiler feed booster pumps mounted on the common shaft. The boiler feed booster pump will be double volute casing, vertical split, casing type. The discharge line of the booster pump will be connected to suction boiler feed pump. Each boiler feed pump will be designed to give parameters to suit the steam generator requirements; such that motor driven feed pump will be used for start-up of unit and will also act as standby BFP. Turbine driven boiler feed pumps will be located at operating floor and the motor driven pump will be located on operating floor and both types will be accessible to turbine house EOT crane for erection and maintenance.



The feed pump will be able to handle feed water of pH. 8.5 to 9.5 and of temperature up to 185⁰C (tentative).

The boiler feed pumps will be of horizontal, centrifugal type. The boiler feed pumps outer casing will be of barrel type with end removal. The inner pump assembly comprising of shaft, impellers, stage casings will be capable of being removed and replaced as a unit without disturbing the feed piping. Each feed pump will be provided with ON-OFF / modulating type recirculation control valve to protect the pump under low flow condition. The boiler feed water system will be designed to operate primarily in an automatic mode over the range of system design loads. The arrangement will provide automatic start-up one of the standby motor driven feed pump under conditions like tripping of the running TDBFP's and/or discharge header pressure low etc.

The turbine of boiler feed pump will be of total controlled governing and consist of reaction stages. During stable / normal operation, steam sources for TDBFP will be from IP / LP crossover piping.

Hydraulic coupling will be utilized to achieve speed control of motor driven feed pumps. Provisions will be made for warm up to standby pump, if required.

5.3.14

Lube Oil Purification System

A suitably sized centrifuge type turbine oil purifier will be provided as an auxiliary of the proposed turbine-generator set to condition the turbine oil continuously to remove the water and other impurities.

In addition, a common central facility will be provided common for both units. This will receive the refill of turbine oil from outside. In addition,



central lube oil facilities will be provided common for both the units. The purification plant will be complete with oil purifiers, one clean and one dirty oil storage tank, filter, necessary pumping sets and vent fans.

5.3.15 Typical Design Parameters of Steam Turbine

The data mentioned below is indicative and each supplier will offer data for the machine being offered:

Description	Unit	Parameter
Type	-	Tandem Compound
Number of cylinders	-	Four (4)
Type of governing	-	Digital electro hydraulic
Speed	RPM	3000
Rated output (continuous)	kW	800,000
Steam pressure before emergency stop valve HP	Kg/cm ² (a)	242
Steam temperature before emergency stop valve	⁰ C	565
Reheat steam inlet pressure	Kg/cm ² (a)	56
Reheat steam temperature	⁰ C	593
SH Steam flow required with 0% make-up and 0.098 ata back pressure	tph	2427
Reheat steam flow	tph	1995
Rated pressure at exhaust of LP turbine	kg (a)	0.1
Maximum temperature rise of circulating water	⁰ C	9



6.0 DESCRIPTION OF MAJOR SYSTEMS

6.1 MECHANICAL SYSTEMS

6.1.1 Coal Transportation, Unloading Facilities and Handling Plant

- a) The coal will be transported to power plant from coal mines through Indian Railways. The nearest port is Kakinada which is about 328 KM from the project site
- b) The coal handling plant (CHP) will be designed to operate throughout the year with coal with average gross, calorific value of 4550 kcal/kg. Typical Coal analysis is given in **Annexure-6.1**.
- c) As per BHEL considering Gross Station Heat Rate of 2109.4 kcal/kwh, the coal requirement for the each unit works out at full load with GCV of coal as 4550 kcal/kg as:

i)	Tonnes per hour (tph)	$\frac{800 \times 2109.4}{4550}$ = 370.88
ii)	Tonnes per day (tpd)	8901.20
iii)	Million tonnes per year at 85% PLF (mtpa)	2.76

6.1.2 COAL HANDLING PLANT

Two (2) independent CHPs are envisaged designated as CHP I & II. CHP-I caters to the fuel requirements for Unit-1/2 and CHP-II for Unit-3/4/5. Two (2) Wagon Tippler Complex# WTC-1A/1B (each with two (2) Crescent type Wagon Tipplers) are provided for CHP-I as well as for



CHP-II. Track Hopper Complex # THC-1A & THC-1B are provided for CHP-I & CHP-II respectively. Capacity of each track hopper shall be 7200 Tonnes. Suitable number of rail tracks appropriately interconnected with each other shall be laid ahead & prior to the track hoppers / wagon tipplers for handling / return of empty rakes. Necessary line side equipment and signaling arrangement for rake movement shall be provided.

Two (2) Wagon Tippler Complex are proposed so that stock building and rake unloading operations can be carried out expeditiously. Two (2) Track Hopper Complex are proposed so that during emergency situation, rakes with bottom discharge wagons can be unloaded in sufficient numbers.

CHP-I & CHP-II are interconnected so that coal can be transferred from CHP-I to CHP-II & vice versa. Each of CHP- I /II is composed of two (2) streams (1W + 1S) operating at guaranteed capacity of 2156 tph each. However, both streams of CHP-I /II shall be designed to operate simultaneously in case of emergency.

Minimum four (4) Diesel Locomotives having minimum 800HP rating shall be provided for local shunting/ hauling purpose etc of rakes within the railway marshalling yard.

SYSTEM REQUIREMENTS

Following Tables describe the coal handling capacity requirements for above CHPs:

Table – 1: System Requirements						
Sr. No.	Item Description	Symb ol	Unit	Formula / ref	Value for	Value for



					CHP-I	CHP-II
1	Installed, MW				2x800 [U-1/2]	3x800 [U-3/4/5]
2	No of Units	N	no.		2	3
3	Unit capacity	C_{p1}	MW	...	800	800
4	Total MW	C_t	MW	$C_t = N \times C_{p1}$	1600	2400
5	Fuel	-	-	...	Blended Coal	Blended Coal
6	Calorific value of above coal	C_{v1}	kcal/kg	...	4550	4550
7	Station heat rate for 1x800 MW	SHR_1	kcal/k whr	...	2109.4	2109.4
8	Hrly coal consumption per unit	q_0	tph	$q_0 = (C_{p1} \times SHR_1) \div (CV_1)$	370.88	370.88
9	Coal consumption per hour	q_1	tph	$q_1 = N \times q_0$	741.8	1112.7
10	Coal consumption per day	q_2	tpd	$q_2 = 24 \times q_1$	17802.4	26703.4
11	Operating Hrs/ day for one CHP stream	t_1	hr	----	14	14
12	Capacity of one CHP stream	C_0	Tph	$C_0 = q_2 \div t_1$	1271.6	1907.4
13	Hence, Capacity of one CHP stream with 10% Margin & post round off	C_1	tph	$C_1 \cong 1.1 \times C_0$	1400	2100
14	Capacity of one CHP Stream selected	C_2	tph	For standardization & interconnection of CHP-I & II	2156	2156
15	Hence operating hr. per CHP Stream	t_0	hr	$t_0 = q_2 \div 2156$	~9 (<14)	~13 (<14)
16	Coal rake size i.e. no of wagon per rake	n_1	no	One coal rake has 58 no. of wagon	58	58
17	Pay load per wagon	q_1	tonne	$q_1 = 77$ tonne [Coal]	77	77
18	Coal qty per rake [=rake load]	q_d	tonne	$q_d = n_1 \times q_1$	4466	4466





19	No. of coal rakes to be unloaded per day (Round off)	n_2	no	$n_2 = q_2 \div q_d$	4	6
21	No. of coal rakes to be unloaded per day considering 2-rake for stock building	n_4	no	$n_4 = n_3 + 2$	6	8

Table – 2: Tippler Qty/ Capacity Selection

Sr. No.	Item Description	Symbo l	Unit	Formula / ref	CHP-I	CHP-II
1.	No. of Crescent Wagon Tipplers proposed	n_1	no.	2 No. for each CHP	2	2
2.	Tippling capacity selected for Crescent Wagon Tipplers	q_c	tip/hr	-----	28	28
3.	No. of wagons tipped per hr per tippler	q_t	no	-----	28	28
4.	No. of coal rakes to be unloaded per day	n_2	no	Refer Table-1	4	6
5.	No. of coal rakes to be unloaded per day considering 2-rake for stock building	n_3	no	$n_3 = n_2 + 2$	6	8
6.	Coal rake size i.e. no of wagons per rake	n_4	no	58	58
7.	Unloading period of one rake	t_1	hr	$t_1 = n_4 / q_t$	2.07	2.07
8.	Unloading period of one rake in minutes	t_1	min	1hr=60 min	124	124
9.	Rake placement time for tippling operation for one rake at tippler complex	t_2	min	Estimated	44	44
10.	Effective unloading period per rake (per tippler)	t_3	min	$t_3 = t_1 + t_2$	168	168
11.	Effective unloading period per rake (per tippler) in hr	t_3	hrs	1hr=60 min	2.8	2.8
12.	Time taken for unloading n_3 rakes by using both Crescent tipplers	t_4	hr	$t_4 = (n_3 \times t_3) \div n_1$	8.4	11.2
13.	Operating hours per day (maximum)	t_5	hr	Assumed	14	14



14.	Hence, rakes unloaded by using both Crescent tipplers in 14 hr. period	N	no	$N = (n_3 \times t_5) \div t_4$	10	10
15.	Hence, rakes unloaded for stock building in 14 hr. period	n_5	no	$n_5 = N - n_2$	6	4
16.	Hence Four (4) No. Crescent Wagon Tipplers of capacity 28 tips per hour each is OK, as $N > n_2 : N > n_3$					
17.	Coal discharge rate from Crescent Wagon Tipplers operating @28 tips per hr	Q_d	tph	$Q_d = q_c \times q_1$	2156	2156
18.	CHP stream capacity as per Crescent Wagon Tippler Discharge rate	Q_1	tph	$Q_1 = Q_d$	2156	2156
19.	Hence, Capacity of one CHP stream selected	Q	tph	2156	2156

Notes:

- (i) Each CHP shall be designed considering both streams operating simultaneously. Hence stock building operation can be done by operating both tipplers for each CHP.
- (ii) No. of CHP streams = Two (2) for CHP-I and Two (2) for CHP-II, Guaranteed Capacity of each stream = 2156 tph.

Table-3: Belt Speed and Width selection for Belt Conveyors (35° Tr. X 3-Equal Roll)					
S.No.	Item description	Symbol	Unit	Ref. / Formula	CHP-I / II
1	Capacity required	Q	tph	From above	2156
2	Material handled	-	-	-----	Uncrushed Coal/ Crushed Coal
3	Maximum Lump Size	-	mm	Raw Coal Size: (-)300mm Crushed Coal Size: (-)20 mm	300 / 20
4	Bulk density	ρ	t/m ³	-----	0.8
5	Capacity of 2000 mm x 35° Tr. Belt for 1t/m ³ material, @ 1m/s and slope factor, K=1, surcharge angle = 20 degree [Coal]	Q_c	tph	IS : 11592, P-12	1713
6	Slope factor for 14° inclination of	K	-	IS:11592,Table-9, Pg.11	0.91



	belt (Max. inclination of belt not to exceed 14°)				
7	Capacity of 2000mm x 35° Tr. belt for 0.8 t/m ³ (coal), @ 1 m/s and K = 0.91	Q_d	tph	$Q_d = \rho \times Q_c \times K$	1247
8	Hence belt speed reqd. (with 5% extra margin to suit G. Box/ Motor RPM)	V_c	m/s	$V_c = 1.05 \times [Q \div Q_d]$	1.82
9	Hence belt speed selected.	V	m/s	----	2.0
10	Check capacity of conveyor @ 2.0 m/s belt speed	Q_D	tph	$Q_D = V \times Q_d$ $= 2494 \text{ tph}$	2494 >2156 Hence OK
11	Belting Selected: 2000mm wide x 3-eq roll x 35° tr. x 2.0 m/s belt speed				
12	Belt speed kept low to avoid vibration at elevated drive base frame of Conv. Drive Unit.				

Table – 4: Stockpile Details

Sr. No.	Item Description	CHP-I / II
1.	Coal Consumption per day, tonne (Refer Table-1)	44505.8 [Value for Unit-1/2 + Value for Unit-3/4/5]
2.	Capacity of stock for 30 days storage	1335174
3.	No. of Stockpiles provided for crushed coal	Six (6) [Designation: CCS-1/2/3/4/5/6]
4.	Type of cross section of stockpile	Trapezoidal
5.	Length of each stockpile, m	745
6.	Height of each stockpile, m	10.5
7.	Width at base, m	50
8.	Width at top, m	22.13
9.	Cross-sectional area, sqm	378.68
10.	Capacity of stockpile for coal in tonne per running meter [Coal @ 0.8 t/cum]	302 [=0.8 x 378.68]
11	Hence capacity of one stockpile in	224990





	tonne, 745m long	
12	Hence capacity of 6 stockpile in tonne, 745m long each	1349940 [> 1335174, hence OK]
13.	Machine Used for stockpile formation [Stockpile# CCS-1/2/3/4/5/6]	<p>(i) Two (2) No. Stacker cum Reclaimer Machine, Bucket Wheel Type with Uni-directional yard belt conveyor (2000mm Belt x 3-Eq. Roll x 35° Tr.) Boom Length : 45m (Approx.) Track CRS: 10m.[Eqpt# SR-1A/1B]</p> <p>(ii) Two (2) No. Stacker Machine with Uni-directional yard belt conveyor (2000mm Belt x 3-Eq. Roll x 35° Tr.) Boom Length : 45m (Approx.) Track CRS: 10m. .[Eqpt# STK-1A/1B]</p>
14	Machine Used for Reclaiming Crushed Coal From Stockpile [Stockpile# CCS-1/2/3/4/5/6]	<p>(i) Two (2) No. Stacker cum Reclaimer Machine, Bucket Wheel Type with Uni-directional yard belt conveyor (2000mm Belt x 3-Eq. Roll x 35° Tr.) Boom Length : 45m (Approx.) Track CRS: 10m. .[Eqpt# SR-1A/1B]</p> <p>(ii) One (1) No. Reclaimer Machine, Bucket Wheel Type with Uni-directional yard belt conveyor (2000mm Belt x 3-Eq. Roll x 35° Tr.) Boom Length : 50m (Approx.) Track CRS: 10m. .[Eqpt# RCL-1]</p> <p>(iii) Bull Dozers for dozing crushed coal from Stockpile# CCS-1/6 into Emergency Reclaim Hoppers of Reclaim Hopper Complex# ERH-1/2</p>

Table – 5: Design Basis of CHP

Sr. No.	Item Description	CHP-I / II
1	Material Handled	: Coal
2	Max. lump size of Coal received at Power Plant	: (-) 300 mm
3	Bulk Density	: 800 kg/m ³





4	Moisture content	:	15% (Max.)
5	HGI of coal	:	48 to 65
6	Crushed coal size	:	(-) 20 mm
7	Angle of Repose of Crushed Coal	:	37 degree
8	Capacity of each CHP Stream	:	2156 tph
9	No. of streams provided to cater to Unit – 1/2 (2x800 MW) under CHP-I	:	Two (2) – [1W + 1S]
10	No. of streams provided to cater to Unit – 3/4/5 (3x800 MW) under CHP-II	:	Two (2) – [1W + 1S]

SYSTEM DESCRIPTION

CHP-I (Refer Flow Diagram)

- 1.0 Two (2) Crescent type Wagon Tippers along with associated equipments are provided in Wagon Tippler Complex # WTC-1A to unload ROM coal & deliver it to Crusher House # CRH-1 via Apron Feeder# AF-1A/2A, Conv. # BC-1A/1B & BC-2A/2B.
- 2.0 To cater to fuel requirements of Coal of Units1&2, One (1) Track Hopper Complex# THC-1A is provided for CHP-I, so that during emergency situation, rakes with bottom discharge wagons can be unloaded in sufficient numbers. ROM Coal from Track Hopper# TH-1A shall be delivered to Crusher House # CRH-1 via Rotary Discharge Machine# RDM-1A/2A/3A/4A, Conv. # BC-1C/1D, BC-1A/1B & BC-2A/2B.
- 3.0 Conv # BC-2A/2B which will feed ROM coal into Grizzly Feeders located in the Crusher House. Grizzly feeders will feed oversize coal i.e. (-) 300 mm (+) 20 mm





to crusher which in turn will crush the oversize coal (from grizzly feeder) to (-) 20 mm product. Under size coal from grizzly feeder i.e. (-) 20 mm and crushed coal from crusher bottom will be fed on to Belt Feeder # BF-1A/1B.

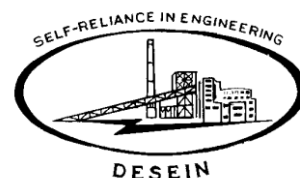
- 4.0 Belt Feeder # BF-1A/1B will feed crushed coal onto Conv.# BC-3A/3B which in turn will feed crushed coal either onto Yard Belt Conv.# YBC-1A [of Stacker cum Reclaimer M/C # SR-1A for stacking coal into crushed coal stockpiles # CCS-1/2 via its boom belt] **OR** onto Yard Belt Conv.# YBST-1A [of Stacker M/C # STK-1A for stacking coal into crushed coal stockpiles # CCS-2/3] **OR** onto Yard Belt Conv.# YBRC-1 for onward transportation of coal to Coal Bunkers of either Unit-1/2 or Unit-3/4/5 via connected set of Belt Conveyors and Bunker Filling Tripper Belt Conveyors. Conv.# BC-3A/3B can also feed Conv.# BC-4A/4B as & when required.
- 5.0 Conv.# BC-4A/4B will feed crushed coal either onto Yard Belt Conv.# YBST-1B [of Stacker M/C # STK-1B for stacking coal into crushed coal stockpiles # CCS-4/5 via its boom belt] **OR** onto Yard Belt Conv.# YBC-1B [of Stacker cum Reclaimer M/C # SR-1B for stacking coal into crushed coal stockpiles # CCS-5/6 via its boom belt] **OR** onto Conv.# BCN-5A/5B of CHP-II for onward transportation of coal to Coal Bunkers of Unit-3/4/5 **OR** onto Conv.# BC-5A/5B for onward transportation of coal to Coal Bunkers of Units 1&2 via connected set of belt conveyors which will feed coal to Bunker Filling Tripper Belt Conveyors # TBC-1A/1B/1C/1D/2A/2B/2C/2D.
- 6.0 Thus stock building operation of crushed coal will be carried out by Stacker cum Reclaimer M/C # SR-1A/1B and Stacker M/C # STK-1A/1B.
- 7.0 When coal rakes are not available, then coal from crushed coal stockpiles will be





reclaimed & fed to Coal Bunkers via following paths:

- (i) Coal from Crushed Coal Stockpiles# CCS-1/2 will be reclaimed by bucket wheel of Stacker cum Reclaimer M/C # SR-1A and fed onto unidirectional Yard Belt Conv. # YBC-1A via the boom belt. Subsequently coal will be fed onto Conv.# RC-1A/1B [in Transfer Tower# TT-3A] for onward transportation of crushed coal to Coal Bunkers of either Unit-1/2 or Unit-3/4/5 via connected set of belt conveyors and Bunker Filling Tripper Belt Conveyors.
- (ii) Similarly, Coal from Crushed Coal Stockpiles# CCS-3/4 will be reclaimed by bucket wheel of Reclaimer M/C # RCL-1 and fed onto unidirectional Yard Belt Conv. # YBRC-1 via the boom belt. Subsequently coal will be fed onto Conv. # RC-1A/1B [in Transfer Tower# TT-5A] for onward transportation of crushed coal to Coal Bunkers of either Unit-1/2 or Unit-3/4/5 via connected set of belt conveyors and Bunker Filling Tripper Belt Conveyors.
- (iii) Similarly, Coal from Crushed Coal Stockpiles# CCS-5/6 will be reclaimed by bucket wheel of Stacker cum Reclaimer M/C # SR-1B and fed onto unidirectional Yard Belt Conv.# YBC-1B via the boom belt. Subsequently coal will be fed onto Conv. # RC-1A/1B [in Transfer Tower# TT-7A] for onward transportation of crushed coal to Coal Bunkers of either Unit-1/2 or Unit-3/4/5 via connected set of belt conveyors and Bunker Filling Tripper Belt Conveyors.
- (iv) Two (2) Reclaim Hopper Complex# ERH-1/2 with Six (6) underground RCC hoppers each with one Vibrating Feeder at bottom along with underground reclaim Conv. # RC-2A/2B are also provided near Stockpile # CCS- 1/6.





- (v) During the event when Stacker cum Reclaimer M/C# SR-1A/1B, Stacker M/C # STK-1A/1B & Reclaimer # RCL-1 are inoperative as well as coal rakes are not available at site, crushed coal will be dosed from stockpile # CCS-1/6 by bull dozers into Emergency Reclaim Hopper Complex# ERH-1/2 and subsequently crushed coal will be delivered to Coal Bunkers of Unit- 1/2 or Unit-3/4/5 via Conv. # RC-2A or RC-2B & connected set of belt conveyors and Bunker Filling Tripper Belt Conveyors.

8.0 Suitable conveyor arrangement has been incorporated so that Coal from conveyors of CHP-II can be fed to conveyors of CHP-I, and vice versa.

9.0 Thus under CHP-I, coal can be fed to Coal Bunkers of Unit – 1/2 as follows:

- a) Directly from Wagon Tippler Complex # WTC-1A to Coal Bunkers via Crusher House # CRH-1 & connected set of conveyors including bunker filling tripper belt conveyors.
- b) Directly from Track Hopper Complex # THC-1A to Coal Bunkers via Crusher House # CRH-1 & connected set of conveyors including bunker filling tripper belt conveyors.
- c) From Crushed Coal Stockpiles# CCS-1/2 to Coal Bunkers via Stacker cum Reclaimer M/C # SR-1A/ Yard Belt Conv. # YBC-1A / connected set of conveyors including bunker filling tripper belt conveyors.
- d) From Crushed Coal Stockpiles# CCS-3/4 to Coal Bunkers via Reclaimer M/C # RCL-1/ Yard Belt Reclaiming Conv. # YBRC-1 / connected set of conveyors including bunker filling tripper belt conveyors.
- e) From Crushed Coal Stockpiles# CCS-5/6 to Coal Bunkers Stacker cum Reclaimer M/C # SR-1B/ Yard Belt Conv. # YBC-1B / connected set of conveyors including bunker filling tripper belt conveyors.



- f) From Crushed Coal Stockpile# CCS-1/6 to Coal Bunkers via dozers/ Emergency Reclaim Hopper # ERH-1/2 and connected set of conveyors including bunker filling tripper belt conveyors.
- g) Refer Flow Diagram; coal can also be fed using stockpile by-pass facility on Machine# SR-1A/1B, STK-1A/1B together with the corresponding yard belt conveyor and connected conveyor system to Bunkers including bunker filling tripper belt conveyors.
- h) Refer Flow Diagram; coal can also be fed from CHP-II to Coal Bunkers of Unit-1/2.

CHP-II (Refer Flow Diagram)

To cater to fuel requirements of Coal Bunker of Units # 3, 4 & 5, Wagon Tripper Complex # WTC-1B as well as Track Hopper Complex # THC-1B are provided for CHP-II.

Configuration of CHP-II will be similar to CHP-I including connection with CHP-I. Refer Layout Plan.

Auxiliary Equipment / Systems for CHP-I / II

In-motion Weigh Bridge at ends of Track Hopper Complex, Side Arm Charger/ Static Weigh Bridge for Wagon Tippler, Inline Magnetic Separators (for tramp metal separation), Metal Detectors, Belt Weighers, Suspended Electromagnets, Sump Pumps etc. have been incorporated at suitable locations. Coal Sampling Systems shall be provided suitably. Three (3) No. Belt Vulcanizing Machines shall be provided to suit vulcanization of all belt widths provided.



Four (4) Elevators of 2T capacity each shall be provided; One(1) each in Crusher House # CRH-1, Crusher House # CRH-2, Junction Tower# JT-12 & Junction Tower# TT-10.

For CHP Buildings viz. Junction Towers / Transfer Towers/ Crusher House / Drive House, Manual Hoists/ Electric Operated Hoist are envisaged for handling cum maintenance purpose for equipments. For Tippler Complex, Crane is proposed.

For Dust Control, Cold Fog Type Dust Suppression System is proposed for coal transfer points in Junction Towers/ Transfer Towers. For transfer points of Crusher/ Grizzly Feeder/ Belt Feeder in Crusher House, Dry type Dust Extraction System with bag filter shall be provided.

For Coal Stockpiles: Plain Water Spray System using Sprinklers is envisaged. Cold Fog dust suppression system On board machine is envisaged for each Stacker Cum Reclaimer M/C, Stacker M/C and Reclaimer M/C.

For Wagon Tippler top, Plain Water Dust Suppression System shall be provided along with pre-wetting system for waiting wagons.

For Track Hopper, Cold Fog Type Dust Suppression System shall be provided.

Compressed Air System (CAS) shall be provided in Track Hopper Complex for opening/ closing of bottom discharge wagons.

Service Water (SW) connections shall be provided in Conveyor galleries & tunnels at suitable intervals. Adequate number of these connections



shall be provided in all CHP buildings, all tripper floors, wagon tippler area, track hopper area, crusher house, Pump Houses, Electrical Buildings, toilets etc.

Potable Water (PW) connections shall be provided in all CHP buildings, wagon tippler top, crusher house, all tripper floors, the machinery well at both ends of track hopper, all control rooms/ MCC rooms/ Operator's cabin and toilets etc.

Each crusher shall be provided with Vibration Isolation system & Vibration Monitoring System.

Vibration Isolation System shall also be provided for conveyor drives located at floors having elevations of 10m and above.

Tunnel Ventilation System using fresh dry filtered air supply type together with exhaust system is envisaged for ventilation of underground tunnels / underground portion of Junction Towers.

Suitable no. of Vent Filters shall be provided above top of Coal Bunkers.

Four (4) Bull Dozers with Coal blade and also Two (2) Front End Loaders shall be provided for stockpile handling, compaction etc. for all crushed coal stockpiles.

Suitable Marshaling Yard shall be provided as per requirement of Track Hopper Complex & Wagon Tippler Complex.

3-D scanner for stockpile capacity determination shall be provided below boom belt of each Stacker cum Reclaimer & Stacker.





DCS System shall be provided for operation & control of CHP. Each Stacker cum Reclaimer, Stacker and Reclaimer shall be provided with PLC System for its operation & control for working suitably in conjunction with its yard belt.

For Main CHP Control Room, Split type A.C. units shall be provided in addition to wall-mounted swiveling Ceiling Fans.

Conveyors and CHP Buildings shall be provided with Fire Protection & Detection System which includes Hydrant System, Medium Velocity Water Spray System & Fire Alarm and Detection System.

Technical Features of CHP-I / II

Major equipments/components (as applicable) like Stacker cum Reclaimer/Stacker/Traveling Trippers/Belt width of Conveyor/Magnetic Separator /Suspended Electromagnet/Metal Detector/Belt Weigher/Elevator/Gates etc. shall be kept identical to the extent possible for standardization purpose so as to maintain minimum inventory of spares.

N/N Belting shall be provided for conveyor shorter than 500m. For conveyor of length 500m & above, steel cord belting shall be provided. F.R Grade cover shall be provided for all belting.

All Junction Towers/ Transfer Towers shall be in steel frame construction with RCC floors & RCC roof. Side cladding shall be of precolour coated sheeting.





Two (2) way chutes at conveyor discharge end (of each CHP stream) shall be provided suitably for streams selection / choice of stream so as to have flexibility of operation.

6.1.2 ASH HANDLING SYSTEM

6.1.2.1 Ash handling system of each unit will include bottom ash handling system, coarse ash system, wet fly ash handling system, dry fly ash handling system, ash disposal system and ash water recovery system. The ash handling system will be complete in all respects with mechanical, civil, structural, electrical, control and instrumentation systems.

Coal consumption at BMCR per unit	-	370.88 TPH
Ash content in coal @ 32 % (50% Indian + 50% Imported) per unit	-	119 TPH
Bottom ash hopper generated @ 25%	-	29.75 TPH
Ash generated in Eco hoppers @ 5 %	-	6 TPH
Ash generated in APH hoppers @ 5 %	-	6 TPH
Ash generated in Duct hoppers @ 5%	-	6 TPH
Fly ash in ESP hoppers @ 90 %	-	107.1 TPH

6.1.2.2 System Description

6.1.2.2.1 Ash formed due to combustion of pulverized coal in the steam generator will be collected either as bottom ash in the bottom ash hopper; coarse ash in economizer hoppers, air pre heater hoppers, duct hoppers and fly ash ESP hoppers.

6.1.2.2.2 Bottom ash of each unit will be collected in a W-shaped water impounded hopper and conveyed to ash slurry sump through jet pumps once in a shift



of eight hours. The ash slurry will further be conveyed to ash disposal area by means of Ash disposal pumps.

6.1.2.2.3 Ash collected in the economizer hoppers of each unit will be extracted continuously by means of flushing apparatus located below each economizer hopper and conveyed to bottom ash hopper. The ash slurry collected in the bottom ash hopper will further be conveyed to the ash slurry sump along with bottom ash slurry for further disposal to ash disposal area.

6.1.2.2.4 Ash collected in the air pre heater and duct hoppers of each unit will be extracted intermittently by means of feeder ejectors located below each APH & Duct hoppers and conveyed to coarse ash tank. The slurry collected in the coarse ash tank will be conveyed to the ash slurry sump through jet pumps.

6.1.2.2.5 The fly ash collected in Electrostatic Precipitator hoppers of each unit will be extracted through vacuum and conveyed to buffer hoppers and thereafter to fly ash silos through pressure conveying system. Fly ash stored in fly ash silos will be disposed in dry form through closed trucks; in conditioned form in open trucks through ash conditioner. Alternatively fly ash will be extracted through vacuum conveyed to Collector tanks for wet fly ash slurry disposal to ash slurry sump through Collector tank, wetting head and ash slurry disposal system.

6.1.2.3 Bottom Ash Handling System

6.1.2.3.1 Bottom Ash System of each unit will consist of 'W-shaped' water impounded, storage type, water-cooled refractory lined bottom ash hopper located directly below the bottom water wall header of boiler. Bottom ash will be collected continuously from the boiler furnace. Bottom ash hopper will be



designed for an effective storage capacity of 8 hours collection of bottom ash and coarse ash from Economizer hoppers generated during worst coal firing.

- 6.1.2.3.2 The bottom ash hopper will have the shape to ensure free flow of bottom ash. BA hopper of each unit will consists of two sections; each section of the hopper will have two outlets provided with two clinker grinders installed directly below the feed gate assembly to limit the size of clinkers to maximum 25 mm. Jet pumps will be provided below each clinker grinder for conveying the ash slurry to the ash slurry pump house for further transportation to ash disposal area. Out of two clinker grinders and two jet pumps provided for each “V” section, one grinder and jet pump will operate while other will be standby.
- 6.1.2.3.3 Bottom Ash Hopper overflow will be routed through overflow seal box to Bottom Ash overflow sump for onward disposal to AHP clarifier for re-use. Two adequately sized BA Overflow pumps (1W+1S) will be provided for each unit to pump contents of BA overflow sump to ash slurry sump or to AHP clarifier. Seal trough overflow will also be led to the BA overflow sump.
- 6.1.2.3.4 Ash collected in Economizer hoppers will be automatically extracted and conveyed to the flushing apparatus located below each economizer hopper. Necessary vacuum/momentum required for extracting ash from the hoppers will be created by the flushing apparatus. The ash slurry thus produced will be routed to bottom ash hopper by gravity. The ash slurry collected continuously along with bottom ash slurry in the bottom ash hopper will be conveyed to the ash slurry sump by Jet pumps from clinker grinders.

Flow Diagram of Bottom Ash Handling System is given in **Annexure – 6.3**.



6.1.2.3.5 Coarse Ash Handling System

Coarse ash collected in Air pre heater and Duct hoppers will be automatically extracted by feeder ejectors located below each APH & Duct hoppers. Feeder ejector will be used to create necessary vacuum for extracting ash from each hopper and mix the ash with water. The ash slurry thus produced will be conveyed to coarse ash tank through piping & from there to ash slurry sump through jet pumps.

Flow Diagram of Coarse Ash System is given in **Annexure – 6.4**.

6.1.2.4 Fly Ash Handling System

6.1.2.4.1 Fly ash collected in various ESP hoppers of each unit will be extracted and conveyed to buffer hoppers automatically and sequentially by means of vacuum generated by mechanical exhausters and will be transported to fly ash silos by means of pressure conveying system. Adequately rated oil free rotary screw type Conveying Air Compressors will be provided to supply compressed air required for conveying fly ash from buffer hoppers to fly ash silos. One (1) buffer hopper will be provided for each vacuum stream. Adequately sized bag filters will be mounted on buffer hopper. Four (4) fly ash conveying streams will be provided for each unit to convey dry fly ash to fly ash silos.

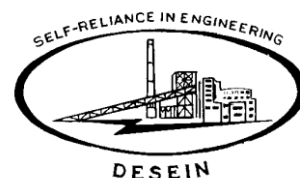
6.1.2.4.2 Five (5) Fly Ash Silos each of 1600 T capacity will be provided, each fly ash silo having an effective storage capacity to store 16 hours fly ash generation of one unit while firing worst coal. Each Fly ash silo will be provided with four outlets; two for unloading ash in dry form into closed trucks through telescopic chute; one for unloading ash in conditioned form into open trucks through ash conditioner; and one outlet will be blind





flanged for future use. Each fly ash silo will be provided with adequately sized vent filter with fan over silo roof. Each outlet (except blind flange) will be provided with rotary feeder for discharging regulated quantity of ash.

- 6.1.2.4.3 Ten (10) adequately rated low speed, oil free, twin lobe, positive type fluidizing air blowers with heaters; (1W+1S) per unit will be provided for fluidizing ESP Hoppers and Buffer hoppers of each unit.
- 6.1.2.4.4 Ten (10) adequately rated low speed, oil free, twin lobe, positive type fluidizing air blowers with heaters (1 working & 1 stand by per silo) will be provided for fly ash silos.
- 6.1.2.4.5 Four (4) adequately rated rotary screw type oil free air compressors with air driers and air receivers, 2(1W+1SB) for Units # 1&2 (Group I) and 2(1W+1S) for Units # 3, 4 & 5 (Group II) will be provided for supplying instrument air required for operating various cylinder operated valves and cleaning of pulse jet type bag filters (Buffer hoppers and pneumatic operated valves).
- 6.1.2.4.6 Two (2) adequately rated rotary screw type oil free air compressors with air driers and air receivers, (1W+1SB) for all Silos at silo area, will be provided for supplying instrument air required for operating various cylinder operated valves and cleaning of pulse jet type bag filters of Silos.
- 6.1.2.4.7 Fifteen (15) adequately rated oil free, rotary screw type Conveying air compressors (2W+1S) per unit for supplying compressed air required for conveying dry fly ash from buffer hoppers to fly ash silos.





6.1.2.4.8 Thirty (30) adequately sized water ring type mechanical exhausters (4W+2S) for each unit will be provided in the air path for creating vacuum in the system for fly ash extraction from fly ash hoppers to buffer hoppers.

6.1.2.5 **Wet Fly Ash Handling System**

Fly ash collected in ESP hoppers of each unit alternatively will be automatically and sequentially extracted and pneumatically conveyed in dry form to the proposed collector tanks through vacuum created by Mechanical Exhausters. Dry fly ash while routed to the collector tank will pass through wetting head where water will be mixed with the dry fly ash and resultant ash slurry will be discharged in to the collector tank. One air washer will be provided on each collector tank to clean the air passing to mechanical exhauster. Flow of air to the Mechanical Exhausters will contain negligible dust. Air washer drain will be connected to collector tank discharge pipe. Adequately sized jetting nozzles will be provided below each collector tank to further convey the slurry to the ash slurry sump.

Flow Diagram of Fly Ash Handling System (Dry/Wet) is given in **Annexure – 6.5.**

6.1.2.6 **Ash Disposal System**

Ash slurry disposal system: One slurry pump house with independent ash slurry sump for Group I and Group II are envisaged.

Bottom ash, coarse ash and fly ash slurry of each unit collected in the ash slurry sump will be pumped to ash disposal area through ash disposal pump series and pipe lines. Eight (8) ash slurry pumping series with associated pipe work and valves will be provided. Out of the eight slurry pumping series, 3 (2W+1SB) for Units # 1& 2 (Group I) and 5 (3W+2S)





for Units # 3, 4 & 5 (Group II) will be provided as shown in the enclosed flow diagram.

Eight (8) disposal lines of 300 NB size will be installed to dispose the ash slurry to ash disposal area from each ash disposal pump house to ash disposal area.

6.1.2.7 **Water System**

Ash water system will be grouped in to 2 groups to cater the water requirements of ash handling system. Each group will comprise of the following,

6.1.2.7.1 **AHP Pumps**

Three (3) AHP Pumps (2W+1SB) will be provided in the raw water pump house to meet the water requirements of ash disposal system of 5 units. These pumps will feed raw water to ash water sump.

6.1.2.7.2 **HP Water Pumps**

Eight (8) High pressure (HP) water pumps, 3(2W+1S) for Units # 1&2 (Group I) and 5(3W+2S) for Units # 3,4&5 (Group II) will be provided to meet the water requirements of jet pumps, seal trough flushing, BA hopper flushing, feeder ejectors of APH & Duct hoppers ash slurry sump jetting nozzles, drain sumps jetting, wetting heads, air washers and jetting nozzles.

**6.1.2.7.3 LP water Pumps**

Eight (8) LP water pumps, 3(2W+1S) for Units # 1&2 (Group I) and 5(3W+2S) for Units # 3,4&5 (Group II) will be provided to meet the water requirements of BA Hopper refractory cooling, seal trough makeup, bottom ash hopper fill.

6.1.2.7.4 Economizer water Pumps

Eight (8) Eco water pumps, 3(2W+1S) for Units # 1&2 (Group I) and 5(3W+2S) for Units # 3,4&5 (Group II) will be provided to meet the water requirements of flushing apparatus below economizer hoppers.

6.1.2.7.5 Seal water Pumps

Eight (8) Seal water pumps, 3(2W+1S) for Units # 1&2 (Group I) and 5(3W+2S) for Units # 3,4&5 (Group II) will be provided for sealing of ash disposal pumps and drain pumps. Out of eight (8) seal water pumps, one will be working for each Ash slurry pump series and three standby.

6.1.2.7.6 Dust conditioner water pumps

Five (5) Dust conditioner water pumps (3W for 5 silos and two common standby) will be provided for conditioning of ash before unloading the conditioned ash into the trucks from Fly ash silos.

6.1.2.7.7 Drain Pumps

Drain pumps are envisaged for BA, ESP, Silo, Compressor house, slurry pump house area etc





6.1.2.8 System capacities

6.1.2.8.1 Bottom Ash Handling System

Bottom ash and economizer ash collected in BA Hopper will be evacuated at a rate of 140 TPH. Capacity of each jet pump will be 70 TPH.

6.1.2.8.2 Coarse Ash System

APH and Duct hoppers ash collected in Coarse ash tank will be evacuated at a rate of 140 TPH. Capacity of each jet pump will be 70 TPH.

6.1.2.8.3 Fly Ash Handling System (Dry & wet)

Ash collected in ESP hoppers will be evacuated @ 180 TPH with 4 fly ash streams operating simultaneously. The removal rate of each vacuum stream will be 45 TPH and removal capacity of each pressure conveying stream shall be 90 TPH.

6.1.2.8.4 Ash Slurry Disposal System

Capacity of ash slurry pumps will be 660 M³/hr. Number of pumps in each series will be decided based on the frictional losses, pipe length of 12KM and static rise in the ash disposal pipe routing. A static rise of 25 M will be considered for ash disposal pump head calculations.

Flow diagram of ash water & ash disposal system is shown in **Annexure – 6.6.**



6.1.2.9 Design Requirements

6.1.2.9.1 Bulk Density of Ash/Ash content is considered as follows:

(a) **Bottom ash**

- (i) For volume calculation : 650 kg/M³
- (ii) For design of structures & supports : 1600 kg/M³

(b) **Fly ash**

- (i) For volume calculation : 750 kg/M³
- (ii) For design of structural supports : 1600 kg/M³

6.1.2.9.2 Capacities of various tanks/sumps

Bottom ash over flow tank	:	10 minutes
Ash Slurry compartment	:	5 minutes
Coarse ash tank	:	5 minutes
Ash Water Sump	:	60 minutes
Drain Sumps (at various locations)	:	5 M ³ or 10 minutes whichever is higher
Ash Conditioner sump	:	60 minutes
Ash water recovery sump in disposal area	:	2500 M ³ or 30 minutes Whichever is higher
Clarifier Sludge pit	:	15 minutes
Seal water sump	:	60 minutes

6.1.2.10 Ash water Recovery System

Recycle water from the ash disposal area will be decanted and reused for ash handling system. The overflow water in the ash disposal area will be



routed to Recycle water sump (minimum 2500 M³) adjacent to the dyke. Three (3) recovery water pumps each having a capacity of 800 M³/hr will be installed in the over flow sump to pump the overflow water to a clarifier (in the plant area) for reuse in ash disposal system.

Two (2) 350 NB MS ERW pipes to IS 3589 will be provided for pumping water from overflow sump (adjacent to the ash disposal area) to the clarifier.

- 6.1.2.11 One (1) clarifier of 3500 M³/hr capacity will be provided for treating ash water recovered from ash disposal area, BA Overflow and drains of ash handling system of all the five units. Needed chemical dosing system will be provided. AHP Clarifier will be designed for outlet water quality of maximum 20 ppm. A sludge sump with two (2) sludge transfer pumps will be provided. The clarifier outlet will be routed to ash water sumps by gravity.

Flow Diagram of Ash Water Recovery System is given in **Annexure – 6.7**.

6.1.2.12 **Ash Disposal Area**

Ministry of Environment and Forests (MoEF) Notification dated 3rd November, 2009 stipulate that “new coal and, or lignite based thermal power stations and, or expansion units commissioned after this notification to achieve 100 % utilization of ash within four year from the date of commissioning of the unit”.

However, in line to CEA guideline and considering the ash utilization potential around Project site, the optimized land area of 490 acres with 25 M height is proposed for ash dyke.



This land will be earmarked for disposing the wet ash generated from all the 5 units. The ash water recovery system from the ash pond with clarification plant etc. will be provided for re use in ash disposal system. Ash disposal area is located at 12 KM from Power plant area and having a storage capacity of 490 acres.





6.1.3 PLANT WATER SYSTEM

6.1.3.1 Raw Water

Consumptive water requirement of five units of 800 MW will be made available by pumping from Krishna river to Plant Raw Water reservoir of capacity 10,17,500 m³, which is sufficient for 3.5 days consumptive water requirement.

6.1.3.2 Water is required in a thermal power station for:

- a) Cooling Tower make-up.
- b) Auxiliary cooling water system - Water for bearing cooling and other auxiliary systems through closed loop circulation
- c) Boiler make-up.
- d) Potable water for plant/colony.
- e) Plant services
- f) Fire fighting
- g) Ash handling

6.1.3.3 Composite Water Balance

The composite water scheme is as per **Annexure – 6.8** & Raw water analysis is as per **Annexure - 6.9**

The consumptive water requirement of 5 x 800 MW units is worked out as follows:



A.	DM Water Requirement	Unit	Quantity for 5 units
-	Make-up water in power cycle $2600 \times 1.5\% = 39 \text{ m}^3/\text{hr/unit}$	M ³ /hr	195
-	DM CW make-up $2.0 \text{ m}^3/\text{hr/unit}$	M ³ /hr	10.0
-	Stator Cooling make up $1.0 \text{ m}^3/\text{hr/unit}$	M ³ /hr	5.0
-	Chemical dosing $1.0 \text{ m}^3/\text{hr/unit}$	M ³ /hr	5.0
-	Condensate polishing unit regeneration for 5 units	M ³ /hr	15.0
-	DM regeneration	M ³ /hr	10.0
	Sub total	M ³ /hr	240
	Hence four DM streams (3 operating + 1 standby) each of capacity $80 \text{ m}^3/\text{hr}$ are considered.		
B.	FILTERED water requirement		
a.	Feed to DM plant including regeneration requirement	M ³ /hr	240
b.	Potable water needs for plant & colony	M ³ /hr	110
c.	Service water	M ³ /hr	750
d.	Ultra / Micro filtration reject	M ³ /hr	1200
e.	CW Makeup $1945 \text{ m}^3/\text{hr/unit}$	M ³ /hr	9725
	Sub Total (B)	M ³ /hr	12,025
	Raw water requirement	M ³ /hr	12,100





In the initial year of the Plant, the water requirement may be varying from 11-12 cusecs depending upon the ash handling system i.e. wet disposal or dry disposal.

6.1.3.4 Pretreatment System

Raw water drawn from in plant water storage reservoir will be filtered through 40 (36W + 4S) 335 m³/hr capacity ultra / micro filtration units along with back wash arrangement. Chlorine will be dozed in raw water reservoir to avoid micro-biological growth. The filter water with SDI<3 and turbidity of 0.5 NTU will be stored in filter water storage of capacity 32,000 cu.m. The reject of ultra / micro filtration units will be transferred to CMB OR ASH HANDLING PLANT.

6.1.3.5 Filter Water System

Filter water will be distributed to various areas of the plant through dedicated pump sets as follows:

- a) Four (4) – (3 working + 1 standby) 33% capacity & adequate head DM plant supply pump sets to supply water to 4 nos. (3 working + 1 standby) DM plant streams, each of capacity of 80 cu.m/hr.
- b) Four (4) - (3 working + 1 standby) 33% capacity adequate head service water pumps to supply filter water to service water distribution network all over the plant building through an adequately sized overhead tank suitably located at a height in the Power Plant.



- c) Five (5) – (4 working + 1 standby) 25% capacity CW make up water pumps to supply make-up water to two(2) nos. CW sumps for loss towards evaporation & CW blow down losses.
- d) Two (2) – (1 working + 1 standby) 100% capacity service water pumps to supply filter water to APH/ESP wash each of capacity 550 cu.m/hr.

6.1.3.6 Condenser Cooling Water System

Closed cycle condenser cooling is envisaged with Natural Draught Cooling tower. Make-up water will be pumped to the circulating water (CW) sump through two (2) no. 100% capacity buried steel pipe. One CW sump will be provided with 5 nos. (4W + 1S) CW pump sets and other CW sump will be provided with 7 (6W + 1S) CW pump sets for pumping water to condenser of two & three units and will discharge back to Natural Draught Cooling Tower having cooling range of 10°C and maintaining a Cycle of Concentration of 5. The recooled water from cooling tower will be channeled to each CW sump. Suitable arrangement for chlorine or chlorine dioxide dosing to curb organic growth and chemical dosing for maintaining Cycle of concentration (COC) of 5 will be made.

6.1.3.7 Bearing Cooling Water System

Demineralised water in a closed cycle is envisaged for all auxiliary equipment cooling of the power plant. This will be recooled by water, circulating on the secondary side of the plate heat exchangers.

- a) 3 x 50% for TG Aux. & 2 x 100% SG Aux. PHE's will be provided for each unit. Four (3W + 1S) 100% ACW pumps for three units & three (2W + 1S) 100% ACW pumps for two units will be provided,





to establish necessary flow & pressure differential required for PHEs. These pumps will be located in respective CW pump houses.

- b) Demineralized water for make up to closed cycle BCW system will be conditioned to avoid corrosion of carbon steel materials. DM CW pump sets utilizing Demineralised water through PHEs will distribute to various coolers of unit auxiliaries under uniform pressure.
- c) Makeup water to DMCW system will be made available through DM transfer pumps of each unit.

6.1.3.8 Demineralization Plant

A fully automatic DCS based Demineralizing plant having four (4) (3W+1S) – 80 M³/hr capacity streams (3 normally operating) will be provided to have mixed bed outlet quality as follows:

Silica	:	< 10 ppb
pH	:	6.8 – 7.2
Conductivity	:	≤ 0.1 μS/cm
TOC	:	< 200 ppb

The filtered water will be pumped to DM plant through cation exchangers, degassifiers, anion exchangers and mixed beds all installed within the DM plant building. The DM water will be stored in five (5) – 1500 M³ each capacity steel plate fabricated vertical cylindrical DM water storage tanks along with proper breathers and floating PVC balls arrangement to prevent absorption of atmospheric gases.





DM water from storage tank will be transported to five (5) 1000 M³ capacity Condensate Storage Tanks (CST), DM water will be used for heat cycle makeup, chemical feed system, DMCW make up, etc. For this, purpose, two (2) numbers 100% capacity Hot well make up pumps for each units, will be provided. Two (2) 100% boiler fill pump sets common for 3 units & two (2) 100% boiler fill pumps sets common for 2 units will be provided, for filling of boiler, condenser and deaerator as per operational requirements.

6.1.3.10 **Condensate Polishing Unit (CPU)**

To maintain the purity of the boiler feed water, condensate polishing unit (CPU) will be provided in the condensate water cycle at the downstream of condensate extraction pumps. The purpose of the condensate polishing unit shall be to polish the condensate effluent from the condenser by removal of suspended solids and dissolved solids to reduce corrosion and depositions in steam water cycle.

The condensate polishing unit shall be full flow, 3x50% Pre filters and 4 (3W+1S) x 50% capacity mixed bed units. The resins used shall Strong Acid Cation and Strong Base Anion type of resin appropriate for the influent water analysis. The resins shall be externally regenerated by transferring it to the dedicated regeneration station. The regeneration waste generated from the CPU unit shall be collected in the Neutralization pit and shall be neutralized before its disposal to the guard pond.

6.1.3.11 **Hydrogen Generation Plant**

Requirement of the generator for hydrogen quality and make-up quantity, the parameter is as follows:



Quality	-	Purity	> 99.9% (H ₂)
	-	Moisture	< 4g/Nm ³
	-	Dew Point	≤ -40°C

Quantity - $(C \times 1.5 \times A + \frac{B}{30}) / 10 \text{ Nm}^3/\text{hr.}$

- C Number of TG units
A Nm³/hr Leakage rate per generator
B Nm³ Requirement of one generator filling

Three (3) (2Working + 1Standby) unit of hydrogen generation plant of 10 Nm³/hr., 3.2 MPa shall meet the requirement 5 x 800 MW Unit use.

The hydrogen shall be generated by the electrolysis of a suitable mixture of DM water & soda or Potash lye or Bipolar Proton Exchange Membrane.

6.1.3.12 Flue Gas Desulphurization (FGD) System (IF REQUIRED)

The FGD system shall be provided to treat gases produced from the combustion of any and all fuels – Fuel Properties. The FGD system shall be lime based scrubber with a proven design & shall be capable of meeting plant emission requirement to prevent a visible stack plume and MOEF requirement i.e.

Particulate Matter	-	30 mg/Nm ³
Sulphur Dioxide (So ₂)	-	100 mg/Nm ³
Oxide of Nitrogen (Nox)	-	100 mg/Nm ³
Mercury (Hg)	-	0.03 mg/Nm ³





The lime based SO₂ system shall be furnished complete with necessary pumps, piping and valves, control and instrumentation and moisture separators for the flue gas.

FGD system shall be designed to remove SO₂ for all load conditions from minimum continuous through BMCR to meet the limits.

FGD system shall be designed and constructed to operate as specified at maximum continuous rated load 24 hours per day, 7 days per week, 365 days per year, except during unit outages. Particulate matter in the flue gas leaving the boiler shall be removed by ESP.

FGD system shall include an emergency water quench system to protect absorber module, linings, and internals from damage in the event of loss of water to scrubber module at normal flue gas temperature for a period of 30 minutes.

The control system shall be DCS based with interface with plant DCS.

6.1.3.13 **Cycle Chemical Feed System**

The boiler feed water and condensate dosing system consists of i.e.

- Ammonia and Oxygen – (CWT) Combined Water Treatment
- Ammonia and Hydrazine – (AVT) All Volatile Treatment

In order to maintain pH and to prevent and reduce the corrosion of equipments.



AVT should be used during start-up / abnormal conditions, and difficult to achieve cation conductivity of feed water < 0.15 Ms/cms. CWT should be used under normal operation when cation conductivity of feed water is maintained < 0.15 μ S/cms and polishing treatment is running normally, then appropriate to add oxygen.

Each feed system for Ammonia & Hydrazine shall consists of one tank and two (2) metering pumps for each unit.

Each unit oxygen dosing device shall consist of a set for dosing oxygen at deaerator outlet and CPU outlet. Each unit equipped with 8 oxygen bottles and set of automatic oxygen device.

6.1.3.14

Specification for Water & Steam:

Description	Specification
DM Water Quality	
Conductivity	≤ 0.08 μ S/cm
Silica	< 10 ppb
pH	6.8 – 7.3
Sodium	< 5 ppb
Total Organic Carbon	< 200 ppb
Main Condensate	
Conductivity (after cation column)	< 0.2 μ S/cm
Silica	< 20 ppb
pH	8.0 – 9.0 (< 9.5)
Feed Water	
Conductivity (after cation column)	< 0.2 μ S/cm
Silica	< 20 ppb
Iron	< 20 ppb





Sodium	< 10 ppb
Oxygen	30 – 150 ppb
pH	8.0 – 9.0 (< 9.5)
Main Steam	
Conductivity (after cation column)	< 0.2 μ S/cm
Silica	< 20 ppb
Iron	< 20 ppb
Sodium	< 10 ppb
pH	8.0 – 9.0 (< 9.5)

6.1.3.15 Specification for Oxygen:

- Purity 99.893%
- Moisture 5 ppm by vol
- Carbon di-oxide 0.5 ppm by vol

6.1.3.16 **Sewage Treatment Plant**

The sanitary waste of all the toilets from the different buildings of the plant shall be collected by gravity into the respective collection chambers and shall lead to common collection sump under gravity flow as far as possible. However, if hydraulics do not permit gravity flow the intermittent collection sumps shall be provided with the lifting stations and such lifting stations shall be provided with 2 nos. (1W + 1S) of pumps.

The sewage treatment plant shall be designed as per guidelines of CPHEEO Manual. The anticipated no. of users shall be 4000 persons. The sewage treatment plant shall be designed to handle a flow of 180 Kld





considering average per capita consumption of 45 lpcd with 80% of used water generated as sewage. The Sewage Treatment Plant shall be modular type based on FAB/MBBR technology followed by disinfection by Hypo and necessary tertiary treatment prior to reuse in horticulture purpose.

The finally treated sewage shall meet the norms of environment protection rules 1986 and its amendments and the rules of CPCB / MOEF/ State Pollution Control Board.

6.1.3.17 Chemical Laboratory

A chemical laboratory shall be provided for the day-to-day testing of fuel samples, water quality, steam quality, blow down, flue gas and analysis, Ash analysis, Pollution monitoring.

6.1.3.18 Rain Water Harvesting System

Rain water harvesting is the process of collecting, conveying and storing water from an area that has been treated to increase the runoff of rainfall. The potential of Rain water harvesting can be illustrated by pointing out that 1 millimeter of rain equals 10,000 litre of water per hectare. A small area of impermeable surface can collect a relatively large volume of water. The most important components, which will be evaluated for designing the rain water harvesting structure, are:

- Hydrogeology of the plant area including nature and extent of aquifer, soil cover, topography, depth of water levels and chemical availability of ground water.





- Areas contributing for runoff i.e. how much area and land use pattern wither plant area, colony area or green belts and general built up pattern of the area.
- Hydro – metrological characters like rainfall duration, general pattern and intensity of rainfall.

The following portions are excluded from the rainwater catchment area, as rainfall in these areas are either do not come out that can be dealt with or rainfall comes out as inefficient and these are dealt separately.

- Cooling Tower
- Guard Pond / RWHP areas
- Coal Stock Pile Area
- Boiler / ESP area
- Fuel oil handling and storage area

6.1.3.19 Waste Water Management System

The Waste Water Management Scheme adopting the philosophy of 100% recycling of treated effluent for a “Zero Discharge” concept. Each identified effluent stream shall be subjected to required treatment. The treatment facilities will be such that quality of outlet from each treatment facility as well as that at the Central Monitoring Basin outlet must individually meet applicable standards for discharge of liquid effluents to surface water.

The Effluent Treatment System shall fully comply with all requirements and limits specified in Environmental (Protection) Rules, 1986, along with all latest amendments to it, requirements and stipulations of the Central Pollution control Board (CPCB), Ministry of Environment and Forests



(MoEF); Government of India and State Pollution Control Board for the project, and any other central or local statutory requirements regarding environmental pollution and its abatement.

As per MoEF clearance, the treated effluents conforming to the prescribed standards only shall be re-circulated and reused within the plant. There shall be no discharge outside the plant boundary except during monsoon. Arrangements shall be made that effluents and storm water do not get mixed.

The sources of waste water effluents from a thermal power station are mainly:

- CW System blow down
- Effluents from WT Plant (Clarifiers, Filters & UF)
- Effluents from regeneration waste (DM, CPU)
- Plant drains
- Oily waste fuel oil unloading & storage areas
- Oily waste from transformer yard areas
- Coal pile area runoff
- Ash water from ash pond.

The waste will be collected, treated and then reused within the plant.

6.1.4 Air-conditioning System

Various control rooms of the plant having a group of sophisticated and precision control and protection devices; as well as computer rooms will be air-conditioned to have controlled environment for proper functioning of the equipment and operating personnel comfort. Centralized air-conditioning system, package / split air-conditioning units & window AC etc. as per



requirement of the area will be provided. The air conditioning system will be common for all the units.

The following indoor design conditions will be maintained inside the air Conditioned areas:

Dry bulb temperature: $22.0^{\circ}\text{C} \pm 1.0^{\circ}\text{C}$

Relative humidity: $50 \pm 5\%$

- a) The centralized chilled water air conditioning system will be provided for the following areas:
- i) Main control room area comprising of unit control room, electronic cubicle room, shift in-charge room, maintenance engineer room, printer room, UPS room, relay room, SWAS panel room, conference room, office room, record room, analyzer room, static excitation room in TG building.

The central air-condition will be achieved through a central and/or distributed chilled water system. It will consist of 2x100% capacity chilled water circulation pumps, condenser cooling water pumps, cooling towers (as needed), hermitically or semi-hermitic type chillers; cabinet type air handling units with centrifugal limit load type backward blowers with 3-way mixing valves & balancing valves etc. Cooled air will be supplied to the various areas by rectangular GI ducts and return air will be taken back through return air grills provided above the false ceiling.

- b) A separate dedicated Direct Expansion type AC plant of 2x100% capacity will be provided for electrostatic precipitator control room.





Packaged air-conditioners will also be provided at following areas:

- 1) Administrative building
- 2) Switchyard control & relay room
- 3) Coal handling control room
- 4) Ash handling control room
- 5) DM plant control room
- 6) Any other control rooms, if required

Split AC units will be provided for office and meeting rooms areas.

6.1.5 Ventilation System

- a) Adequate ventilation system will be provided for the TG building, ESP control building (non-air conditioned areas) and other areas such as DG set room, air compressor room, A/C plant room, DM plant building, battery rooms and various pump houses such as fuel oil pump-house, DM water pump house etc to achieve:
 - i) Dust free comfortable working environment.
 - ii) Scavenging out structural heat gain and heat load of various equipment, hot pipes, lighting etc.
- b) **Power Plant Machine Room Building**

Supply air system will be provided with evaporative cooling plant by a set of air washers of 2x50% capacity with cooling water coils (water supplied from an independent source). The system will include 2x50% capacity supply air fans, inlet louvers, bird screens, viscous filters, cooling coils, recirculating water system with 2x100% circulating water pump sets, bank of spray nozzles &





flooding nozzles, eliminator plates and masonry sump tank etc for supply and distribution of cooled air at various locations. The exhaust system will consist of roof extractors (for machine room); axial flow wall mounted exhaust fans with GI ducts, dampers, grilles and other accessories as necessary. The system will be designed to maintain close to ambient dry bulb temperature inside the building.

Various rooms of the power plant building such as cable spreader room, switchgear room etc will be ventilated by means of pressurized supply and exhaust fans suitably located.

c) **ESP Control Building**

For ventilation of this building, ambient air will be drawn through Unitary Air filtration unit comprising fresh air intake louver, dry type filter and cooling coils conveying water [supplied from an independent source] and supplied to the space by means of centrifugal fans through ducting, grilles etc.

The supplied air will be exhausted through wall mounted gravity operated dampers to maintain higher over pressure (measurable) in mm water column to reduce dust and fine sand.

d) **Other Buildings**

Ambient air ventilation system will be proposed for all the other areas which are not air-conditioned such as:

- i. CW pump house
- ii. Service building
- iii. Air compressor room



- iv. AC plant room
- v. DG set room
- vi. Battery and battery charger room
- vii. All MCC rooms & cable vaults
- viii. All toilets
- ix. Stores
- x. Fuel oil pump house
- xi. Ash water and ash pump house
- xii. Compressor/vacuum pump house (AHP)
- xiii. Clarified water pump house
- xiv. Switchgear room

Elevator machine rooms will be provided with pressurised ventilation to avoid ingress dust from boiler & mill area. The elevator shaft of boiler will be covered on all sides with CGI sheets or perforated corrugated metal cladding.

The system will comprise supply air fans/louvers and exhaust air fans/roof extractors or combination so as to ensure adequate number of air change per hour generally followed norms.

System will comprise axial flow fan, pre & fine filters ducts wherever required, inside dry bulb temperature will be maintained lower than ambient by about 5°C. Fire dampers will be provided on duct work routed through electrical installation areas. Ventilation system of respective areas will be suitably interlocked with fire detection system to control spreading of fire.

- e) The normal design criteria for the design of the ventilation system is to consider at least 10 air changes per hour for an effective volume of space 4 m from the floor level. In areas such as the





machine room of the plant building TG bay, etc. where the volumes handled are very large, the system is designed by providing limit load type backward curved centrifugal DIDW blowers/fans (mounted on suitable heavy duty vibration isolators) inside an acoustically insulated room with dedicated ductwork so that all the heat generated is removed and a temperature lower than the ambient is maintained. The system envisages to maintain a temperature of 5°C lower than the ambient temperature for providing comfortable working atmosphere.

6.1.6 Compressed Air System

To cater for the plant requirements it is proposed to install required number of instrument air compressors and service air compressors of adequate capacity for the compressed air at 8.4 kg/cm²(g). The instrument air compressors will be oil free type, complete with desiccant type dryers and individual air receivers to absorb pressure pulsations and for acting as reserve supply of compressed air to permit continued operation following failure of the operating compressor until the standby one is put into service. The instrument and service air headers will be interconnected in a manner that in case of emergency the service air be used for the plant instrument air.

Station service air requirement for normal cleaning purposes, atomizing air for warm-up guns and ignitors, motive power for burner drive mechanism and emergency air for air drive motors of air pre-heaters will be met from service air compressors. It is proposed to install these compressors in a separate building.

Compressed air scheme is given in **Annexure - 6.10**.



6.1.7 Cranes and Hoisting Equipment

In order to facilitate the handling of various equipments during erection and maintenance of the power plant, a number of cranes and hoists will be required at various locations.

Four (4) electrically operated traveling (EOT) cranes of 125/40 tonne capacity complete with all accessories to operate independently will be provided for AB bay of TG building.

The generator stator will be the heaviest piece of equipment. To avoid extra load on the turbine building columns and foundations, the generator stator will be lifted by jacking/cribbing process. For other heavy pieces to be lifted such as generator rotor, LP turbine rotor etc., 125/40 tonnes capacity EOT crane will be utilized.

Conventional and special type of cranes for maintenance of a few important equipment of SG and TG packaged plants such as FD/PA/ID fans, pulverizers, air heaters, condenser water box, ESP transformer rectifier sets etc. will be provided. For clarified water pump house, DM plant building, raw water pump house, hydrogen generation plant, ash handling system & coal handling system under-slung cranes of adequate capacity and pendant operated cranes with electrical hoists will be provided. For each circulating water pump house pendant operated electric overhead traveling crane will be provided having capacity of about 40/10 tonnes.

Maintenance cranes/handling devices of suitable capacities will be considered for all other areas. Monorails for lifting heavy motors and other equipment within the powerhouse not covered by EOT crane such as miscellaneous pumps, heat exchangers etc will also be provided. Suitable





rails embedded on floor for dragging the horizontal feed water heaters to have the approach under EOT cranes will also be provided.

6.1.8 Fire Protection System

6.1.8.1 For protection against fire, all yard equipment and plant equipment will be protected by a combination of hydrant system; automatic sprinkler spray system (emulsifier system); fixed foam system for oil handling areas; automatic high velocity and medium velocity sprinkler spray system; auto-modular inert gas based system for control rooms apart from portable and mobile fire extinguishers located at strategic areas of plant buildings and adequate Passive Fire Protection measures. The systems will be designed as per the recommendations of NFPA or approved equals in accordance with the Tariff Advisory Committee (TAC) of the Insurance Association of India stipulations.

- 6.1.8.2 (a) In view of vulnerability to fire and its importance in the running of the power station, effective measures will be taken to tackle fire in the susceptible areas such as cable galleries; fuel oil handling areas; coal handling plant areas including transfer points, crusher houses and tunnels, etc.
- (b) For containment of fire and preventing it from spreading in cable galleries, unit wise fire barriers with self-closing fire doors will be provided. In addition, all cable entries/openings in the cable galleries, tunnels, floors will be sealed with non-inflammable/fire resistant sealing materials to prevent fire propagation for at least three (3) hours. Fire protection cable coating compound over cables at switchgear entry points, power station building entry points and trays



will be provided to prevent damage from fire for at least thirty (30) minutes.

Adequate distances will be maintained between different process blocks and hazardous equipment. To prevent fire from spreading through ventilation & air conditioning ducts, dampers with auto closing arrangements will be provided at appropriate locations.

Dedicated fire water pumps will be installed in the clarified water pump house. In the clarified water storage tank about 4000 M³ water will be stored as dedicated dead storage for meeting fire water requirement in exigencies. The details of system are as follows:

- a) Three (3) electric motor driven fire water pump sets of 410 M³/hr capacity having 88 MWC head along with two (2) identical capacity & head diesel engine driven backup fire water pumps will provided for hydrant and sprinkler system in addition to two (2) Jockey pump sets having capacity of 25 M³/hr and 88 MWC which would be brought to operation automatically when hydrant pressure drop indications are received. In addition to these pump sets, other auxiliaries for the fire protection system such as hydro-pneumatic tanks, compressors, pipe work, valves etc will be provided as required.
- b) Hydrant system will feed pressurized water to hydrant valves located throughout the plant and also at strategic locations within the powerhouse.
- c) High velocity water spray system (HVWS) will be provided for Generator transformers; Unit auxiliary transformers, station





transformers, turbine oil storage tanks, boiler burner zone and generator seal oil system.

- d) Medium Velocity Water Spray System (MVWS) will be provided for
- i) Cable galleries, cable valets, cable vaults, cable spreader room, cable riser/shaft in main plant, switchyard, ESP, AHP control room & CHP control room, coal conveyers & transfer points etc.
 - ii) Fuel oil area,
 - iii) Compressor room & DG set room.

Adequate arrangement for detection of fire and smoke will be provided at different locations of vital installations. Laser based fiber optic type LHS fire detection and alarm system will be provided for coal conveyors and cable galleries. IRD system with sprinkles will also be provided for coal conveyors. Centralized control panel indicating zone of fire will be located at central control room. Fire alarms will be distributed throughout the plant and important location so that security gate/fire station persons and control room get immediate information.

The ventilation system provided in cable galleries will be so interlocked with the fire alarm system that in the event of a fire, the ventilation system would be automatically switched-off.

Automatic high velocity spray system will be used for protection of burner zone of each of the boilers.





- e) Fuel oil tanks in the fuel oil farm area will be provided with MVWS system as well as fixed foam mechanical system to extinguish accidental fires in tanks as well as outside the dyke. Water for foam system will be drawn from the plant hydrant system. Adequate numbers of hydrant points will be distributed near the oil tanks farm area. Fire hoses fitted with couplings and nozzles will be located suitably at the oil unloading station and kept in hose boxes.
- f) Automatic inert gas based flooding type extinguishing system will be provided for unit control room, areas independently apart from the provision of detection and fire alarm system in that area.
- g) Adequate number of fire hydrant points will be distributed throughout the plant building, service building, coal handling plant, ash handling plant and other areas along with fire hoses fitted with couplings and nozzles and kept in the hose boxes.

In addition to the above facilities, adequate number of manual call points; (MCP) as well as portable and mobile (wheel mounted) fire extinguishers of soda acid type; foam type; chemical type; and carbon-dioxide type will be provided at strategic locations throughout the plant area to meet National Fire Protection Association (NFPA) and Loss Preventive Association (LPA) codes, Tariff Advisory Committee (TAC) stipulation etc. These extinguishers may be used during the early stages of fire to prevent the fire from spreading.

Two (2) nos. of fire tenders will be provided which will be kept in readiness complete with all accessories at fire station located close to fire control room.





6.1.9 Elevators

One (1) No. 3000 kg capacity passengers-cum-goods elevators will be provided for each boiler connecting various boiler floors and power plant building floors for carrying men & heavy material for operation and maintenance of boiler.

Four (4) elevators of capacity 1080 kg (suitable for 13 persons) in TG building to facilitate movement of O&M personal will be provided. Elevators will be designed as per relevant IS/4665 (All parts).

Further, one (1) 1080 kg capacity elevator will be installed in the service building and one (1) 2000 kg capacity elevator will be provided for the Crusher house.

One (1) stack elevator of capacity about 400 kg capacity, rack and pinion type vertical lift complete with all accessories will be provided for the each chimney.

6.1.10 Coal Mill Rejects Handling System

The Coal Mill Rejects Handling System will be provided for collection of the rejects from the mills and to convey to storage bunker. Each mill will be provided with collection and transportation equipment comprising of one no. Pyrite Hopper with water spray arrangement plate valves at inlet and outlet and a transport vessel connected to storage bunker.

6.1.11 Fuel Oil System

- a) A fuel oil system for boiler start-up as well as for flame stabilization during low load operation will be provided. Light diesel oil for furnace



light up and boiler start-up and HFO for flame stabilizing of furnace flame will be used

- b) Fuel oil will be brought to power plant by road/rail tankers and unloaded by fuel oil unloading pump sets located in the fuel oil pump house. The unloading pump sets will transfer the fuel oil to storage tanks from oil header provided with plug valves, flexible hoses etc.
- c) The station oil system mainly will consist of three (3) HFO storage tanks having a capacity of 4000 kilolitres each, unloading/transfer pump sets, two (2) light diesel oil storage tanks of 1000 KL capacity.
- d) Pressuring units, heating system for FO heating and associated steam & condensate pipe work, oil pipe work, steam and thermal insulation, valves, fittings, local/remote instrumentation etc. will be provided.

6.1.12 **Chemical Laboratory**

A chemical laboratory will be provided for the day-to-day testing of fuel samples, water quality, steam quality blow down etc.

6.1.13 **Mechanical Workshop**

A mechanical workshop for the regular maintenance work will be provided with necessary equipments.



6.2 ELECTRICAL SYSTEMS & EQUIPMENTS

6.2.1 Basic Design Concepts

The electrical system will be designed to assure high reliability of operation and high availability of the power plant through use of proven equipment conforming to International Standards, Codes and Practices and adequate level of redundancy. The electrical systems & equipment will also have to comply with the guide lines issued / notified by Indian Statutory Authorities viz. the Central Electricity Authority (CEA), Central Board of Irrigation & Power (CBIP), Indian Electricity (IE) Rules & Act, National Electrical Code (NEC), etc.

6.2.2 Generators

Generator will be directly-coupled to the turbine and will be two-pole type alternator having hydrogen-cooled stator & rotor and will have demineralised water-cooled vacuum pressure impregnated stator winding. The generator excitation system will be rotating diode, brushless type with a permanent magnet generator (PMG) or static type with slip rings, based on generator manufacturers' standard design.

To maintain and control the generator terminal voltage under various operating conditions and external faults, a digital multi-channel automatic voltage regulator (DAVR) will be provided.

Other auxiliary systems such as seal-oil system, hydrogen / stator cooling water system, etc. will be provided, as standard.





The turbo-generator will be designed for continuous operation at VWO output of the connected steam-turbine, at rated voltage and speed.

Other salient technical requirements of turbo-generator are given in Table - 1 below for reference and guidance:

TABLE – 1

1.	Rated continuous active power output, kW	800,000
2.	Rated Power Factor	0.85
3.	Rated terminal voltage, KV	21~27
4.	Rated Frequency, Hz	50
5.	Permissible continuous variation in terminal voltage	± 5
6.	Permissible continuous frequency variation	-5%, +3%
7.	Rated Speed, RPM	3000
8.	No load short circuit ratio (saturated)	≥ 0.5
9.	Permissible unbalanced loading :	As per IEC-60034-1
10.	Class of insulating material	F
11.	Permissible maximum temperature rise	As per Class B
12.	Efficiency at rated full load	>98%

6.2.3 Generator Neutral Earthing

In line with prevalent practice, high impedance earthing will be adopted for the generator winding neutral. The earthing system will be designed



keeping in view the overall system capacitance to earth and the capacitive current flow during a phase to earth fault.

High impedance earthing system will comprise, a single phase distribution transformer with its primary winding connected between generator neutral and earth. The secondary of the distribution transformer will be loaded by a resistor.

6.2.4 Generator Phase & Neutral Connections

The generator will be connected to its associated step-up transformer on the phase side and to its star-formation cubicle on the neutral side by means of isolated-phase bus ducts. The bus ducts will be continuous type with natural / water-cooled, pressurized air circulation.

6.2.5 Generator CTs / VTs and Surge-Protection

Required current transformers (CTs) & voltage transformers (VTs) for metering, protection and voltage control will be located within the generator busduct / generator circuit-breaker (GCB) enclosures which will also house surge-diverters and capacitors to protect the generator from lightning/switching surges and over-voltages.

6.2.6 400 kV Switchyard

Power generated will be stepped up to 400 kV for evacuation.

For evacuation of power, open outdoor 400 kV, Air Insulated Switchyard is considered. Following parameters shall be considered for the design of 400 kV switchyard:



Highest System Voltage:	420 kV
Lightning Impulse level:	1425 kVp
Short Circuit fault current & duration:	50 kA for 1 sec

One and half breaker bus arrangement is envisaged for the reliability and flexibility of this configuration.

The switchyard shall be provided with necessary breakers, Isolators, Instrument Transformers (CT & PT) Surge Arrestors, Wave Traps, Bus Reactors, Protective Relays, PLCC and associated equipments, etc.

In line with latest CEA recommendations, OPGW system for power line communication can be opted for instead of wave trap and PLCC system.

The AIS shall comprise of following bays/ circuits:

Description	No of bays
Generator Transformer Bays	5
Line Feeder Bays	8
Station Transformer Bays	3
Bus Reactors	2
Bus VTs	2
Total	19

6.2.7

Arrangement for Auxiliary Power Supply

As per CERC norms, the auxiliary power requirement of thermal power plant having electric motor driven BFPs and induced draft cooling towers is to be considered as 5.25% of the generated power i.e. about 210 MW (262.5 MVA at an average power factor of 0.8).



The largest single auxiliary motor in the power plant would be the 50%-rated boiler feed pump motor estimated to have a rating of approximately 15~19MW.

Keeping in view the suggested GCB configuration, the total plant auxiliary consumption may be distributed between a numbers of unit transformers (UTs) connected to generator bus duct tee-offs. It would be prudent also to build in some spare capacity in the number or rating of the auxiliary transformers to cater for possible outage of any one auxiliary transformers. Further, the auxiliary transformers rating has to be so chosen as to limit transient voltage dip on DOL starting of the largest rated HV motor i.e the BFP motor, to less than 20% while also limiting the maximum HV switchgear fault level to 50kA (rms) with the fore-mentioned considerations, two nos. suitably rated UTs are envisaged.

In line with the most prevalent practice for unit ratings ≥ 500 MW, it is recommended to adopt the following voltage levels of auxiliary supply in the power plant:

1. HV : 11KV AC
2. MV : 3.3KV AC
3. LV : 415V AC

Drive motors rated above 1.5 MW would require to be connected to 11KV supply. Medium-rated drive motors (>160 KW <1.5 MW) would require a supply voltage of 3.3KV. Smaller motors (<160 MW) can be connected to 415 V AC supply.





Apart from the above, essential service drive motors/auxiliaries can be operated from 220V DC supply.

The first level of auxiliary voltage i.e. 11KV would be derived by stepping down from the generator voltage through a number of unit-connected auxiliary transformers.

The proposed auxiliary supply system is shown in conceptual single line diagram vide **Annexure - 6.11**.

6.2.8 Start-up Power Requirement

The GCB obviates the need for providing start up transformers and associated 400 KV switchyard bays. In the context of green-field ultra-mega power projects, GCB scheme offers a highly cost-effective and technically preferred solution for deriving start-up power.

Apart from this, GCB provision has many techno-economic benefits, such as:

- Improved protection to generator, GT, IPBD and UT due to faster clearance of fault contribution from generator side.
- Better protection to generator against single phasing.
- Better breaker failure protection with two breakers in series.
- Reduced switching operations, improved life & reduced maintenance of EHV circuit breaker.
- Relieving EHV circuit breaker of synchronizing and out of phase switching duty.
- Elimination of need for separate startup /station transformer(s) and associated EHV switchyard bays, HV switchgears and cables/busducts resulting in considerable cost saving.





- Simplification of station startup & shutdown procedures by elimination of automatic & planned manual transfers.
- Increased life of plant auxiliary drive motors due to elimination of frequent bus transfers which subject the drives to higher torques and higher fault levels.
- Reduced maintenance of power auxiliaries.
- Reduction of equipment/installation, operation & maintenance costs.

6.2.9 Construction Power

Owner will arrange power source free of cost at 11kV level at one point. Further distribution system comprising of 11kV Switchgear, distribution transformers, HT & LT power and control cables, earthing pits & necessary earthing accessories, necessary civil works for mounting HT Kiosks, Transformers, LT Boards & capacitor banks (for power factor improvement) and fencing work, illumination of substation area and street lighting shall be done by the EPC contractor. High mast lighting and adequate lighting from safety point of view is to be provided in the construction area by the EPC contractor.

6.2.10 Generator Transformers

The Generator Transformer for each unit will comprise three (3) single (1) Phase Oil-immersed outdoor type units with class 'A' or better insulation on HV side and uniform type on LV side, having an OFAF rating of 332MVA each. The transformer will also have ONAF and ONAN ratings of approximately 80% and 60% respectively of the OFAF rating. The low voltage side of the transformer will have isolated phase bus duct connection to the generator circuit breaker, while the high voltage side will be connected to the 400 KV switchyard by means of ACSR overhead



conductors. Voltage ratio for the GTs will be 400/ $\sqrt{3}$ / generator rated kV for all the units. Each Transformer will be provided with off circuit taps on HV windings which will have graded insulation. The impedance of the transformer at normal tap will be chosen such as to be compatible with the switchyard and bus duct fault levels and full load regulation. The noise level of the transformer will be restricted to 90 dB. The three phase windings of the transformer will be connected in star on HV with neutral brought out for solid earthing. The secondary windings will be connected in delta. The GTs will have to be suitable for bi-directional power flow.

Each transformer will be provided with a lightning surge arrester on each phase.

Five (5) single phase transformer will be provided as common standby for all the GTs and suitably located in the transformer yard.

6.2.11 Station Transformers (STs)

Three (3), 3 phase, 3-winding 125/62.5/62.5 MVA STs having a voltage ratio of 400/11.5/11.5 kV, star/star, YNyn0yn0 outdoor oil immersed, with ONAN/ONAF/OFAF cooling, are envisaged. These transformer are backup to the UT's and catering station loads as shown in conceptual single line diagram vide **Annexure - 6.11**.

The transformer will be of constant percentage impedance type. The ONAF rating will be about 80% of the OFAF rating while the ONAN rating will be atleast 60% of the OFAF rating. The HV winding of the STs will have graded insulation and will be provided with OLTC of a suitable range in 1.25% steps for maintaining constant voltage on the 11 KV side. The HV terminal bushings will be connected to 400 kV switchyard gantries through





overhead ACSR conductors. The LV phase terminals will be connected to 11 kV station switchgears through segregated phase bus ducts. HV neutral will be solidly earthed and LV neutral will be earthed through a medium resistor to limit the earth fault current to about 300 amps.

The transformer will be provided with lightning surge arrestor on each phase on 400KV side.

6.2.12 Unit Transformers

Two (2) 3-phase transformers of suitable rating having generator rated voltage / 11.5kV with ONAF/ONAN cooling will be provided connected on IPBD tap off of each unit to supply unit loads. OLTC will be provided on HV winding of the UTs with suitable range in steps of 1.25% each for maintaining constant voltage on the 11 KV side

6.2.13 Unit/Station Service Transformers

Power from 11KV switchgears will be stepped down to 3.3 kV and 415V through a number of 11/3.6 kV auxiliary transformers and 11/0.433KV service transformers. Outdoor located transformers will be oil-filled type while indoor located transformers will be class 'F' insulated dry type resin-cast type. Maximum rating of 11/0.433KV transformers will be limited to 2500 kVA in order to restrict the 415 V system fault level to 50 kA (rms). LV neutral of 11 kV & 3.3 KV systems will be resistance earthed while 415V neutral will be solidly earthed for fast detection and clearing of earth fault. Off circuit taps will be provided on HV windings for controlling the voltage on the LV side.





The configuration of auxiliary service transformers to be adopted for various systems will be 2x100%.

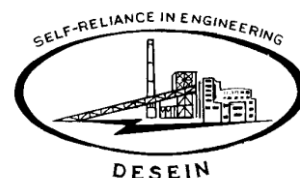
6.2.14 11 KV & 3.3 kV Switchgear

The Station transformers, Unit transformers and Auxiliary transformers will supply power to 11 KV and 3.3 kV switchgears through segregated phase bus-ducts. These switchgears will directly feed high voltage motors, LV auxiliary transformers and other HV switchgears

The HV switchgears will be vacuum type in metal clad cubicles suitable for indoor installation. Incomers, bus-coupler, tie feeders and motor feeders will be controlled by Vacuum circuit – breakers. Motors rated 1000kW and above shall be provided with differential protection. Motor feeders of Coal Handling & Ash Handling plant requiring frequent switching may be controlled by latched type vacuum contactors backed up by HV HRC fuses.

6.2.15 415 V Switchgears

Power from Unit / Station LV service transformers will be supplied to 415 V switchgears. These switchgears will distribute power to LV auxiliary motors and also to other auxiliary loads viz. MCCs / ACDBs, etc. LV switchgears will be of metal enclosed indoor type. Incomers / bus-couplers, outgoing tie feeders rated above 400 amps and motor feeders rated 90 kW and higher, will be equipped with air circuit breakers of fault interrupting capacity of 50 KA rms. Lower rated feeders will be equipped with fully-rated MCCBs.





6.2.16

Motor Control Centers & Distribution Boards

Power to MCCs & AC distribution boards (ACDB) will be supplied from the 415V switchgears through redundant incomers.

The MCCs will be of modular, metal enclosed indoor, drawout type. Each outgoing motor feeder will have a direct on-line (DOL) starter unit. The motor starter will consist of ACB/ MCCB / MPCB, contactor, control fuses and bi-metallic thermal overload relay and single phasing preventors.

The DBs will be of metal enclosed, indoor, fixed type and suitable for 3 phases 4-wire, 3 phases – 3-wire, and 1 phase – 2 wire distribution system, as applicable.

The motor feeders of sizes above 90 KW & upto 160 KW will be controlled by circuit breakers, motor feeders above 50 & up to 90 will be controlled by MCCB with contactor while motor feeders up to 50 KW shall be MPCB & contactor control. Circuit breakers will be of air-break type with fault interrupting capacity of 50 kA (rms). DOL starters of essential Boiler & TG LV auxiliary motors such as seal oil pumps, lube oil pumps, jacking oil pump etc will be provided with a delayed drop-off feature to permit auto-restart following changeover of supply from one bus to another bus.

6.2.17

Electric Drive Motors

HV & LV motors shall be energy efficient type, F class insulated with maximum temperature rise within class 'B' limits, having IP-55 enclosure protection (with canopy for vertical outdoor motors), designed for direct-on-line starting with as low starting current as possible. Starting





current of motors will be designed so as not to pose a problem in starting or cause drop out of running auxiliaries.

Motor rating will be chosen so as to provide sufficient margin (at least 15%) over the driven equipment power requirement under all design/operating conditions.

Motors will be capable of starting and accelerating to full speed at 80% of the nominal voltage and will be capable of either two starts in quick succession with third start after 5 min., in cold condition or two starts at 15 min. intervals in hot condition, both cases with voltage and frequency variation within specified limits. Motors will also be capable of restarting under full load after a momentary loss of voltage with the possibility of application of a total of 150% nominal voltage during fast bus-transfer.

Motor torque characteristic will be such as to ensure smooth and rapid starting and acceleration of the driven equipment.

Motors rated above 30 kW will be provided with space heaters to be switched on when the motor is idle.

6.2.18 **Metering**

Microprocessor based multi-function energy meters with communication facilities, non-volatile memory, MMI and self-diagnostic facilities shall be provided for all 400 kV transformers, generators, and auxiliary transformers on 11 kV and 3.3 kV buses for energy audit.

Separate 0.2 class or better energy meters will be provided for main and check Availability- Based Tariff (ABT) metering for both import and export of power from the 400V buses and incoming end of the 400KV transformers.



For this purpose, separate, dedicated CTs and VTs of accuracy class 0.2 will be used.

All 11 kV and 3.3 kV feeders connected to station and unit switchgear buses will be equipped with multifunctional microprocessor based feeder management devices having protection and metering facilities alongwith ports for interface with plant DDC MIS system.

All other feeders will be provided with conventional indicating and metering instruments.

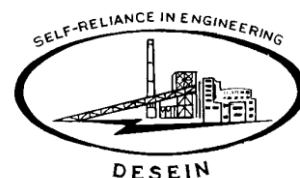
6.2.19 **Protection**

Electrical protection proposed for the various equipment will be generally as per guidelines.

6.2.20 **Electrical Controls Philosophy**

A centralized control room will be provided at the operating floor of steam turbine-generator building in which controls / control panels for the steam generators, steam turbine generators, GCBs, GTs, auxiliary transformers and distributed digital control system (DDCMIS) equipment will be housed. In addition, auxiliary system electrical relay panels and fire alarm control panel will also be provided in this control room.

The control & synchronizing of generators, generator excitation system, generator transformers, auxiliary transformers, 11/3.3/0.415kV incomers, ties and main outgoing circuit breakers to the auxiliaries will be also achieved from the keyboard of Operators Control Station in the Main Plant Control room.





A separate control cum relay room will be provided for the 400KV switchyard in switchyard area. Switchyard controls will be achieved through computerized **Substation Automation System (SAS)** comprising IEDs, RTUs, bay controllers, GPS, Ethernet data highway, etc. The switchyard relays will be of numerical type with remote communication interface such that all bay level data can be transmitted to the SAS system through optical fiber cable data highway. It will be possible to operate the switchyard disconnecting switches and circuit breakers from the SAS operator control stations located in the Switchyard Control Room or main Control Room. Gateways will be provided for transmitting switchyard data/status to Main Plant DDCMIS system.

Separate control rooms for the ash / coal handling / Compressors / DM & WT plants, water intake and other offsite systems will be provided.

6.2.21 Earthing

The earthing requirement of the power station complex will be divided into the following two main categories viz. System Earthing and Equipment Earthing:

- a) **System Earthing:** The system neutral earthing at different voltage levels has been described below:-

Neutrals of 400 kV and 415 V systems will be solidly earthed. Generator neutrals will be earthed with resistance loaded distribution transformer, 11 KV and 3.3 kV system neutral will be earthed through high resistance limiting the earth-fault current to about 300 amps.





- b) **Equipment Earthing:** The equipment body earthing will be adopted to provide protection to personnel from potentials caused by earth fault currents and lightning discharges. A suitable earth grid will be provided for earthing of equipment and structures maintaining the step and touch potentials within safe limits. An earth mat will be laid in and around the main power station. These mats will be buried at a suitable depth below ground and balance of plant areas and provided with earth electrodes at suitable spacing. The earth mats of main plant & BOP will be interconnected by two or more interconnections. All metallic parts of equipment supposed to be at earth potential will be connected to the earthing mat including building structures, substation towers, plant rail road tracks, perimeter fencing etc. The earthing system will comply with IEEE 80, IEEE 665 and IS: 3043.

6.2.22 Lightning Protection System

Lightning protection system in accordance with IS: 2309 will be installed for protection of tall buildings / structures and equipment against lightning discharge. This will be achieved by providing lightning conductors on tall structures, stacks, power house building, flood light towers etc. and connecting these with ground electrodes.

6.2.23 Emergency Power Supply

Suitable number, (at least one per unit plus one common standby) emergency diesel generator sets of suitable rating (at least 1750 kVA) will be installed in the station to serve as emergency power source. This emergency source will provide power for safe shutdown and other emergency services in case of complete loss of station AC supply. The



diesel generating sets will be provided with AMF panel for the immediate auto start so as to cater to the following essential services:-

- Turning gear and jacking oil pumps
- Auxiliary Lube oil and seal oil pumps
- Oil vapour extracting fans
- Elevators
- Fire Sirens
- Instrumentation and control
- Lighting and intercommunication in vital areas
- Station battery chargers.
- Exhaust fans& UPS for H2 Plant
- Air compressors

6.2.24 Power and Control Cables

a) Main factors considered for selection of power cable sizes will be follows:-

- System short circuit current withstand time of 0.16 seconds for circuit breaker controlled feeders
- Derating factors due to higher ambient temperature and grouping of cables.
- Continuous current rating.
- Voltage drop during motor starting and under continuous operation (Limited to 15% for motor starting and 3% for continuous operation).
- Standardization of the cable size to avoid too many sizes.





- b) All 11 / 3.3 kV system cables will be of stranded aluminum conductor, XLPE insulated, screened, PVC inner sheathed wire / strip armoured, fire retardant low smoke (FRLS) overall PVC sheathed type. The cables will be suitable for unearthed system. All LV power cables will be of 1100 V grade aluminum / copper conductor, XLPE insulated, PVC inner sheathed, steel wire / strip armoured, FRLS PVC outer sheathed type. The cables will be suitable for earthed system. Control cables will be of multicore 1100 volt grade 2.5 mm² stranded annealed tinned copper conductor, PVC insulated, PVC sheathed, steel wire armoured, FRLS PVC overall sheathed type.

LV power and control cables for essential services will be of copper conductor and fire survival type.

6.2.25

Plant DC System

- a) A reliable DC power source will be provided to supply the normal DC loads and those loads, which will be required to function on a loss of AC power. The DC power supply system will comprise of:
- 220 Volts DC batteries
 - Battery chargers (float and float cum boost chargers)
 - DC distribution and sub-distribution boards

The batteries will be plante positive plate lead acid type.

The following minimum sets of batteries, battery chargers & Distribution Boards (DBs) will be provided:-



- i) Two (2) sets – 220 V DC battery, float & float cum boost chargers and DBs for each unit (including part station load), 400 KV switchyard, coal & ash handling plants and any other offsite area if required.

The requirement of 24V DC supply where required will be catered from UPS battery system.

- b) Basis of selection of the above items will be as follows:-

i) **Battery**

Normal requirement of the battery is to supply power for the following:

- Control and monitoring of the entire power plant.
- Alarm and annunciation of plant condition under emergency.
- Tripping power for all major circuit breakers simultaneously.
- Starting of jacking oil pump.
- Starting of emergency lube oil pump.
- Starting of barring gear.
- Seal oil pump
- Plant emergency DC illumination system
- Indication, alarm and annunciation



ii) **Battery Charger**

Battery chargers of suitable capacity will be provided with trickle charging and boost charging for each of the aforesaid battery sets. Completely automatic and self-regulating type of battery charger comprises of independent float cum boost chargers. The float charger will be capable of floating the battery and at the same time supply the continuous DC load. The boost charger will be capable of quick charging the battery and have a capacity to restore a fully discharged battery to a state of fully charged condition in 8-10 hours and at the same time supply the continuous DC load. 20% spare margin over the maximum charging rate should be considered.

c) **DC Distribution Board**

One main DC distribution board for each of the battery sets will be provided with DC sub-distribution boards as required. The DC distribution board will have two incomer DC switch-fuses and required number of outgoing switch fuse units selected to have a continuous current rating of not less than 125% of the nominal load current.



6.2.26

Telephone and Intrasite-communication Systema) **Telephone system**

A 1000 extension, 15 incoming line Digital Automatic EPABX exchange based on time division-multiplexing technique will be installed at one convenient location. This will serve the thermal power plant. A separate 500 extension EPABX will be provided for the colony. There will be interconnection between plant and colony exchanges.

b) **Intrasite-communication System**

The inter-communication system will be provided in power plant to facilitate plant operations by establishing quick communication among the operating personnel at various locations of the plant. A public address system with page and party channels and a number of walky-talky or radio pagers will be provided for this purpose.

6.2.27

Illumination System

Suitable illumination is necessary to facilitate normal operation and maintenance activities and to ensure safety of working personnel. This is achieved by artificial lighting. Power for the illumination system will be obtained from the 415V bus through a number of 415/433 V transformers of adequate capacity for plant areas and buildings.

The rating of the transformers will be decided in order to restrict the fault level of the lighting circuits to safe level for humans and to avail of MCBs.



For yard illumination, 30 M high lighting masts with cradle mounted flood lights will be installed at suitable locations to provide requisite level of illumination. Pole mounted high-pressure sodium vapour fixtures will be used for approach and work roads.

The distribution from the lighting transformers will be through 415V, 3 phase, 4 wire distribution boards. Suitable number of lighting panels will be located in each area, which will be supplied power from main lighting distribution boards.

In addition to normal illumination, emergency AC and emergency DC lighting schemes will also be provided in the power station complex. About 20 percent of the total lighting fixtures will be fed from emergency AC supply and about 10 percent of the fixtures will be fed normally from AC supply; and upon failure of AC, these will be fed from 220V DC through inverters. However in Main Control Room 30 percent of the total lighting fixtures will be fed from emergency AC supply. Station emergency AC/DC lighting fixtures or panels will be fed from station emergency 415V AC/220V DC distribution system during failure of normal AC supply. Remote DC lighting for isolated buildings in areas where station 220V DC is not available, will be from self contained battery with charger units, flood lamp fixtures will be energized upon loss of normal AC supply to such isolated areas.

Compact fluorescent lamps (CFL) will be provided at indoor location such as control rooms / offices to conserve energy.

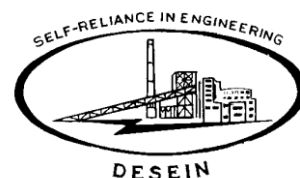




6.2.28

Electrical Testing Laboratory Equipment

An electrical lab will be provided for the day-to-day maintenance /testing and calibration of the electrical equipment of the power plant. The same shall be finalized during detailed engineering.





6.3. CONTROL AND INSTRUMENTATION SYSTEM

6.3.1 Design Philosophy

The Control and Instrumentation shall be through state of art microprocessor based Distributed Digital Control, monitoring and information system (DDCMIS) for the entire main plant covering the total functional requirements of modulating control, sequence control, interlocks & protection, monitoring, alarm, data logging, fault analysis, performance calculation & optimization, maintenance scheduling & machine monitoring & analysis etc.

The design of the control system and related equipment shall adhere to the principle of “fail safe” operation at all system levels (i.e) the loss of signal, loss of power or failure of any component should not cause a hazardous condition; and at the same time prevent occurrence of false trips and provide reliable and efficient operation of the plant under dynamic conditions and attainment of maximum station availability.

The complete controls of Boiler, Turbine, Regenerative cycle and few Balance of plant (BOP) packages are controlled from single DDCMIS. Whereas as other BOP packages are controlled from separate DCS / PLC systems. The DDCMIS and DCS shall be of same family.

There shall be two Central control Rooms (CCR) for all five (5) units i.e. CCR-1 for Unit – 1 & 2 and CCR-2 for Unit 3, 4 & 5.

6.3.2 BOILER INTEGRAL CONTROLS

The Boiler Integral Controls such as Furnace Supervisory Safe Guard System (FSSS), Secondary Air Damper Controls(SADC), etc shall be



implemented in Triple Modular Redundant (TMR) based TUV certified or 2 out of 3 based modules and Soot blower controls and Auxiliary Pressure Reducing and Desuperheating control shall be dual redundant.

a. **Furnace Supervisory Safe Guard System (FSSS)**

The FSSS shall be provided with automatic self-monitoring facility. All modules to be used in this system shall be of fail safe design. The FSSS shall meet all applicable relevant safety requirements including those stipulated in latest editions of VDE 0116, Section 8.7, VDE 0160, NFPA 8502/ 8503 etc. Bidder shall furnish compliance for already implemented MFT similar to that proposed for this project to VDE 0116, Section 8.7, VDE 0160 safety standards from recognized/ authorized third party certifying agencies.

FSSS Interlock and Protection consists of Boiler Starting Interlock, After ID and FD fans have been started, the conditions such as Purging of Boiler at a pre determined air flow for a pre-determined time, Resetting of MFT, Permissive for starting Igniter are ensured. For purging the conditions such as Either or both I.D. Fans running, Either or both F.D. Fans running, MFR in tripped position, Air registers in purge position, Air flow between 25% to 30 % MCR, No flame condition is true. All fuel closed, Boiler Tripping, etc. are ensured. Once when MFT is generated, following minimum actions will be executed Tripping of all oil burners, Tripping of all pulverizers and coal feeders, HT Supply to ESP, Turbine trip, etc.

b. **Secondary Air Damper Control (SADC) System**

SADC system shall be provided to achieve the following functions

- i. Control of fuel air flow.



- ii. Control of auxiliary air flow at the oil elevations.
- iii. Control of wind box/furnace differential pressure.
- iv. Limit NOX content in the flue gas by modulating over fire dampers, if provided.

c. **Auxiliary Pressure Reducing and Desuperheating Station (Aux PRDS) Control system**

- (i) Auxiliary PRDS control system shall be provided to control the low capacity PRDS (with steam tapping off from CRH line) and the high capacity PRDS (with steam tapping off from MS line) and coordinate their operation under all regimes of unit/plant operation.
- (ii) Each of the aux. PRDS units (i.e. low capacity PRDS and high capacity PRDS) shall be provided with automatic control loops for steam pressure control, steam temperature control and spray water pressure control. However, facility for remote manual control shall also exist in case the automatic control fails.

d. **Soot Blower Control System (SBCS)**

Soot Blower Control (SBC) system complete with provision for individual operation of any soot blower and facility to bypass any soot blower shall be provided with following. Soot blower Control system shall be independent hardware in redundant loop based control system.

- i. Automatic starting of each soot blower in the system.





- ii. Canceling the operation of any soot blower in the system when required.
- iii. Indication of the soot blower-selected to operate.
- iv. Capability to monitor all the essentials of the soot blowing system.
- v. Capability to prevent continued soot blower operation if the system is not functioning properly.
- vi. The ability to operate two soot blowers located in opposite walls simultaneously.
- vii. Manual over-riding of the automatic operations.
- viii. To prevent automatic blowing when the parameters of soot blowing system are beyond permissible limits.
- ix. Indications of soot blower which has malfunctioned.
- x. Control circuit for the retractable blowers shall be so designed as to prevent insertion of the blowers into the combustion chamber unless the blowing medium is available.
- xi. Limit switches and Torque switches are to be connected to DDCMIS and command termination shall be done in DDCMIS only for each of the blowers.
- xii. Soot Blower control system shall also provide controls for
 - a. Pressure control of steam
 - b. Warm up control of the complete piping system which shall include flow control, drain temperature control etc.
 - c. Steam temperature control





6.3.3. **SG Related Control & Instrumentation System / Equipment**

SG Related Control & Instrumentation System / Equipment such as Flame Monitoring System, Flame Detector Testing Kit, Coal Feeders Control and Instrumentation, Electromatic Relief (Safety) Valves, Furnace Temperature Probe, Acoustic Pyrometers, Furnace and Flame Viewing System, Conductivity Type Level Switching System, Mill and Airheater Fire Detection System, Boiler Tube leak detection System, “On Line Carbon in Ash” Analysers System, Coal Mass Flow & Velocity Measurement System, shall be envisaged.

6.3.4. **Turbine Integral controls**

The Turbine Integral Controls such as Electro Hydraulic Turbine Control – Governing system (EHTC / DEH), Turbine Protection System (TPS), Main steam turbine EHTC, etc. shall be envisaged in Triple Modular Redundant (TMR) based TUV certified or 2 out of 3 based, SIL3 fail safe design cards. ATT, ATRS, TSE, HPBP, LPBP, TDBFP A & B – EHTC / DEH, TPS & TSI and other TG integral controls shall be designed as per dual redundant philosophy.

a. Turbine Protection System (TPS)

The Turbine Protection system shall meet all applicable relevant safety requirements including those stipulated in latest editions of VDE 0116, Section 8.7, VDE 0160 etc. The system design shall be such that safety function of the total system must not be jeopardized on occurrence of fault. Turbine Protection system initiates turbine trip in case of abnormal operating conditions for Turbine set and its auxiliary system. All modules to be used in this system shall be of failsafe design. Turbine Protection System shall





ensure protections such as Bearing Temperature Protection, Bearing Casing Vibration protection, Condenser Pressure Protection, LP Exhaust Temperature Protection, Over Speed Protection, Steam Turbine Protections (Control Fluid Supply, EPBs operated, Boiler Protection tripped, etc.), etc.

b. Turbine Control System (TCS) Function

The Turbine Control System shall consist of Turbine Governing System, Turbine Stress Control System HP/LP Bypass system & Automatic Turbine testing (ATT) system. Turbine control system shall be interfaced through OPC with DDCMIS in addition to Hardwired signals.

c. Turbine Supervisory Instrumentation (TSI) System

The Turbine supervisory Instrumentation system is provided for vibration measurements of Turbine Generator such as Shaft eccentricity detection, Differential expansion of rotor and cylinder for HPT, IPT and LPT, Overall expansion of HPT and IPT, Absolute bearing vibration measurement of each bearing in both X & Y directions (for turbine and generator bearings), Axial shift of the rotor, Absolute & relative shaft vibration measurement, of each bearing in both X & Y direction (for Turbine and Generator bearing), Turbine speed, Keyphasor, Stator winding vibration measurement in radial and tangential directions, Emergency stop and Control valve position, turbine metal & casing temperatures, Emergency stop and Control valve position, etc.





The Turbine Supervisory Instrumentation monitoring system shall meet the requirement of API-670-1994 (Latest edition) and BS: 4675, Part-2. The system shall be provided with suitable hardware for necessary signal processing. The system should suitably HW interfaced with DDCMIS system.

6.3.5. STATION C&I CONTROLS

Station C&I Controls shall include operation, monitoring, sequential interlocks, Analog Controls & Binary Controls of Boiler and Turbine auxiliary systems such as CEPs, CPU, Vacuum Pumps, MDBFP, TDBFP, Feed Control station, Deaerator, HP & LP Heaters, ID fans, FD fans, PA fans, Air Pre Heaters, HP/LP dosing system, Hotwell make-up pumps, Generator Auxiliaries such as TG Stator Coil Cooling water, TG H₂, CO₂ Gas system, TG Seal Oil System, Generator Monitoring and auxiliary system, Electrical systems, Common BOP Packages such as Self-cleaning strainer, COLTCS, CW & ACW Systems, ECW system, cooling towers, etc.

DDCMIS shall also be suitable to interface BOP DCS/ PLCs and other microprocessor based control systems through OPC / MODBUS protocols.

Coordinated Master Control (CMC) Scheme

Co-ordinated master control system receives unit load demand signal from the Owner's automatic load dispatch centre or through the unit master control station and translates this signal into feed forward signals to the boiler and turbine control systems. The main objective is to enhance the response of the boiler and turbine control system in the overall operating



condition while maintaining the outputs of the turbine, boiler and major plant auxiliaries, within their safe operating limits.

The co-ordinated control system shall ensure that boiler generates that much steam as required by turbine and the turbine utilises as much steam as generated by the boiler.

The unit load demand signal shall be limited by the conditions such as Maximum unit load limit, Minimum unit load limit, Unit load rate of change limit, Runback limits, Directional block for increase in demand, Directional block for decrease in demand, etc. CMC Scheme operates in Boiler follow Mode, Turbine Follow Mode, Manual Mode.

6.3.6 BOP offsite packages Control System (DDCMIS, PLC, etc)

The Control for balance of plant (off-site) packages shall be through DCS/PLC / microprocessor based control system / Relay based system covering the total functional requirements of modulating control, sequence control, interlocks & protection, monitoring, alarm, data logging, etc.

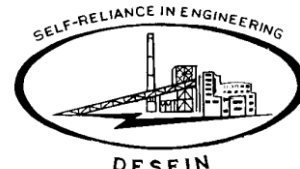
The list of all BOP packages and their type & interface methodology are listed below.

S. NO.	SYSTEM / PACKAGE	CONTROL SYSTEM	CONTROL ROOM		INTERFACE WITH DDCMIS (FOR MONITORING ONLY)	INTERFACE
			Local control room	CCR		
1	Coal handling system including Dust Extraction system, Dust Suppression system, Service Water System,	BOP DCS	CHP LCR (Near Crusher House)	YES	YES	1 No. EWS cum OWS + 2 No. OWS + 1 No. A4 Size LJP B/W + 1 No. A3 Size LJP Colour + 1 No. LAPTOP + 2 Nos. LVS Screen





S. NO.	SYSTEM / PACKAGE	CONTROL SYSTEM	CONTROL ROOM		INTERFACE WITH DDCMIS (FOR MONITORING ONLY)	INTERFACE
			Local control room	CCR		
	Potable Water System, etc.					+Mimic based control desk in main CHP CR
1b	Stacker - Reclaimer system (For Each System)	SR PLC	S-R Machine	-	Through BOP DCS	1 No. Panel Mounted OWS & control desk with joysticks, push buttons / switches + 1 No. LAPTOP + 1 No. EWS / OWS at E-House
1c	Coal Sampling System (For Each System)	CSU PLC	Crusher House LCR		Through BOP DCS	Control Panel with Hard-wired Mimic, Push Buttons, Indicating Lamps, Alarm Facia Windows, etc + 1 No. LAPTOP
1d	Wagon Tippler System (For Each System)	WT PLC	Wagon Tippler LCR	-	Through BOP DCS	1 No. EWS cum OWS + 1 No. A4 Size LJP B/W + 1 No. LAPTOP
1e	Weigh Bridge System (For Each System)	Microprocessor Based System	Wagon Tippler LCR	-	Through Wagon Tippler PLC	1 No. EWS cum OWS
2	Ash Handling Plant including silo loading / unloading system, HCSD System, Clarifier & Dosing system (Treatment System) for Ash Water System, Fly Ash System, Bottom Ash System	BOP DCS	AHP LCR	YES	YES	HMI will be common for all the three units : 1 No. EWS cum OWS + 3 No. OWS + 1 No. A4 Size LJP B/W + 1 No. A3 Size LJP Colour + 3 Nos. Large Screen + 1 No. LAPTOP
3	Ash Supply Water Recovery System	PLC	AWRS LCR	-	-	Relay Based Local Control Panel with Annunciation Windows, Hardwired Mimic, PBs, Indicating lamps, Selector Switches, etc.





S. NO.	SYSTEM / PACKAGE	CONTROL SYSTEM	CONTROL ROOM		INTERFACE WITH DDCMIS (FOR MONITORING ONLY)	INTERFACE
			Local control room	CCR		
4	Mill reject handling plant	PLC		DDCMIS	None	1 OWS +1EOWS in Local CCR + 1 MIMIC based Control Desk.
5	Fuel Oil handling and storage	BOP DCS	YES	YES	None	1 OWS in Local control room + 1 MIMIC based control desk.
6	Fire Detection & protection system+ Fire water pumps	Microprocessor based detection, BOP DCS based pump controls and solid state annunciator	YES	YES	None	1).1 OWS+1EOWS+ 1 MIMIC based LCP for Fire protection system 2) 1 GUI based monitor in CCR
7	Raw water and Pre-treatment Plant	BOP DCS	YES	No	None	May Be clubbed with DM plant BOP DCS
8	DM Plant including DM & Condensate Transfer Pumps, Hotwell Makeup Pumps, Boiler Fill Pumps, etc.	BOP DCS	DM Plant LCR	YES	YES	1 No. EWS cum OWS + 2 No. OWS + 1 No. A4 Size LJP B/W + 1 No. LAPTOP + 1 No. OWS* in CCR
9	CW Chlorination System & Chemical dosing	PLC	YES	No	None	1 OWS+1EOWS+ 1 MIMIC based LCP in Local control room





S. NO.	SYSTEM / PACKAGE	CONTROL SYSTEM	CONTROL ROOM		INTERFACE WITH DDCMIS (FOR MONITORING ONLY)	INTERFACE
			Local control room	CCR		
10	Raw Water Chlorination System	PLC	Raw Water Treatment Plant Building	YES	YES	Control Panel with Hard-wired Mimic, Push Buttons, Indicating Lamps, Alarm Facia Windows, etc + 1 No. LAPTOP
11	Effluent Treatment plant	BOP DCS	YES	YES	None	MIMIC based LCP in local control room, 1 OWS+ 1EOWS in CCR
12	Compressed air system	Microprocessor based (Redundant)	YES	YES	Soft link & Hard wired	All drive logics in Microprocessor based LCP which is part of compressor skid. Only start/stop from DDCMIS and standby compressor start, loads/unloads
13	Air conditioning system & ventilation	PLC (COMMON FOR AC & Ventilation system)	YES	NO	None	1 OWS+1EOWS in local control room
14	CW&ACW SYSTEM	DDCMIS	YES	DDCMIS	None	MIMIC based Local control desk in local control room, 1 EOWS connected to RIO panel
15	DMCW System	DDCMIS	NO	YES	None	MIMIC based Local control desk in local control room, 1 EOWS connected to RIO panel
16	COLTCS	DDCMIS	NO	YES	None	
17	Self - cleaning strainer	DDCMIS	NO	YES	None	
18	CPU	DDCMIS	-	YES	None	One OEWS in DM LCR for regeneration





6.3.7 Distributed Digital Control, monitoring and information system (DDCMIS)

The design of the control system and related equipment will adhere to the principle of “fail safe” operation at all system levels (i.e) the loss of signal, loss of power or failure of any component should not cause a hazardous condition; and at the same time prevent occurrence of false trips and provide reliable and efficient operation of the plant under dynamic conditions and attainment of maximum station availability.

Refer System configuration diagram # 114-01-0100.

i. Redundancy Criteria

The CPU / Controllers, communication modules, data highway, power supply modules, etc for all DDCMIS, DCS and other control systems shall be 100% hot standby redundant. Redundant I/O modules shall be used for all signals used for closed loop controls and signals used for protection & interlocks. All hardwired signals (inputs/outputs) from/ to breaker & isolators shall be redundant. All field instruments used for protection/interlock will be triple redundant. All field instruments used for permissives will be dual redundant. Field instruments used for monitoring will be single.

No redundancy at I/O card level is required which are executing purely data acquisition/monitoring functions.

The following redundancy criteria may be followed for measurements at (sensor level):



- a. Two out of three measurements shall be adopted for critical analog signals.- closed loop systems .
- b. One out of two measurements shall be adopted for non-critical analog signals for all closed loops. The Control system shall select the median value for the normal purpose.
- c. Two out of three measurements shall be adopted for critical binary signals for protection & interlock.
- d. One out of two measurements shall be adopted for non-critical binary signals for protection./ permissives.

ii. Response Times

The system shall have adequate speed of response through all regimes of system loadings. For critical closed loops, the loop cycle time shall be max. 100 milli seconds. For non-critical closed loops, the loop cycle time shall be max. 250 milli seconds. For all open loops, sequential interlocks & protection it shall be max. 100 milli seconds. (The loop cycle time is defined as the time taken from change at input module to change in output module for command).

iii. Established Reliability

All components and systems shall be of established reliability considering its failure rate/meantime between failures (MTBF) & meantime to repair (MTTR), such that the availability of the complete system is assured for 8700 hours / year (99.7%) or better





Continuous self checking features shall be incorporated in system design with automatic transfer to healthy/redundant circuits to enhance the reliability of the complete system.

iv. Controller

Each controller shall have Processing word length of 32/64 bit (Preferably 64 bits), 32 Mbytes RAM, Redundant power supplies, Power fail/auto start feature, Watch Dog timer, Self-monitoring & diagnostic feature, RISC based, Real time data controller, adequate capacity of volatile memory, memory expandability

v. Analogue / RTD / TC Input Modules / Cards

(Max. 16 channels per card)

Analogue input module shall be capable of accepting inputs like 4-20 mA current signals, RTD (PT 100), Thermocouples or Voltage input signal. Analogue input module shall have Linearization and error checking of TC and RTD signals and reference junction temperature correction facilities for T/C (for cold junction compensation), Fuse Protection and Fuse failure detection, Input filtering for Noise level, Galvanic/optical channel to channel Isolation shall be built in Module, HART compatible.

vi. Analogue Output Modules / Cards

(Max. 8 channels per card)

Analog Output Modules shall give output 4-20mA DC signal. Analogue output module shall have Diagnostic level shall be at Channel level, Loop check back of output, Failure of individual





channel shall not disturb the other channels for AO card, Galvanic/optical channel to channel Isolation shall be built in Module.

vii. Digital Input Modules / Cards

(Max. 16 Channels per card)

The Digital input modules shall accept voltage / potential free contacts and also pulse inputs and shall have Galvanic/optical channel to channel Isolation shall be built in Module. The contact input from fields shall be monitored in the binary input modules for non-co-incidence, wire break, ground, short circuit, proof, etc. for all important signal used for control & protections, Contact bounce filtering.

viii. Digital Output Modules / Cards

(Max. 16 channels per card)

The Digital output modules shall have each channel shall be individually fused, each channel shall have individual contact suppression, Supply of contacts voltages – with 24/48 V DC, Individually definable default state, Short Circuit Protection.

ix. Communication System:

The main data highway shall have a speed of at least 1Gbps. It would consist of medium (physically) redundant fibre optic cables.



**x. Interface with other Systems:**

- a. There would be possibility to connect Excitation System on Main Data Highway.
- b. System will support open gateways through Modbus RTU.
- c. System will have OPC connectivity.

xi. High Resolution Sequence of Event Monitors

Sequence of Event Monitoring System forming an integral part of the DDCMIS. SOE is to be provided in UNIT DDCMIS for critical conditions like each of the protection condition of HT drives, MFT, TG protection, trip of HT & critical drive and status of some important electrical breakers. All field inputs are time tagged on acquisition (i.e. at the I/O card level). The sequence of event monitor shall have 1 ms resolution with 512 points/unit.

xii. Large video screens

Total Five. (5) no. 67 inches full HD Large Video Screens (LVS) shall be provided for each unit DDCMIS and three (3) nos. LVS for common DDCMIS along with workstation and graphic processor to dynamically display plant data/ mimic/ alarms/ and any other process information. Common system LVS shall have additional features to work in association with multiple numbers of plant cameras shall be provided

**xiii. Workstations and printers**

Ten (10) Operating workstation shall be provided on unit control desk for each unit and two (2) operating stations shall be provided on common control desk. Two (2) Engineering station and one no. shift-in-charge workstation for each unit and one(1) workstation for station in charge shall be provided which shall be common for all units

Heavy duty dot matrix printers and laser printers for taking printouts of logs/reports, colour hardcopy and for printing shall be provided.

Xiv. Unit Control Panel (UCP)

Control panel which shall house Annunciation Facia Windows, Digital Indicators, Push Buttons for safe shutdown of the plant, etc.

Alarms shall be DDCMIS driven with facia window size of min. 70 mm x 50 mm RED / Amber color LED lamps shall be provided. The inscription shall be in black with white back ground. Digital indicators for monitoring of all important plant parameters such as MW, frequency, rpm, Main steam Pressure, Main Steam Temperature, HRH temperature, etc shall be provided.

6.3.8 BOP DCS

Features of BOP DCS shall be same as DDCMIS. Redundancy shall be provided for controller, Communication modules, Power supply modules, rack power supply modules. However, all I/O cards shall be non-redundant



6.3.9 Programmable Logic Controller (PLC)

Programmable Logic Controller (PLC) based control system with dual Central Processing Unit (CPU) configuration with hot standby mode shall be provided. PLC system shall be complete with CPU of word length of 32 bits, Communication modules, Power supply modules, Input / Output Modules, etc. Redundancy shall be provided for Controller, Communication modules, power supply modules. Other salient feature of PLC shall be similar to that of DDCMIS as explained above

6.3.10 Uninterruptible Power Supply (UPS) Systems

Separate “2x100% parallel redundant UPS with 50% load sharing with static bypass through static switch to Static controlled voltage stabilizer regulated supply” including static inverters, static switches, manual bypass switch, chargers, A.C. Power distribution panels and 2 x 100% Battery banks with all required isolating and protecting devices and all other equipment and accessories required for completeness of this system. There shall be no common component like in phase transformer (IPT), common power supply to any redundant component and common point of failure in the UPS.

The type of batteries shall be 2 V Plante type Batteries for Main Plant, CHP, AHP, DM Plant, etc. Whereas for other systems / packages, 2 V, SMF lead – Acid / Ni-cd batteries shall be provided.

Applicable codes and standards for UPS System include ANSI, NEMA, TEEE, NEC and IS. The UPS shall cater power supply to all 230 VAC operated instruments, Analyzers, Solenoid Valves, Annunciation System, DDCMIS / DCS peripherals such as Work stations, Printers, Network switches, LVS, etc. within the control room and/or in the field.(Outside the





main control room) and comes under the scope of SG & STG packages as well as BOP packages. All UPS systems for main plant as well as for BOP off-site packages shall preferably be of same make.

6.3.11

Field Instruments

- a. Smart type transmitters will be provided for Pressure, Differential Pressure, Temperature, Flow and Level measurements. These will be of electronic type, two-wire configuration with 4 to 20 mA DC output signal, HART compatible and capable of driving loads up to 600 ohms at 24 V DC. These will be provided with integral indicator of 5 digit display with an accuracy better than $\pm 0.075\%$.
- b. The pressure gauges having sensing element / movement material will be SS316 with die cast aluminium case. The accuracy will be $\pm 1\%$. These gauges will also be provided with snubbers / pulsation dampers, siphons, seals as required.
- c. Temperature measurements will be made through

Thermocouples of Duplex K-type shall be ungrounded type. The accuracy will be ± 1.1 Deg.C. Thermocouple extension cable will be connected upto the JB to provide cold junction compensator at JB and from there on shielded instrumentation cable to the control and monitoring system will be used or Compensating cables from thermocouple head (through JB / Marshalling cubicle or directly as the case may be) will be connected to the control and monitoring system.





Ungrounded type Duplex Resistance temperature detector (RTD) of 3-wire platinum type. The nominal resistance will be 100 ohm at 0 Deg.C. The response time will be 15 sec. (bare) and 30 sec. with thermo well. The accuracy will be + 0.35 Deg. C.

Local Temperature Gauges will be Inert Gas filled / liquid filled type with separable SS316 thermo well, die cast aluminium case. The accuracy will be +/- 1% & response time will be max. 15 sec.

- d. Level transmitters for Coal Bunkers, Ash Silos, etc shall be 3D Acoustic based Transmitters with Volumetric Analysis having Accuracy +/- 1% of full scale or better. For liquid level measurement, DP type, Displacer type, RADAR type, Ultrasonic type transmitters shall be provided. Level gauges such as Float and Board type, Reflex type, Tubular type, etc will be provided for local indication and Level switches will be of external cage float type.
- e. Flow meters for Water applications except DM water shall be Ultrasonic clamp-on / Parshall fume type. For DM Water Flow measurement, whose conductivity is very low, DP type flow transmitter shall be provided. For Fuel Oil Applications, Coriolis Principle based mass flow meters shall be provided. For Instrument Air and Service Air Flow measurement, Vortex Flow meter shall be provided. Sight Flow glass, on-line / Bypass Rotameter shall be provided for Local flow indications.
- f. All transmitters shall be HART protocol based as far as possible.





6.3.12 HART Management System

A dedicated standalone PC based HART Management System (HMS) will be provided for centralized configuration, maintenance, diagnostic and record keeping of all electronic smart transmitters. The type of transmitters covered is Pressure, Differential Pressure, DP type Flow & Level Transmitters, Flow Meters, Level Transmitters and Smart Positioner.

Transmitter signals shall be wired parallel to DDCMIS for the connectivity to the HART multiplexer modules of HMS through patch board where ever redundancy is applicable, HART master will be connected to PC through serial communication link. However, transmitters for monitoring purpose shall directly be wired to the HART enabled AI modules of control system and the HART information shall be passed to HART PC through Ethernet. Complete diagnostic, record keeping, calibration and configuration, event and log reports, historical data base records of all transmitters shall be possible from the HMS.

6.3.13 FLOW ELEMENTS

For measurement of water flow, orifice plates will be used as primary sensing device. The flow sensors are sized as per BS 1042 or confirming to the latest codes of ASME and calculation parameters. For airflow measurement, flow-sensing devices will be venturi tubes. For steam flow measurement, flow-sensing devices will be of nozzle type and condensation chambers of identical dimensions will be used and installed as near to the sensor as possible. Sensing Instruments and their mounting accessories for steam line and high-pressure applications will be IBR certified.



For flow measurements of line size upto 500 mm, carrier ring type orifice plates will be used. Beyond this size, disc type orifice plate will be used. The orifice plate will be installed not less than with a straight pipe length of 10 D on the upstream side and 5 D on the downstream side, free from bends, tees, branch pipes, valves etc.

6.3.14 **CONTROL VALVES**

Control valves shall be multistage, multi path cage or disk design depending upon the control applications. All control valves shall be provided with SMART Positioners with HART based protocol. Control Valve diagnostics shall be transmitted through this HART Protocol to DDCMIS.

Pneumatically operated control valves will operate on 0.2 to 1 Kg/cm² air signal. Control valves will be sized so that the CV required for normal flow will not be more than 62.5% of the published CV for 100% valve opening; and the minimum flow will occur at 30% of valve opening and or more to have a good operating range. Valve lift shall be limited to 80% of the travel at max. flow load. All control valves shall be provided with SMART Positioners with HART based protocol, Air lock relay, limit switches, solenoid valves and filter regulators as needed.

6.3.15 **STEAM AND WATER ANALYSIS SYSTEM (SWAS)**

Separate Steam and Water Analysis System shall be envisaged for continuous monitoring and control of water and steam purity in the plant cycle of each unit and at other important points as specified in this specification. The sampling system shall obtain samples from steam and water system, which shall be adequately conditioned and fed to analyzers



for continuous analysis and provide parallel facility for grab sampling as specified. The system shall be furnished complete with sample conditioning devices and monitoring instruments (for temperature, pressure, flow & sample), analyzers, transmitters, indicators, alarm initiating devices, interlocks, isolated 4-20 mA DC for plant monitoring system and all required accessories to provide a complete and integrated sampling and analysis system. All analysers shall be connected to SWAS workstation via RS-485 modbus protocol

The system shall be designed in accordance with the recommendations in ASME PTC 19.11 (2008), Water and Steam in Power Cycle, ASTM standards - 31 water and ASTM D1066-69 standard method of sampling steam.

Following are the streams and their measurements

Sno.	Sample Stream	Type of Measurement
1	Make-up DM Water	pH, Conductivity (specific & cation), silica
2	Hot well both side condensate	pH, Conductivity (insertion / retractable type)
3	Condensate Extraction Pump discharge	pH, Conductivity (specific & cation), silica, dissolved O2, Sodium
4	Deaerator outlet	pH, silica, dissolved O2
5	Boiler Feed Pump suction line	pH, specific conductivity, dissolved O2
6	Feedwater at Economiser Inlet	pH, Conductivity (specific & cation), Hydrazine, DO2,





		silica
7	Boiler Separator outlet steam at LTSH inlet	Conductivity (specific & cation), Hydrazine, silica
8	Boiler saturated steam	pH Conductivity (Specific & Cation), Silica
9	Main steam	Conductivity (specific & after cation), silica, pH, sodium
10.	HRH Steam	pH, specific Conductivity, sodium
11.	DMCW (SG & TG) Water	pH,
12	Out let of each Condenser Polishing unit vessel	pH, Conductivity (specific & cation), silica, dissolved O ₂ , Chloride
13	Condenser Cooling Water discharge	Conductivity, pH, Chlorine

6.3.16

Continuous Emission Monitoring System (CEMS)

Separate Continuous Emission Monitoring System shall be envisaged for each Unit as per Emission latest Regulation of CPCB/State PCB. CEMS shall comprises of Flue Gas Oxygen analyzer for control and monitoring, Carbon Mono Oxide, Sox / NO_x, Dust & Opacity analyzer, Mercury analyser for Boiler Emission monitoring system. All stack emission monitoring instruments shall be of Extraction type. A programmable controller shall be provided for signal output, alarms, calibration cycle timers and measurement indication for each analyzer. Each analyser shall be independent and shall not share power supply processor etc. All the data shall also be available on DDCMIS for analysis and monitoring from CEMS.

Following are the Flue Gas measurements and their locations:





- i) Zirconia Probe type Boiler Flue Gas Oxygen analyzer and before and after APH for control and monitoring (i.e. HT O2 Analyser and LT O2 Analyser).
- ii) Stack emission monitoring system comprising of CO, Sox / NOx, Dust, Opacity analyzer, Mercury Analyser.

6.3.17 Instrumentation Cables

Instrument (pair / core) cables (annealed, tinned copper conductor, 1100V / 650 V grade, 0.5 sq mm (signal cable) / 1.5 sq mm (control cable). FRLS type, PVC insulated, Stranded Drain wire, Aluminum Mylar type shielding armoured, ST1 type Inner Sheathing, ST-2 type outer Sheathing for analog and digital signals for connecting field instruments, switches, transmitters to respective junction box and compensating cables used to interconnect thermocouples to control and monitoring systems (KX, 1.5sqmm, FRLS type, PVC insulated, armoured) complete with all accessories are envisaged.

6.3.18 Erection Hardware

All required installation hardware including impulse pipes, tubes, valves, manifolds, fittings, etc. required for proper installation and interconnection of instrumentation and control systems shall be provided. All materials and installation thereof shall confirm to latest editions of American national Standard Code for pressure piping, ANSI B 31.1, ANSI B 16.1, ASME Boiler and pressure vessel codes, IBR and other applicable ASME, ANSI and local standards



6.3.19 Master Clock System

The Master clock system shall be provided based on Global Positioning system (GPS). Master clock shall have separate signal conditioner facilities to transmit clock pulses of specific formats, (such as IRIG-B, pulse, NTP/SNTP etc.) for time synchronizing other equipment in the power plant such as, DDCMIS system, PLCs, SOE & for all microprocessor based system like TSI, VMS, HMS, Flame monitoring & detector system, Boiler tube leak detection system, etc. All the PLC & Microprocessor based system in entire plant shall be time synchronized from Master Clock System. Master Clock System shall be common for all the system in complete plant.

6.3.20 Vibration Monitoring and Analysis System

One no. Microprocessor based standalone online vibration / machinery monitoring and analysis system for each unit shall be used for condition monitoring, analysis & diagnostic of STG and HT drives/motors with fans / pumps, air compressor, and any other HT drives envisaged for subject plant. Raw buffered output from BOP Offsite VMS Systems shall also be interfaced with VMAS for condition monitoring, analysis & diagnostic. VMAS shall take care of predictive maintenance of all machines / equipments. And shall be compatible and of same family of turbine vibration monitoring system / HT drives vibrations system. The monitoring / protection system should be compliant to API670 (Latest edition) and must meet the detailed specifications such as High Speed Multi-channel Online – Data Acquisition Communication Processors (CPs), Data Acquisition, Data Management and Machinery/Process Data Display System, Process Data Interface – For correlation of Mechanical



behaviour with Process Data, Advanced Automated Machinery Diagnostics System, Transducer System & other inputs, etc.

6.3.21 **C&I Lab instruments**

Two (2) nos Computer aided Pneumatic and Electronic C&I maintenance calibration instruments/equipment shall be provided for calibration of Pressure, temperature and other electrical field instruments for all five units i.e one C&I lab common for unit # 1& #2 and one for Unit #3, #4& #5. Table mounted calibration instruments having highest accuracies to support testing/calibration of field instruments whereas the portable calibration instruments shall be used for site applications to perform testing/ calibration at site. Automatic calibration and system documentation for generating calibration certificates, keeping calibration/ maintenance records for which one workstation shall be provided

6.3.22 **Ambient Air Quality Monitoring System (AAQMS)**

Four (4) no. On-Line Continuous Ambient Air Quality Monitoring System (AAQMS) will be provided. Each station will have Sulphur Dioxide (SO₂), Oxides of Nitrogen (NO₂), Suspended Particulate Matter (SPM), Respirable Particulate Matter (RPM) size less than 2.5 microns & 10 microns and Carbon Monoxide (CO) measurements. In the Central station, One (1) Ozone analyser shall be provided. Interconnection between all the AAQMS shall be Wireless.

The Meteorological Monitoring System (MMS) will be provided with Wind Speed, Wind Direction, Ambient Temperature, Ambient Pressure, Relative Humidity, Solar Radiation and rain gauge measurements. The MMS will be installed at one of the AAQMS station.



The AAQMS will be as per MOEF / CPCB norms. All the Plant parameters and Environmental monitoring parameters shall be displayed at the main gate of the Plant.

6.3.23 Plant security and surveillance System

The Plant security and surveillance system shall be provided taking into account the potential security risk to the plant. The system comprises of perimeter intruder detection system, plant monitoring system, security card access system and patrol card system. All CCTV cameras shall be IP based, with weather proof enclosures, fire/explosion proof enclosures for FOPH area and H2 generation plant (as per NEC code). System shall be provided as follows

- i. Inside Plant- IP based PT2 cameras
- ii. For transformer and switchyard area- Thermovision cameras
- iii. CCTV-connectivity/control-service building

6.3.24 PERFORMANCE CALCULATIONS, ANALYSIS, DIAGNOSTIC AND OPTIMIZATION PACKAGE (PADO)

PC based online Performance analysis, diagnosis & optimization system(PADO) for station, which will provided proper guidance to plant operator to enhance operational efficiency, carry out process and equipment diagnosis to ensure against performance degradation and facilitate optimal controller tuning.

The performance calculation shall be broadly sub divided into two classes:
Class I : Equipment protection calculations and





Class II : Plant equipment efficiency calculations.

The Diagnostic and Optimization Package shall include BOILER PERFORMANCE OPTIMISATION SYSTEM (BPOS), Soot Blowing Optimization Module, Boiler Stress analyzer and service life monitoring, Emission Analysis and Monitoring and Interactive Chemistry control, Regenerative cycle performance optimization, Water Chemistry Management, Merit order Rating System, etc.

6.3.25. **Station LAN and Management Information System (MIS).**

A plant wide Local Area Network (LAN) encompassing the different plant buildings shall be provided. The Station LAN shall interconnect all the buildings together and shall facilitate the smooth transfer of Data from one building to the other.

Any integrated management information system (MIS) shall be provided, which includes

Plant operation information, Plant maintenance related information and Environmental information.

6.3.26 **Simulator**

The High Fidelity training simulator capable of Simulating continuously, automatically & reliably the real time plant system including equipment, control and instrumentation and all operations of the plant shall be provided

The Simulator shall include equipment, Instrumentation and controls that will enable an operator to function in all modes of the specified



supercritical technology based coal fired power plant operation including plant start-up and Shut-down, monitoring and control during normal, abnormal or emergency situations and in safety procedures except as specifically noted otherwise.

The Simulator envisaged shall be capable of training and assessing operators in the operation of Distributed control system (DCS) and in-Plant operation, including training in-plant start-up and shut-down, emergency situations and safety procedures. The System shall be ideally suitable for in-house training as well as to conduct refresh courses to engineers with earlier plant experience.

The simulator system shall consist of simulation computers / Servers, simulator programmer station, instructor's station and total HMI system (consisting of LVS, servers, workstation programmer station, TFT monitors, Printers, etc

6.3.27 **Wireless Connectivity**

Latest state of art Wireless connectivity will be provided for connectivity between main Coal Handling plant DDCMIS and Stacker – Reclaimer Machine PLC. The signals which are transmitted through wireless shall be used for monitoring. However, Hardwired connectivity also envisaged, through which signals which are critical and used in the control logics. Also wireless connectivity shall be provided for interconnecting all AAQMS stations.



6.3.28 Interface with Numerical relays and Intelligent Controllers

For HT switchgear feeders for ACB control incomers, bus couplers, LT switchgear feeders etc. Numerical relays shall be provided with IEC 61850 protocol and shall be directly linked to DDCMIS/ DCS/ PLC without converters.

For LT MCC feeders intelligent controllers shall be provided, Ethernet-based protocol shall be used for linking to DDCMIS/ DCS/ PLC and shall be linked to DDCMIS/ DCS/ PLC.

Protocol shall be finalized during detailed engineering.

6.4 CIVIL AND STRUCTURAL ENGINEERING ASPECTS

6.4.1 Basic Design Consideration

6.4.1.1 Plant Levels

Ground level are varying from 65 m to 125 m level.

6.4.1.2 Soil Characteristics

The Soil of the District is mostly consisting of clay sand with Rock Strata. The fertile black cotton soil forms only 9 percent and occurs on the banks of Krishna and isolated patches here and there. Among the red soils 47% is dubba soil (Loamy sands), which has a very low moisture retaining capacity, and the rest is chalka soil, forming 44 %.

Consequently raft/spread footing in foundation has been considered for foundations except for major plant and equipment like TG deck, boiler columns, power station building columns, chimney and cooling tower.





However, during project implementation, detailed geo-technical investigation will be carried out for the plant structures located as per the plot plan to ascertain appropriate type of foundation for heavy equipment and structures.

6.4.1.3 **Seismic Considerations**

The power station is located under Zone-III as per IS: 1893/2002. Analysis and design of structures to resist the seismic forces are to be carried out as per the provisions of IS: 1893 2002/1985 (latest).

6.4.1.4 **Wind Loading**

The applicable design wind pressure will be computed as per IS: 875 (Part-B)-1987 part III and design of buildings and structures as per IS: 802 and IS: 875.

The wind rose diagram has been developed based on the data collected over a period of 30 years by Indian Meteorological Department at the nearest observatory, Nalgonda. The data indicates that South-easterly wind is strong contributing 28.5% in frequency distribution. There is 4% calm period as observed.

6.4.2 **Power House Building Superstructure**

The main power plant building comprising TG bay (A-B bay) and the adjacent electrical & deaerator bay (B-C bay) will be of steel framed construction upto the roof level. The floor slabs at intermediate levels will be of RCC and supported on steel beams & columns. The TG bay roof (A-B bay) and side cladding above operating floor will be provided with 0.8 mm pre-color coated double skin metallic sheeting. BC & CD bay





comprises HP/LP heaters, control room LT & HT switchgear. The deaerator bay (B-C bay) will have side cladding of permanent colour and sand witted in saturated metallic sheeting at B-row and brick cladding at C-row. Floor slabs and roof covering of B-C bay will be of cast in situ RCC construction. A-B bay will be equipped with EOT cranes B, C & D row walls will be of bricks.

Doors, windows and rolling shutters will be provided as per IS:1038, IS:1361 & IS:4351 etc.

The transverse frames will be of framed type. In the longitudinal direction, these transverse frames will be braced to resist horizontal forces.

6.4.3 Civil Works in Plant Area

All the walls and floors will be provided with approved painting and floor finishing. RCC roofs will be provided with approved water proofing treatment.

1. Special Foundation Requirements for Rotating Equipment

The foundation systems for rotating equipment will be sized and proportioned not to exceed the bearing and settlement criteria and to assure satisfactory performance of the equipment. In addition to a static analysis, a dynamic analysis will be performed to determine the fundamental frequencies of the foundation system. To preclude resonance, the fundamental frequency of the foundation will be 25 percent from the operational frequency of the equipment. The dynamic behavior of the foundation will meet the requirements of IS:2974 (Part I to IV) – Code of Practice for Design and Construction of Machine Foundations.





All rotating equipment will be provided with vibration isolation spring system mounted foundations. The vibration isolation system supplied will be of proven make, consisting of steel helical spring units and viscous dampers (providing damping resistance in all three planes). The vibration isolation foundation system will be provided for Turbo-generator, Boiler feed pumps, ID/FD/PA fans, Coal mills and Coal crushers.

The vibration isolation system will be capable of vibration isolation not less than 95%.

If minor equipments are to be supported on building structures, floors etc. suitable vibration isolation will be provided.

Civil foundations will be designed to take into consideration soil bearing capacity and ground water table. Generally, raft/spread foundations will be considered. Safe load bearing capacity is considering 25t/M^2 foundation system will be decided after preliminary soil investigation of the site. The minimum grades of concrete will be in accordance with appropriate class of exposure as per IS – 456 – 2000. Concrete grade for various works will be -

- M 30 machine foundations.
- M 30 Chimney shell, and substructure of spring supported machine foundation.
- M 25 structural RCC work in foundations and superstructures, water retaining structures and chimney raft foundation.
- M 20 Grade slab & other miscellaneous items



- M 10 / M15 Sub-grade filling, mud-mat etc (depending upon the aggressiveness of foundation soil)

IS:875 code is referred to for considering all the required provisions. Brickwork in cement mortar 1:4/1:6 will be used for plant buildings as applicable. Ductile detailing of RCC structures will be as per IS:13920.

Foundations of all major equipment with vibrating load such as fans (ID, FD, SA, PA, coal mills and coal crusher etc. will be spring supported deck type with supporting framed structure of RCC. Equipment foundation will be separated from adjoining part of building and other foundations joints at floor/slab will be suitably sealed.

All building will be provided with 1000 mm wide and 150 mm thick plain cement concrete paving around on the outside. The plinth protection will be laid over prepared sub-base and base.

Grade slab foundations will be provided for ESP columns, duct supports and miscellaneous minor equipment. ESP control room electrical room will be of flat RCC roof construction with brick walled construction.

Stairs, platforms and galleries will be of minimum 900 mm width complete with hand-rails, toe-plate and curbing as required. Stair treads will be of 250 mm with 150/190 mm height between successive treads.





Steel doors, windows, rolling shutters will be provided with glazing as required.

The roads in the plant area will be of adequate thickness and width as per requirement of different areas. It is proposed to have water-bound macadam roads during construction stage and the same will be finished with asphalt surfacing during completion stage. Adequate plant roads/culverts, grading and drainage will be provided. All roads will be designed & provided as per applicable IRC standards.

Steel doors, windows, rolling shutters will be provided with glazing as required.

2. Structural Works

Structural works will be designed for dead-load plus adequate live-load plus worst of wind load and earthquake load with importance factor of 1.75 and seismic load as per IS:1893/2005 (Part IV) as applicable for Zone III.

Mill & bunker bay will comprise of structural steel framework supporting the coal bunkers, feeder floor and tripper floor. The structural frame will be designed as a fixed joint frame in the transverse direction and braced frame in the longitudinal direction. Coal bunkers will be of structural steel plates and will be lined with stainless steel liner plates in the entire conical portion. The floors will be of reinforced concrete with hardened top and supported on steel beams. The column foundation and mill foundations will be supported on raft/spread foundations. Tripper bay and conveyor galleries will be provided with colour coated sheet cladding.



3. Liquid Retaining Structures

RCC Water retaining structures will be leak proof and designed as uncracked section.

The design will conform to IS:3370. In all liquid retaining structures, PVC water bar will be provided at each construction/expansion joint.

RCC foundations of boiler columns and other miscellaneous equipment will be included. RCC grade slab covering the boiler area will be provided for.

6.4.7 Civil Works for Plant Water System

1. Natural Draft Cooling Tower

Circulating cooling water system using Natural draft cooling towers is considered. Cooling tower will be provided to handle approximate 84.200 M³/hr. water with leak proof underground basin and RCC hyperboloid stack life structure as per requirement of BS:4485-1996 Part I to IV.

2. CW Piping System

A new inplant water reservoir will be provided. CW pipe line will be constructed by burring the pipe line in a trench after being rapid coated with bitumen bound approved coating pipes will be vested on 500 mm thick will compacted sand bed and filling sand will be packed upto the 50% height of the pipe followed by fitted up by





good earth so as to have min. 1.5m earth cushion. While crossing the road & railway suitable road/rail structure will be constructed as per IRC codes & class “AA” loading. A separate in-plant raw-water storage reservoir is envisaged. Also a filtered water/fire water tank with dedicated storage of 3600 M³ for firefighting will be provided. The in plant reservoir will be compartmentalized to ensure de-sludging/maintenance of any section without affecting plant operation. With a view to conserve water PVC lining as per IS 3370 will be provided on bed and sides.

With a view to conserve water, the fire water reservoir will be provided with concrete slabs on top as protective cover, PVC lining will be provided on bed and sides to prevent seepage loss. The in plant reservoir will be compartmentalized to ensure de-sludging/maintenance of any section without affecting plant operation.

6.4.8 Civil Works for Coal Handling Works

Conveyors galleries, supporting trestles, superstructures of crusher house and transfer houses will be of fabricated structural steel work. All components will be of welded fabrication with belted/welded joints for erection and assembly in the field. Intermediate floors and roof in transfer houses and crusher house will be of reinforced concrete supported on structural steel framing. Side cladding will be of plastered brickwork or GI sheeting; and necessary windows/louvers will be provided for natural lighting and ventilation. Crusher foundation with vibration isolation spring system for isolating the crusher house building will be of RCC frame. Conveyor tunnels will be of concrete box section with provision of





appropriate water proofing arrangement. Marshaling yard & Railway lines to be provided for coal handling system.

6.4.9 Civil Works for Ash Handling Plant Works

Ash handling system of each unit will include bottom ash handling system, coarse ash system, wet fly ash handling system, dry fly ash handling system. The Ash water pump house with the ash water sump and ash slurry sump will be of RCC construction with RCC columns and beams. The ash slurry sump will be compartmentalized lined with abrasion resistant liners. Similarly the ash water sump will be compartmentalized for mounting pump separation walls and other needed facilities. Provision for suitable steel inserts will be made for installation of the pipes, valves etc. The pump house will have the provision for traveling crane of adequate capacity and lift. The blower/compressor room will be separate RCC construction in flat roof construction located close to ESPs to accommodate the blowers/compressors with its auxiliaries.

Pipe rack for conveying the ash and water pipes to slurry sump will be of structural steel framed construction having its columns mounted on the RCC foundations.

6.4.10 HFO & LDO Handing System

Proposed extension of HFO & LDO handling area will be surrounded by RCC wall all along the periphery having HFO & LDO day tank of MS are to be founded on bitumen concrete bed over well ramped earth surrounding by well foundation. The yard will be paved with RCC pavement on which pipe supporting pedestal will be founded.





6.4.11 **Waste Water Management**

Water treatment plant effluent comprises of DM and CPU regeneration waste. This effluent shall be pumped to the Central Monitoring Basin (CMB) after neutralizing.

Plant drains from Fuel Oil Tank Form area, Lube oil system, Transformer area and TG area shall be led to a sump. These oily effluents shall be treated in an oil water separator for removal of oil. The clear water shall be led to the Central Monitoring Basin (CMB) and the dirty oil shall be disposed off in drums separately.

The Central Monitoring Basin shall have two (2) compartments, each compartment having adequate storage to collect a day's effluents. Facilities in the form of chemical dosing system, effluent recirculation system, etc. shall be provided to treat the effluent and to bring the quality suitable for disposal outside the plant, if required.

6.4.12 **Switchyard Civil Works**

Switchyard civil work consists of 400 KV switchyard, tower foundations, equipment foundation, foundation for LM towers, control room building and cable trenches roads and trains chain link fencing.

6.4.13 **Chimney**

Two (2) Nos. twin flue & One (1) No. single flue RCC chimney with steel lining & insulation (insulated outside the flue) will be provided with windshield for five (5) units. The height of the chimney as per CPCB will be 275 M. Chimney will be fitted with rack & pinion type elevator/staircase inside the shell.



Upper portion of chimney will be painted with red & white bands from outside. Chimney will be provided with lightning arrestor, aviation warning lights as per statutory requirement.

6.4.14 **Approach Road**

A rail track for transportation of heavy equipment will be extended to the service bay of the turbine hall. Also an approach road connecting the state highway will be constructed for transportation of heavy equipment.

6.4.15 **Auxiliary Facilities**

In addition to the power plant technological structures/buildings, the following non-technological buildings will be provided/enhanced.

- a) Parking shed
- b) Service building attached to the main plant building.
- c) Workshop & store enhancing
- d) Additional guard/watch towers spaced adequately around the boundary wall of 10 metre high, 4 metre square at top.
- e) Additional green belt area as per Environment Pollution Control norms.
- f) Adequate number of toilets and bath rooms in the TG building and other areas including associated septic tanks/sewage disposal system.



6.4.16 Residential Colony

Considering all the factors and on the ground of economy, accommodation is proposed for personnel for the power plant operation and maintenance staff, staff employed in finance, administration, accounts, welfare and purchase, and staff for schools, bank, post office, hospital, park, township maintenance, for the security and firefighting staff. Guesthouse & bachelor hostels will also be provided.

Plinth areas for Quarters

Sl.No	Type of quarter	Plinth area excluding common area.	
		(Sq.ft)	(Sq.m)
1	A	1800	167
2	B	1617	150
3	C	1594	148
4	D	1289	120
5	E	1155	107
6	F	956	89

Community Facilities

The township will be developed with an aim to satisfy the diversified needs of the employees and their families. Accordingly, adequate and different types of community facilities will be provided in township area. These will include children's play areas and play fields, park, primary-cum-nursery schools, crèche, health center and hospital, shopping facilities, community center, club house, open air theatre, bank, post office, police outpost etc.,





7.0 PLOT PLAN AND GENERAL ARRANGEMENT

7.1 Plot Plan

The general plant layout for the proposed power station is shown in Plot Plan super imposed on the area allocated for the proposed 5x800 MW as **Annexure - 7.0.**

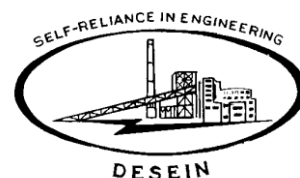
The General layout drawing shows the location of main plant equipment with its auxiliaries, 400 KV switchyard, cooling tower with water facilities, ash pipeline and proposed approach road. The plant layout has been developed keeping in view the following:

- i. Location within the designated area best suited from the point of view of available land.
- ii. Wind direction
- iii. Proximity to the water source of Krishna River.
- iv. Location of ash dyke area

The main plant equipment and auxiliary are selected on the basis of unit system design concept except for such common facilities common to the existing operating units such as coal unloading, stacking and handling facilities, water in-take system from Krishna River, ash disposal pond etc.

The layout provides for:

- i. Dedicated dead 7 days storage of raw water for plant consumption use and for fire protection as per TAC requirement.
- ii. Independent coal unloading, storage & handling facilities.
- iii. Space for future FGD Plant (if required).
- iv. Fly Ash Silos





- v. Adequate space for built-up and open area for construction offices, stores, fabrication yard, pre-assembly yard etc.

7.2 General Plant Layout

7.2.1 Layout of Steam Generator and Auxiliaries

- 7.2.1.1 The general disposition of furnace with its supporting columns; FD, PA and ID fans with drives and handling columns; Rotary air pre-heaters etc. will be located as applicable to 2-pass construction, front wall fired/corner fired/down-shot burner configuration boiler. The layout is subject to revision based on the final selection of the steam generator (either single pass tower type or 2-pass conventional type). In any case, the pulverizers will be located in between the boiler air heaters and Electrostatic precipitator for better maintenance access and to reduce the critical piping lengths. The flue gas ducts from the air heater pass below feeder floor for connection to ESP and then will be connected to a 275M high RCC twin flue / single flue stack, connected through two (2) ID fans.

ESP control room will be provided separately.

- 7.2.1.2 Ash water pump house with slurry sump will be located near ESP.
- 7.2.1.3 Conveying air compressor house will be located adjacent to ESP.
- 7.2.1.4 One (1) passenger-cum-freight-elevator of 3000 kg capacity will be located for the each boiler. This will be connected to various platforms of Boiler.

The elevator machine room will be provided with pressurized ventilation/air-conditioning to avoid ingress of dust from Boiler & mills





area. The elevator shaft will be covered on all sides with CGI sheeting or perforated corrugated metal cladding.

7.2.2 Layout of Machine Room Building with Annex

7.2.2.1 The machine room building will comprise of 36 M span turbine hall followed by 10 m bay for heaters and 12 M bay for electrical and control room. The machine room will be provided with one (1) 125/40 tonne capacity Electric Overhead Travelling (EOT) crane. Generator stator will be lifted by special temporary jacking arrangement. Steel columns with brick/aluminum cladding and precast RCC roof is envisaged for covering the machine room to protect it against rain, wind etc. A clear passage will be kept between C-row column line and boiler first columns to facilitate critical pipe work routing into the machine room; and to locate other auxiliary equipment such as blow down tanks etc.

7.2.2.2 415 V/3.3/11 KV Switchgear will be located mostly on floors in B/C bay. Boiler Auxiliaries MCC; Boiler valves MCC; Soot-blower MCC; 240 Volt ACDB etc. dedicated for the unit will be located at higher levels scattered close to the equipment to the extent possible to minimize the cable lengths. 240 Volts Station Battery units and its Chargers room along with UPS Battery will be also located in B/C bays. Control equipment room, DCS room, 24 V Battery and its charger room will be located between B/C bays. One (1) Central control room is envisaged for the total plant. The air-conditioning plant with its associated auxiliaries such as AHU room etc. serving the unit control room will be located in B/C bay at higher elevation floor. Deaerator with its storage tank will be also located at 36.0 M floor level separately.



7.2.2.3 The ground floor, apart from the unloading space for handling the equipment through EOT cranes, in between A/B bays, the following equipment with auxiliaries will be installed:-

- 3x50% capacity condensate extraction pump sets;
- Turbine dirty oil & clean oil tanks with associated pump sets; & purification plant;
- Gland steam condenser / drain coolers;
- Station service and instrument air compressors with intercoolers, after-coolers, air receivers, air drying plant etc;
- Chemical dosing equipment
- Hydrogen cooling systems

7.2.2.4 Regenerative feed water heaters will be located in the machine hall between A/B bays (LP heaters below operating floor while HP heaters will be located at operating floor. They will be located for shell withdrawal.

7.2.2.5 As per TAC requirement, access staircases will be provided for interconnection to all main floors and for evacuation of operators during an emergency.

7.2.3 Switchyard

400 KV switchyard will be located of the plant building beyond transformer yard as shown in the layout drawing. Power will be evacuated from the plant at 400 KV through the Switchyard.

7.2.4 Three (3) Nos. Natural Draft Cooling Towers for cooling the circulating water will be located to the East side of the power station building and two (2) Nos. will be located to the East side of the power station building. The location is selected, such that it does not affect the 400 KV switchyard.



8.0 ENVIRONMENTAL ASPECTS

8.1 Pollution Control Measures

8.1.1 Air Pollution Control System

Electrostatic precipitators (ESP) would be installed to control the emission of ash particles. The precipitators would be designed to limit the particulate emission to less than 50 mg/Nm^3 . Two (2) number twin flue & One (1) No. single flue stack of 275 m height are envisaged as per existing norms for deciding stack height (**Attachment-8.1(A)**). Besides on-line monitoring system, the chimney would be provided with access for regular monitoring of stack emissions. For the control of fugitive dust emission within and around the coal handling plant, coal dust extraction and suppression systems would be provided. Dust suppression system would be installed at all requisite points in CHP and coal stackyard.

Advanced combustion technology for lower emission of nitrogen oxide would be necessary to control NOx emission in the boilers.

Space is provided for the Flue Gas Desulphurisation system. The design and layout of steam generator and its auxiliaries would be such that a wet / dry FGD system can be installed.

Besides, ambient air quality concentration will be maintained as per National Ambient Air Quality Standards (**Attachment - 8.1(B)**).





8.1.2 Water Pollution Control System

Effluent management scheme would be implemented with the objective of optimization of various water systems so as to reduce intake water requirement which would result in lesser waste water discharge. The effluent management scheme would essentially involve collection, treatment and recirculation / disposal of various effluents. Adequate treatment facilities would be provided to all the waste streams emanating from the power plant to control water pollution.

Effluent from the pretreatment plant (clarifier and filtration plants) will comprise sludge and water. Sludge will be separated and compacted in sludge presses and will be disposed off in solid form as landfill. The balance water will again re-cycled in clarifier along with raw water available from the reservoir.

Effluents from the demineralizer plant resin regeneration circuit, generally acidic from the cation units and alkaline from the anion units will be neutralized in a neutralizing pit. The neutralized effluent will have less than 100 ppm suspended solids and a pH value of about 7.5 to 8.0. The neutralized effluents will be led into the use CMB.

The cooling tower blowdown will be utilized for ash disposal in thick slurry form as also for green belt around the plant.

The run-off from the coal handling area will flow through channels around the coal storage area and coal handling buildings into a common basin (settling tank) from where it will be pumped into the station sump.





The oil-water mixture collected in the existing drains, provided around the oil unloading area and the pump house, etc. is led to an oil-water separator. The separated water containing less than prescribed limit of oil and grease and will be led into the drainage system which will be finally discharged into station sump. The waste oil as separated out will be reutilized, if possible.

The sewage from the various buildings in the power plant as well as the colony will be routed through a sewage treatment Plant. The treated effluents from the sewage treatment plant will be utilized suitably for land application as per the existing standards.

The ash pond will be suitably lined to prevent ingress of ash water in sub soil. In the later years, when ash utilization is progressively increased, lower quantity of raw water will be required and more treated effluent water will be used for CHP dust suppression, BA hopper refractory cooling and watering of green belt. Excess liquid effluent will be discharged in a Central Monitoring Basin, where the treated liquid effluent will be monitored and recycled for use in the ash disposal water system. A suitable water / effluent scheme will be developed for reusing the treated waste water under normal operating condition. The effluent quality of various streams will be maintained as per the existing standards of thermal power effluents (**Attachment - 8.2(A)**). The final effluents, after treatment, will conform to the standards for discharging into / on existing water body / land for irrigation (**Attachment - 8.2(B)**).

Detailed studies were undertaken on drainage pattern in the project area for evolving a drainage decongestion plan, are provided in a separate on-area drainage study report.





8.1.3 Noise Pollution

The major noise generating sources are turbines, generators, compressors, pumps, fans, coal handling plant etc. Acoustic enclosures shall be provided to control the noise level below 90 dB (A). Personal protective equipment shall be provided to the persons working in high noise area.

Ambient noise inside and outside the plant area will conform to the prescribed noise levels for various land use categories as per National Standards for Ambient Noise (**Attachment - 8.3**). This will be ensured through proper designing of the equipment with adequate acoustics permitting the ambient noise levels without exceeding the specified criteria from the source.

The socio-economic issues are addressed in a separate socio-economic survey report.

8.1.4 Solid Waste Management

The power plant, being Coal-fired power station, would generate coarse as well as fine ash. All efforts shall be made to utilize the fly ash for various purposes. Ash Management Plan will be developed for 100 % utilisation of fly ash within the time period prescribed by MoEF. The unused ash, till such time, would be disposed in the emergency ash pond to be built within the plant premises.



8.1.5 Ash Management

MoEF vide gazette notification dated 3rd November 2009 have stipulated about the utilization of ash generated by coal / lignite based thermal power station. The details are as under:

New coal and, or lignite based thermal power station and, or expansion units commissioned after this notification to achieve the target of fly ash utilization as per table given below:

S.N.	Fly Ash utilization level	Target date
1.	At least 50% of fly ash generation	One year from the date of commissioning
2.	At least 70% of fly ash generation	Two years from the date of commissioning
3.	90% of fly ash generation	Three years from the date of commissioning
4.	100% of fly ash generation	Four years from the date of commissioning

With a view of proper utilization, fly ash has to be handled separately and fly ash has to be stored in dry form for subsequent utilization. The dry fly ash could be transported in closed trucks for commercial utilization. Alternately, to minimize the cost of transportation, fly ash utilization plants could be located close to the thermal power stations.

Bottom ash after being collected in ash bins for decantation is conveyed in trucks outside the plant site, and is used extensively as a replacement



for cinders. The use of bottom ash in area filling has provide satisfactory over the years, by virtue of which it finds ready marketability.

Fly ash, being a high temperature product, has pozzolonic properties and forms a cement like material when mixed with lime and water. These properties make it suitable for a number of commercial uses; the most promising of these are as follows:

a) **Bulk Utilization**

Fly ash can be utilized in bulk form filling low lying areas, abandoned mines and in forming dykes and bunds. For this purpose, fly ash slurry is prepared specially to render the mass semi-rock once it settles in low lands, thereby making the reclamation of land possible. The slurry thus prepared is termed as 'Emulgate'. 'Emulgate' can also be used to serve irrigation projects by creating bunds to channelize water. Other probable uses can be for making rail & canal embankments, filling for making roads, land scaping etc.

b) **Value Added Utilization**

Modest quantities of fly ash can be used by generating a product which has some commercial value. The products are made by making use of some of the qualities of fly ash. The pozzolanic activity and lime reactivity of fly ash is employed for numerous uses including manufacture of building construction materials, as listed below:



- i) Fly ash clay bricks
- ii) Fly ash - lime & sand bricks
- iii) Cellular bricks / blocks
- iv) Light weight aggregate
- v) Portland pozzolana cement
- vi) Precast concrete blocks
- vii) Sewerage pipes etc.

c) **High Value Utilization**

Products / services of high value can be made by utilizing fly ash. The value of the end product is much more pronounced than the quantity of ash utilized. Probable usage / products are as follows:

- i) Treatment of acidic soil for waste land reclamation for agricultural purposes.
- ii) Construction of road sub-base and rigid pavements for runways.
- iii) Manufacture of coagulants to remove turbidity of water.
- iv) Extraction of valuable materials like Vanadium, Cadmium, Uranium etc. from certain rich fly ashes.
- v) Manufacture of insulating bricks.

For the proposed 5x800 MW power plant, fly ash will be collected in dry form. This dry fly ash will then be transported to the neighboring ash



utilization plants, to be set up by private parties, by truck. Any surplus fly ash not used in the manufacture and bottom ash will be disposed off in slurry form to the ash dyke.

8.1.6 Green Belt Development

As per MoEF guidelines green belt should be 33% of plant area. Green belt develops in all available space.

8.1.7 Pollution Monitoring and Control Measures

Combustion of fuel and discharge of chemicals and effluents from the plant through waste water. A well defined environmental monitoring programme will be provided with trained and qualified staff who will monitor the ambient air as well as stack flue gas quality to ensure that the quality of effluents are maintained within the permissible limit. The main stack will be provided with portable monitors to periodically monitor the SPM CO, NO_x and SO_x constituents in the flue gas on daily basis. The plant effluents will be periodically analyzed on a weekly basis so that the effluents are maintained within the permissible levels of the pollution control board regulations.

8.2 Post Operational Monitoring Programme

Regular mentoring of pollutants in different environmental disciplines like air, water, etc. will be undertaken during the post operational phase of the plant. The monitoring locations will be finalised in consultation with State Pollution Control Board. However, a minimum of four (4) monitoring locations will be required in all the four directions.





8.3 Institutional Set-up

The post operational monitoring programme will be under the supervision of the Environmental Management Group (EMG) at the project site. The station will be equipped with all necessary instrumentation / equipment and manpower required for ensuring effective monitoring. The EMG at site will interact with State Pollution Control Board for all environmental issues during operation of the station.

8.4 Rapid EIA

Rapid environmental impact assessment report elaborates the assessment of the environmental scenario around the proposed Power plant, with air, water, soil, noise and socio-economic conditions.

8.5 Project Impact on Environment

The proposed project impacts on the environment in two distinct phases, Construction phase and Operation phase.

8.6 Demography & Socio-economic

Construction of any major project invariably leads to socio-economic changes. Large-scale influx of manpower, material and finance tends to change the economic status of the local community. The installation of the power station will activate the people in the area. The impacts would begin to be felt with the start of construction activities. The project will generate many employment opportunities for the local population especially during construction when the floating population would be at its peak. In addition to construction labour, the local population would get





business opportunities such as setting up of petty commercial establishments, small contracts for supply of locally available construction material, ancillary infrastructure etc. It is proposed to recruit a majority of the unskilled labour and skilled labour force, depending on the availability, from the local population. Such activity is bound to increase the economic conditions of the people in and around the power station area. Marked improvement can be expected in public life, infrastructure facilities, health, education and employment potential.

8.7 Clean Development Mechanism (CDM)

8.7.1 Overview of Kyoto Protocol

Climate change emerged on the political agenda in the mid-1980s with the increasing scientific evidence of human interference in the global climate system and with going public concern about the environment. Kyoto protocol was signed in 1997 and came into force since 16th February 2005 and protocol commits industrialized countries to reduce their greenhouse gas emissions by 5.2% below 1990 levels in 2008-12.

- Individual, quantified emission targets for each industrialized country.
- Six greenhouse gases covered: CO₂, CH₄, N₂O, HFC, PFC & SF₆

The protocol establishes three cooperative mechanisms as given below:

- Clean Development Mechanism (CDM)
- Joint Implementation (JI)
- International Emissions Trading

8.7.2 Clean Development Mechanism (CDM)

Clean Development Mechanism (CDM) allow emission reduction projects that assist developing countries in achieving sustainable development and the generated Certified Emission Reductions can be used by the industrialized countries or companies.

8.7.3 Projects Eligible Under Clean Development Mechanism

Renewable Energy	Hydro, Wind, Solar, Biomass, Bagasse, Geothermal, Tidal
Waste Heat Recovery	Cement, Steel/Metal Coke Ovens
Waste Management	Waste Water Management, MSW Management, Fuel pellets, Power Generation, Use as Fuel
Transportation	LPG, NG, Biodiesel, MRTS, Pipeline, Railways Shift
Process Change	Petroleum Refineries, Oil & Gas Refineries, Fertilizer CO ₂ Recovery, Nitrous Oxide (N ₂ O) Destruction, Refrigerant: HFC Abatement, Aluminum: PFC Control
Energy Efficiency	Efficient Generation (Efficient Machinery, T&D Loss Reduction, Thermal / Fuel, Steam Saving, Thermal Saving, Process Fly ash in Cement)
	Efficient Utilization (Energy efficiency measures for buildings and industries), Efficient Steam Utilization in Process
Industrial Fuel Switch	Fossil Fuel to Natural Gas, LPG Biomass
LULUCF	Plantation / Forestry, Afforestation, Reforestation

The purpose of the project activity is to set up Yadadri Thermal Power Station (5x800 MW), Telangana, India.



The fuel used in the power station will be blended coal (imported + coal) for generating electricity with super critical technology which leads to lower greenhouse gas emissions. In the absence of project activity the same power will be generated by fossil fuel fired plant is located in the region. Since the project will use cleaner fuel like natural gas the project is eligible for getting carbon credits under clean Development Mechanism of Kyoto Protocol.

8.7.4 Road Map Moving Ahead

The proposed project needs to be developed under CDM cycle to monetize the carbon credits envisaged from the project. Project will be developed as bilateral CDM project, with CER buyer. CER buyer will take the responsibility to develop and finance the subject project in CDM cycle. CDM Cycle involves following steps and these components will be taken care by CER buyer with no financial implication to TSGENCO.

8.7.5 CDM Project Cycle

1 Project Development

- Determine real emissions reduction:
 - ✓ Choose project boundary
 - ✓ Select project baseline
 - ✓ Set crediting period
 - ✓ Calculate emissions reductions
- Develop emissions monitoring and verification protocol
- Prepare investment plan and undertake financial analysis.



2. National Approval

- Carry out an Environmental Impact Assessment if required
- Obtain stakeholders comments
- Obtain host country approval.

3. Validation and Registration

- Prepare Project Design Document
- Operational Entity evaluates and validates project
- Executive Board registers project.

4. Verification and Certification

- Operational Entity verifies emissions reduction
- Executive Board certifies project and issues CERs.

8.7.6 GAS CYLINDERS (H₂, CO₂, N₂)

- The Hydrogen Gas shall be filled in the generator for cooling purposes. Hydrogen gas cylinders shall supply make up to the system.

The number of hydrogen gas cylinders for the plant shall be assessed in accordance with the following guidelines

N_1 = LX30XN where,

N_1 = Total Number of hydrogen Gas Cylinders required

L = Bidder shall specify normal leakage rate per day (not less than 2 cylinders per day)



N = Number of generator units, one (1)

The no. of hydrogen cylinders required for (4x800) MW units shall be computed as above or 750, whichever is higher.

- The Carbon di-oxide shall be used to purge the air out of the generator before initial filling or to purge out hydrogen during shut down condition. Total minimum quantity of Carbon-di-oxide cylinders to be supplied shall be minimum 225 nos.

The no. of Carbon dioxide cylinders required for the plant shall be assessed in accordance with the following guidelines.

$N_2 = [(M \times L) / V] + X$ where,

N_2 = Total No. of CO₂ Cylinders required for 4x800 MW unit

M = No. of fills required, to be taken as two (2) minimum

L = Total fill required for the turbo generator in NM³.

V = Volume occupied by CO₂ in each cylinder, in NM³.

X = No. of cylinders to be kept in stock additionally to account for unforeseen eventualities.

The no. of Carbon dioxide cylinders shall be computed as above or 75 whichever is higher.

- The Nitrogen gas shall be used for nitrogen capping of boiler parts, regenerative heaters etc. Total minimum quantity of nitrogen gas cylinders to be supplied shall be 150 nos.
- The water holding capacity of each H₂, N₂ & CO₂ Cylinder





shall be 46.7 liters.

- The H₂ & CO₂ cylinder shall conform to IS 8198/equivalent standard and gas cylinder rules.
- The nitrogen cylinders shall conform to IS 7285/equivalent standard and gas cylinder rules.
- Each cylinder shall be hydro-tested at a pressure of 250 kg/cm² (g) (minimum).
- The gas cylinders shall be located in a separate facility. Each cylinder shall have an integral isolating valve including cap & neck rings. The inlet side of these valves shall match with the threads of the cylinder neck ring and the outlet shall be as per IS 3224 (latest revision) /equivalent standard for further connection downstream.





ATTACHMENT – 8.1(A)

THERMAL POWER PLANTS: STACK HEIGHT / LIMITS

Generation Capacity	Stack Height (Meters)
500 MW and above	275
200 MW/210 MW and above to less than 500MW	220
Less than 200 MW/210 MW	$H = 14 (Q)^{0.3}$ Where Q is emission rate of SO ₂ in Kg/hr, and H is Stack height in meters.

Source: EPA Notification [G.S.R. 742 (E), dated 30th August 1990]

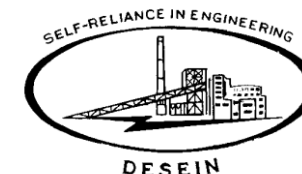




ATTACHMENT - 8.1(B)

INDIAN NATIONAL AMBIENT AIR QUALITY STANDARDS

S.No.	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (Notified by Central Government)	Methods of Measurement
(1)	(2)	(3)	(4)	(5)	(6)
1	Sulphur dioxide (SO ₂) µg/m ³	Annual*	50	20	- Improved West and Gaeke - Ultraviolet fluorescence
		24 hours**	80	80	
2	Nitrogen Dioxide (NO ₂)µg/m ³	Annual*	40	30	- Modified Jacob & Hochheiser (Na-Arsenite) - Chemiluminescence
		24 hours**	80	80	
3	Particulate Matter (size less than 10 µm) or PM ₁₀ µg/m ³	Annual*	60	60	- Gravimetric - TOEM - Beta attenuation
		24 hours**	100	100	





4	Particulate Matter (size less than 2.5µm) or PM _{2.5} µg/m ³	Annual*	40	40	- Gravimetric
		24 hours**	60	60	- TOEM - Beta attenuation
5	Ozone (O ₃) µg/m ³	8 hours**	100	100	- UV photometric
		1 hour**	180	180	- Chemiluminescence - Chemical Method
6	Lead (Pb) µg/m ³	Annual*	0.50	0.50	- AAS/ICP method after sampling on EPM 2000 or equivalent filter paper
		24 hours**	1.0	1.0	- ED-XRF using Teflon filter
7	Carbon Monoxide (CO) µg/m ³	8 hours**	02	02	- Non Dispersive Infra Red (NDIR)
		1 hour**	04	04	Spectroscopy
8	Ammonia (NH ₃) µg/m ³	Annual*	100	100	- Chemiluminescence
		24 hours**	400	400	- Indophenol blue method
9	Benzene (C ₆ H ₆) µg/m ³	Annual*	05	05	- Gas chromatography based continuous analyzer - Adsorption and Desorption followed by GC analysis





10	Benzo (a) Pyrene (BaP)- particulate phase only, $\mu\text{g}/\text{m}^3$	Annual*	01	01	- Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As), $\mu\text{g}/\text{m}^3$	Annual*	06	06	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni), $\mu\text{g}/\text{m}^3$	Annual*	20	20	- ASS /ICP method after sampling on EPM 2000 or equivalent filter paper

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 08 hourly or 01 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Note:- Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

Source: MoEF Notification GSR 826(F) dated 16.11.2009



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ATTACHMENT – 8.2(A)

**THERMAL POWER PLANT: STANDARDS FOR
LIQUID EFFLUENT**

Source	Parameter	Concentration not to be exceed, (mg/l) (except for pH)
Boiler blowdown	Suspended Solids	100
	Oil & Grease	20
	Copper (total)	1.0
	Iron (total)	1.0
Cooling Tower Blowdown	Free available Chlorine	0.5
	Zinc	1.0
	Chromium (Total)	0.2
	Phosphate	5.0
	Other corrosion inhibiting material	Limit to be established on case by case basis.
Ash Pond Effluent	pH	6.5 - 8.5
	Suspended Solid	100
	Oil & Grease	20

Source : EPA Notification [S.O. 844 (E), dated 19th November 1986].





Attachment – 8.2(B)

INDIAN GENERAL STANDARDS FOR DISCHARGE OF ENVIRONMENTAL POLLUTANTS: EFFLUENTS

S.No.	Parameters	Standards for discharge into/on			
		Inland Surface Water	Public Sewers	Land for Irrigation	Marine Coastal Areas
1.	Colour and odour	*	*	*	*
2.	Suspended solids, mg/l	100	600	200	(a) For process wastewater-100 (b) For cooling water effluent 10% above total suspended matter of influent
3.	Particle size of suspended solids	Shall pass 850 micron IS sieve	–	–	(a) Floatable solids, max. 3 mm (b) Settable solids, max. 850 microns
4.	pH value	5.5-9.0	5.5-9.0	5.5-9.0	5.5-9.0
5.	Temperature	Shall not exceed 5 ⁰ C above the receiving water temperature	–	–	Shall not exceed 7 ⁰ C ** above the receiving water temperature



6.	Oil and grease, mg/l	10	20	10	20
7.	Total residual chlorine, mg/l	1.0	-	-	1.0
8.	Ammonical nitrogen, mg/l	50	50	-	50
9.	Total Kjeldahl nitrogen (as N), mg/l	100	-	-	100
10.	Free ammonia (as NH ₃), mg/l	5.0	-	-	5.0
11.	Biochemical oxygen demand (5 days at 20 °C), mg/l	30	350	100	100
12.	Chemical oxygen demand, mg/l	250	-	-	250
13.	Arsenic (as As), mg/l	0.2	0.2	0.2	0.2
14.	Mercury (as Hg), mg/l	0.01	0.01	-	0.01
15.	Lead (as Pb), mg/l	0.1	1.0	-	2.0



16.	Cadmium (as Cd), mg/l	2.0	1.0	–	2.0
17.	Hexavalent chromium (as Cr ⁺⁶), mg/l	0.1	2.0	–	1.0
18.	Total chromium (as Cr),mg/l	2.0	2.0	–	2.0
19.	Copper (as Cu), mg/l	3.0	3.0	–	3.0
20.	Zinc (as Zn), mg/l	5.0	15	–	15
21.	Selenium (as Se), mg/l	0.05	0.05	–	0.05
22.	Nickel (as Ni), mg/l	3.0	3.0	–	5.0
23.	Cyanide (as Cn),mg/l	0.2	0.2	0.2	0.2
24.	Fluoride (as F), mg/l	2.0	15	–	15
25.	Dissolved phosphates (as P), mg/l	5.0	–	–	–
26.	Sulphide (as S), mg/l	2.0	–	–	5.0
27.	Phenolic compounds (as C ₆ H ₅ OH), mg/l	1.0	5.0	–	5.0



28.	Radioactive materials (a) Alpha emitters, uc/ml (b) Beta emitters, uc/ml	10^{-7} 10^{-6}	10^{-7} 10^{-6}	10^{-7} 10^{-6}	10^{-7} 10^{-6}
29.	Bio-assay test	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent
30.	Manganese (as Mn), mg/l	2.0	2.0	—	2.0
31.	Iron (as Fe), mg/l	3.0	3.0	—	3.0
32.	Vanadium (as V), mg/l	0.2	0.2	—	0.2
33.	Nitrate nitrogen, mg/l	10	—	—	20



Schedule VI inserted by Rule 2 (d) of the Environment (Protection) Third Amendment Rules,

** 1993 notified vide G.S.R. 801 (E) dated 31.12.1993.

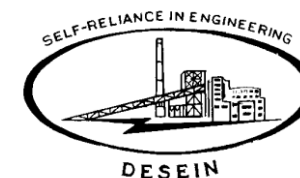
Source : *Pollution Control Acts, Rules and Notifications issued thereunder : Pollution Control Law PCL) / 2 / 1992, published by Member Secretary, Central Pollution Control Board*



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**AMBIENT AIR QUALITY STANDARDS IN RESPECT OF NOISE**

Area Code	Category of Area/Zone	Limits in dB(A) L_{eq}	
		Day Time	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

Note:	1.	Day time shall mean from 6.00 a.m. to 10.00 p.m.
	2.	Night time shall mean from 10.00 p.m. to 6.00 a.m.
	3.	Silence zone is an area comprising not less than 100 meters around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority.
	4.	Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.
	*dB (A) L_{eq} denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing	
	A "decibel" is a unit in which noise is measured.	
	"A" in dB (A) L_{eq} , denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear. Leq: It is an energy mean of the noise level over a specified period.	

Source: Ministry of Environment and Forests (MoEF) Notification (S.O. 123 (E) dated 14th February 2000), (S.O. 1046 (E) dated 22nd November 2000), (S.O. 1088 (E) dated 11 Oct. 2002), (S.O.1569 (E) dated 19th Sept. 2006) and SO 50 (E) dated 11th January 2010 under the Environment (Protection) Act 1986.





9.0 EXECUTION AND MANAGEMENT

9.1 General

TSGENCO will execute the project and also carry out operation and maintenance.

9.2 Infrastructure Facilities

The proposed coal based project is an extension project. Construction facilities being created for ongoing project will be augmented for timely and unhindered implementation of the Project.

Construction office space and covered storage space built during construction will be retained as offices, stores etc. after the power station is constructed.

In addition to the above, the facilities for the construction staff such as canteen, garage, yard toilets etc. will be provided.

9.2.1 Construction Water

The requirement of construction water is estimated to be about 1000 M³/hr during peak construction period. The water will be drawn from Krishna River.

9.3 PROJECT IMPLEMENTATION

The major phases of the project during its implementation are as follows:





- 1) Planning & Contract Packaging
- 2) Design, Engineering, Tendering & Contract award
- 3) Manufacturing, Inspection & Expediting
- 4) Construction, Erection & Commissioning
- 5) Operation & Maintenance and Manpower Training & Placement.

During construction phase, a team of engineers headed by Chief Engineer of TSGENCO supported by Implementation Consultant's Site Construction Manager & Construction supervision Engineers will supervise the activities of the EPC Contractor.

9.3.1 Planning & Contract Packaging

TSGENCO has entered in to a MOU for establishment of 6000 MW Thermal Power Plants with BHEL as EPC contractor in Telangana State. This proposed 5x800 MW Units is part of the 6000 MW capacity addition. The initial site development and enabling works will be carried out by TSGENCO through local contractors.

The project implementation can either be done through grouping the various system based packages or on EPC basis. Projects executed through packages route require break up of work for tendering and ordering of each package and coordination of various packages etc. through project organization and Consultants. This method entails some extra implementation period. This is due to time taken in preparation of detailed specifications with well defined boundaries and decision making on various packages. Further these results in deployment of large in-house staff for coordination.





In EPC route, the inter-package coordination between various sub vendors is the responsibility of the EPC contractor and his consultants and the contract can be on firm and fixed cost, subject to penalties for non-fulfillment of technical guarantees / delivery. This method further assures better quality of work due to vetting / approval of EPC contractors & sub-vendor's designs / drawings by EPC contractor's followed by vetting / approval by Owner's engineer.

The EPC route also generally finds favour with lending agencies / financial institutions due to contract being on fixed price with technical and commercial guarantees on a single point responsibility basis and less chances of cost / time overruns. Lower overall implementation period and that too at a fixed completion cost results in lower IDC and earlier availability of power.

In case of split package contracting, the packages may be as follows:

1. BTG
2. Civil Works
3. Misc. Balance of Plant (BoP) Systems
4. CHP
5. AHP
6. Water System

9.3.2

Design, Engineering, Tendering & Contract award

The basic engineering issues initiated during the Project Report stage will be addressed in a more focused manner during this phase. The engineering services plan and the schedule of the project engineering activities, within the time frame specified for the engineering milestones is finalized in the Master Network. The engineering programme at Level-





2 accordingly will show the dates for data availability, tender drawing release, specification release, bid evaluation and construction drawing release etc.

Based on the key event dates identified in the Master network, detailed plan for pre-award activities up to award of contract is finalized and monitored vigorously. When contracts are awarded, detailed programme in the form of networks are tied-up with the contractor to clearly establish the Owner's (TSGENCO) obligation and Contractor's responsibilities. The Owner's inputs in terms of land availability, construction power/water availability, civil fronts readiness etc., while that of the contractor's, in terms of drawing submission, manufacture, supply, transportation, erection & commissioning etc are clearly brought out in the program. Monthly progress reports are generated for monitoring & tracking purposes.

9.3.3 **Manufacturing, Inspection & Expediting**

All Contractors shall follow a comprehensive Quality Assurance and Control Program developed by TSGENCO / Consultant for entire project. The quality control and assurance activities would be supervised by the TSGENCO / Implementation Consultant and / or through the appointed offsite approved agencies for shop as well as field activities. Before the award of any contract the Quality Assurance Dept shall finalize a mutually acceptable inspection program and detailed quality plan with the prospective Contractors. In the post-contract stage, the inspection reports generated by the inspectors shall be reviewed to evaluate the quality status with respect to the specified levels and necessary coordination of all actions required to ensure the achievement of the planned quality levels. The quality plans after





discussions and finalization with the Contractor will form a part of the contract.

Expediting-visits will be made periodically to the works of equipment suppliers for inspection and ensuring that works progress as per schedules. This will be done in coordination with EPC contractor. The manufacturing & quality plans finalized at the time of contract award shall be utilized by the inspectors/expeditors for monitoring the manufacturing & quality status. Specified reports at regular intervals shall be submitted highlighting the areas of schedule variations, if any, their likely impact on delivery schedules, any recommendations for improvement etc.

9.3.4 **Construction, Erection & Commissioning**

The group involved in the implementation of the project will be headed by General Manager. He will be the overall in-charge of the project right from the beginning up to the commissioning stage. He will be responsible for all site activities and guide EPC Contractor to complete the job within the time frame. The technical wings of the organization will be headed by Deputy General Manager who will be assisted by Managers Engineers officers and staff for each discipline of activity

9.3.5 **O&M and Manpower Training & Placement**

The Operation and Maintenance of the plant will be organized by TSGENCO. The suggested organization for O&M is as per **Annexure - 9.0.**

The training of O&M personnel at various levels will be arranged through prevailing methods and practices of TSGENCO which include





computerized plant operation simulator, various audio visual aids, a well maintained library and most important the requisite set up for training activity.

These will be reinforced by:

- i. In plant training of operators at the site itself prior to commissioning of the plant.
- ii. Continued training of operators and maintenance staff through experts and supplier's staff as part of the in-plant training program.
- iii. Specialized training at various training institutes in the country.
- iv. Training, during manufacture, at supplier's works.

9.4

Role of Implementation Consultant

TSGENCO will appoint an Implementation Consultant to assist them throughout the development of the Project, from preparation of RFQ for the EPC Contractor till handing over of the Plant by the EPC Contractor.

The Implementation Consultant would engage multidisciplinary experienced engineering teams at their Home offices to undertake the various tasks related to the engineering, design, project implementation/management and monitoring. Apart from this, they would also provide necessary engineering back up support during construction, installation and commissioning at site. The drawings and documents generated by the contractor would be reviewed and checked/ approved by the Implementation Consultant to ensure the following:





- Compliance to the contract requirements
- Compliance to the various local/ statutory authorities
- Correct design and technology
- Seamless interfacing amongst various systems / equipment / sub-Contractors.

Further, Implementation Consultant will also be involved in shop inspection of various critical equipment / components in line with the agreed project quality assurance plan. Implementation Consultant will also be involved in ensuring field engineering / construction quality as well as ensuring that the contractor meet all guaranteed parameters during performance testing of the unit.

9.5 **Operation Philosophy**

The operation of the plant will be optimized by implementation of Operation Performance Management System. This system will clearly define the responsibilities of all key O&M personnel including the shift-in-charge. The Operation Performance Management System will also cover the system of daily reporting to TSGENCO Corporate Office and monthly O&M review meetings.

9.6 **Maintenance Philosophy**

The maintenance of the plant will be carried out as per the maintenance management system of TSGENCO presently being followed in all its operating plants. This system aims at maximising the availability of the generating units while ensuring minimum maintenance cost and safety of plant & personnel. The maintenance management system covers organizational structures, preventive maintenance schedules, detailed





work specifications covering all maintenance jobs, permit-to-work system, long term maintenance planning, safety aspects etc.

9.7

Completion Schedule

A bar chart giving the schedule for the major activities is shown in Project Schedule as **Annexure - 9.1**.

The project will be scheduled to go into commercial operation in 64 months from the 'zero date'.

Unit – I & III	52 Months
Unit – II & IV	58 Months
Unit - V	64 Months





10.0 COST ESTIMATES AND FINANCIAL ANALYSIS

10.1 Cost Estimates

An estimate of the total cost of the project has been made. The estimate has been made under three heads, namely Civil, Mechanical and Electrical.

The following factors have been taken into account in the preparation of the cost estimates:

1. Cost of spares has been taken as 4.0% of the equipment cost.
2. Excise duty 12.50% including education cess of equipment cost.
3. Freight @ 4% and insurance @ 1 % on the equipment cost have been taken.
4. CST @ 2% of equipment cost have been considered.
5. Erection, testing, commissioning has been taken @ 10% of equipment cost.
6. Service tax & education cess @ 14% has been considered on erection, testing & commissioning and freight & insurance cost.
7. Repayment of long term loan has been considered 15 years on quarterly basic considering a moratorium period of 2 years after commercial operation.
8. Projection of project cost has been done for 25 years economic life of Power Plant.





10.2 Financing Structure

It is proposed to finance the project such that Capital structure is built up of:

Equity Capital	-	30%
Debt Capital	-	70%

The equity capital will be funded by TSGENCO.

The financing of debt capital, comprising loan capital and interest during construction will be arranged from Indian Financial institutions.

10.3 Interest During Construction (IDC)

An interest rate of 12% has been considered for pre- commission.

Also the payment of interest has been worked out at the end of each quarter of construction period in line with financial institutions' requirements.

10.4 Working Capital

Provision for working capital requirement has been made in line with CERC/APERC guidelines.

- i. 1 month O&M expenses
- ii. 2 months receivables
- iii. 2 months fuel charges (coal)
- iv. 2 months support fuel charges
- v. Maintenance spares





10.5 Discounting factor has been considered as 13.10%.

10.6 Project Competition Period will be **64 Months** from 'Zero Date'.

10.7 **Cost of Generation**

Indices for working out cost of generation are given below. GOI guideline, APERC & CERC indices, wherever utilized, are marked with asterisk.

➤		Option-I (50% Imported + 50% Indian Coal)	Option –II (100% Imported Coal)
➤	Plant Capacity	5x800 MW	5x800 MW
➤	Auxiliary Energy Consumption	5.25%	5.25%
➤	Station Heat Rate (kcal/kwh)	2109.4	2109.4
➤	Depreciation	For first 12 years – 5.28% & for balance 13 years – 2.05%	For first 12 years – 5.28% & for balance 13 years – 2.05%
➤	O&M	2.29% escalated @ 4% every year	2.29% escalated @ 4% every year
➤	Loan Repayment period	15 years	15 years
➤	Interest on Loan	12.50% per annum	12.50% per annum
➤	Loan repayment	60 equal quarterly installments with 2 year moratorium	60 equal quarterly installments with 2 year moratorium
➤	GCV of coal (Design)	4550 kcal/kg	5700 kcal/kg
➤	Present day Coal Price	` 3675/tonne on delivered basis with 5% annual escalation	` 5300/tonne on delivered basis with 5% annual escalation
➤	GCV of Support fuel	10,000 kcal/kg	10,000 kcal/kg
➤	Support fuel present day price	` 55,000/tonnes for HFO/LDO	` 55,000/tonnes for HFO/LDO
➤	PLF	85%	85%





➤ Return on Capital Employed (RoCE)	13.65%	13.65%
➤ Completion Schedule	64 months	64 months
➤ Economic Life of plant	25 years	25 years

10.8

Cost of the Project

Cost of Project excluding IDC	Rs 21526.48 Crores	Rs 21526.48 Crores
Interest During Construction	Rs 3572.94 Crores	Rs 3572.94 Crores
Total Cost of Project including IDC	Rs 25099.42 Crores	Rs 25099.42 Crores
Cost per MW	Rs 6.27 Crores	Rs 6.27 Crores

10.9

Tariff

Levelling tariff at 85% PLF	Rs 4.57/ kwh	Rs 4.98/kwh
First year tariff at 85% PLF	Rs 3.98/ kwh	Rs 4.27/kwh

10.10

Financial Evaluations

Internal Rate of Return (IRR)	20.19%	20.41%
Average Debt Service Coverage Ratio (DSCR)	1.96	1.98

Capital cost and other financial computations are as per following tables.



Option			
100% Domestic Coal			
Unit	1 & 3	52	Months
Unit	2 & 4	58	Months
Unit	5	64	Months

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5X800 MW YADADRI THERMAL POWER PROJECT
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Exchange Rate: 1 USD = RS 64.50
* F.C- Foreign component in million US\$
** D.C Domestic Component in Rs Crores

Sl. No.	DESCRIPTION	COMPLETED COST							
		EPC Cost		Non-EPC Cost		Total Cost		Grand Total	Cost/MW
		F.C.*	D.C.**	F.C.*	D.C.**	F.C.*	D.C.**	Rs in crores	Rs Crores
1	Land & R&R issue				845.00		845.00	845.00	
2	Steam Generator, Turbine & generator with Auxiliaries (As per details at Sl. No. 1 - 5 of Mechanical Work)		7900.00		0.00		7900.00	7900.00	
3	Balance of Plant								
I)	Mechanical		3902.30		185.00		4087.30	4087.30	
II)	Electrical and C&I		730.00		10.50		740.50	740.50	
4	Sub Total of Equipment Cost		12532.30		195.50		12727.80	12727.80	
5	GST @ 18% of S.No. 4		2255.81		35.19		2291.00	2291.00	
6	Initial Spares		300.78		4.69		305.47	305.47	
7	GST @ 18% of S.No. 6		54.14		0.84		54.98	54.98	
8	Equipment Cost including Spares		12833.08		200.19		13033.27	13033.27	
9	Equipment Cost incl. duties, taxes & spares		15143.03		236.22		15379.26	15379.26	
10	Freight & Insurance on Sl. No. 4		250.65		5.61		256.26	256.26	
11	Freight & Insurance on Sl. No. 6		6.77		0.14		6.91	6.91	
12	Total Equipment Cost incl. Freight & Insurance		15400.45		241.97		15642.43	15642.43	
13	GST @ 18% of S.No. 10		45.12		1.01		46.13	46.13	
14	GST @ 18% of S.No. 11		1.22		0.03		1.24	1.24	
15	Unloading at site, site handling, Erection, Testing & Commissioning on Sl. No. 4		1697.44		19.55		1716.99	1716.99	
16	GST @ 18% of S.No. 15		305.54		3.52		309.06	309.06	
17	Civil Works		3160.00		1897.50		5057.50	5057.50	
18	GST @ 18% of Sl. No. 17		568.80		341.55		910.35	910.35	
19	Total works Cost		5778.11		2263.15		8041.27	8041.27	
20	Contingency @2.5% of Total works i.e. Sl. No.19		144.45		56.58		201.03	201.03	
21	Sub Total - EPC & NON-EPC Cost		21323.02		3406.71		24729.73	24729.73	6.18
22	Establishment Costs including Head quarter charges @3% of Sl. No. 21				741.89		741.89	741.89	
23	Consultancy & Engineering				40.00		40.00	40.00	
24	Start up Fuel				50.00		50.00	50.00	
25	Operator training				6.00		6.00	6.00	
26	Total Hard Cost		21323.02		4244.60		25567.62	25567.62	6.39
27	IDC & Financing Cost								
i)	Financing Expenses @0.05% of Sl. No. 21				12.36		12.36	12.36	
ii)	Interest During Construction				4265.63		4265.63	4265.63	
28	CSR @0.4% of Total Project Cost				119.86		119.86	119.86	
29	Total Project cost including IDC & FC		21323.02		8642.46		29965.48	29965.48	7.49

**COST ESTIMATE
MECHANICAL WORKS**

FE Rate 1 US\$ = Rs 64.50

Sl. No.	DESCRIPTION	EPC Cost	Non-EPC	Total Cost
		(Rs Crores)	(Rs Crores)	(Rs Crores)
1	Steam Generator with associated auxiliaries	7900.00		7900.00
2	Electrostatic precipitators			
3	Turbine Generator with associated auxiliaries			
4	Power Cycle Equipment			
5	Power Cycle Piping			
6	Condensate Polishing Plant	55.00		55.00
7	EOT Cranes	5.00		5.00
8	C&I including DAS	100.00		100.00
9	Coal Handling System	350.00		350.00
10	Fuel Oil Handling System	45.00		45.00
11	Ash handling System	200.00		200.00
12	CW Pumps	100.00		100.00
13	Make up Water System	100.00		100.00
14	Cooling Towers (NDCT) fills, nozzles etc.	20.00		20.00
15	Water Treatment Plant	15.00		15.00
16	Compressed Air System	45.00		45.00
17	Effluent Treatment Plant	5.00		5.00
18	Miscellaneous Pumps	35.00		35.00
19	Hydrogen Generation Plant	20.00		20.00
20	Station Piping	50.00		50.00
21	Fire Protection System	40.00		40.00
22	Air Conditioning & Ventilation	32.00		32.00
23	Workshop & Lab Equipment	5.00		5.00
24	Hoisting Equipment	2.50		2.50
25	Diesel Generator	12.00		12.00
26	Equipment Cooling System	15.00		15.00
27	Weigh Bridge	0.80		0.80
28	Signaling & Telecommunication and Marshalling yard and Railway line		185.00	185.00
29	HCS system for wet fly ash handling system	100.00		100.00
30	RO for treating cooling tower blow down water	50.00		50.00
31	SCR & FGD	2500.00		2500.00
	TOTAL	11802.30	185.00	11987.30

**COST ESTIMATE
ELECTRICAL WORKS**

FE Rate 1 US \$ = Rs 64.50

Sl. No.	DESCRIPTION	EPC Cost	Non-EPC Cost	Total Cost
		(Rs Crores)	(Rs Crores)	(Rs Crores)
A	Electrical System			
1	Generator Transformers	60.00		60.00
2	Unit Transformers	15.00		15.00
3	Generator Circuit Breaker	30.00		30.00
4	LT Outdoor Transformers	10.00		10.00
5	LT Indoor Transformers			
6	Generator Bus Duct	70.00		70.00
7	HT Switch gear	150.00		150.00
8	HT Bus duct	45.00		45.00
9	LT Switch gear	55.00		55.00
10	D.C. Battery & Charger	25.00		25.00
11	Station lighting System	20.00		20.00
12	Control & Relay Panels	15.00		15.00
13	HT Power Cables.	140.00		140.00
14	LT Power Cables			
15	Control Cables			
16	Cabling, earthing & Lightning Protection	10.00		10.00
17	Unit Aux. Transformer	30.00		30.00
	Sub-Total (A)	675.00	0.00	675.00
B.	Switchyard (400 kv)	40.00		40.00
	Bus reactors	15.00		15.00
	Sub-Total (B)	55.00	0.00	55.00
C.	IT, SAP & Telecommunications including software development		5.50	5.50
D.	CCTV & Wi-Fi facility		5.00	5.00
	TOTAL (A+B+C+D)	730.00	10.50	740.50

**COST ESTIMATE
PRELIMINARY & CIVIL WORKS**

Sl. No.	DESCRIPTION	EPC Cost	Non-EPC Cost	Total Cost
		(Rs Crores)	(Rs Crores)	(Rs Crores)
1	Land & R&R issue		845.00	845.00
2	Survey & Soil Investigation		2.50	2.50
3	Site Clearance & Leveling	341.00		341.00
4	Non Plant buildings including Administrative & service buildings, Roads, Bridges,Culverts, drains etc.		470.00	470.00
5	Marshalling yard and railway line		450.00	450.00
6	Boundary Wall (45 km) & Permanent fencing		75.00	75.00
7	Enabling Works (Site office, Construction power, Water etc.)		150.00	150.00
8	Permanent Township		400.00	400.00
9	Foundations	375.00		375.00
10	General Civil Works	250.00		250.00
11	Structural Steel Works	425.00		425.00
12	Chimney	375.00		375.00
13	Coal Handling System	350.00		350.00
14	Fuel Oil Handling System	30.00		30.00
15	CW System	125.00		125.00
16	External Water System including piping		175.00	175.00
17	Water Treatment Plant	50.00		50.00
18	Cooling Tower (NDCT)	500.00		500.00
19	Civil work for FGD, SCR & ESP etc.	100.00		100.00
20	Ash handling System	150.00		150.00
21	Ash pond		125.00	125.00
22	Green Belt & Other Soil Erosion mitigation measurs committed to forest department		50.00	50.00
23	RCC Pavement for crushed coal storage yard	39.00		39.00
24	Raw Coal Storage yard	50.00		50.00
	TOTAL	3160.00	2742.50	5057.50

TSGENCO
5X800 MW YADADRI THERMAL POWER PROJECT
DETAILED PROJECT REPORT

Phasing of Expenditure & IDC Calculation

Rs (All Figures in Rs)

Project Cost without IDC	25699.85	Crores
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Unit	Rs	Project Cost without IDC	IDC	Project Cost with IDC
1 & 3	Crores	12849.92	2077.99	14927.91
2 & 4	Crores	7709.95	1293.23	9003.18
5	Crores	5139.97	894.42	6034.39
Total	Crores	25699.85	4265.63	29965.48

TSGENCO
5X800 MW YADADRI THERMAL POWER PROJECT
DETAILED PROJECT REPORT

Phasing of Expenditure & IDC Calculation

(All Figures in Rs)

Project Cost without IDC			12849.92	Crores	IDC 2077.99 Crores														
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TSGENCO
5X800 MW YADADRI THERMAL POWER PROJECT
DETAILED PROJECT REPORT

Phasing of Expenditure & IDC Calculation

(All Figures in Rs)

Project Cost without IDC			7709.95	Crores	IDC 1293.23 Crores																
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TSGENCO
5X800 MW YADADRI THERMAL POWER PROJECT
DETAILED PROJECT REPORT

Phasing of Expenditure & IDC Calculation

(All Figures in Rs)

Project Cost without IDC			5139.97	Crores	IDC 894.42 Crores 14.82%																		
Project Completion Period			64	months																			
Debt(%)			70																				
Debt (including IDC)			4224.07	Crores																			
Equity(%)			30																				
Equity			1810.32	Crores																			
Project Cost including IDC			6034.39	Crores																			
Rate of interest			12.00	%																			
No. of Installment/year			4																				
Quarterly Installment		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Phased Expenditure(%)	Unit - 5	10					2.5	2.5	2.5	2.5	2.5	5	5	5	5	5	5	5	7.5	7.5	7.5	10	10
Total Phased Expenditure(%)		10.00	0.00	0.00	0.00	0.00	2.50	2.50	2.50	2.50	2.50	5.00	5.00	5.00	5.00	5.00	5.00	5.00	7.50	7.50	7.50	10.00	10.00
Phased Expenditure		514.00	0.00	0.00	0.00	0.00	128.50	128.50	128.50	128.50	128.50	257.00	257.00	257.00	257.00	257.00	257.00	257.00	385.50	385.50	385.50	514.00	514.00
Fund Requirement arranged from	Equity	154.20	0.00	0.00	0.00	0.00	38.55	38.55	38.55	38.55	38.55	77.10	77.10	77.10	77.10	77.10	77.10	77.10	115.65	115.65	115.65	154.20	154.20
	Debt	359.80	0.00	0.00	0.00	0.00	89.95	89.95	89.95	89.95	89.95	179.90	179.90	179.90	179.90	179.90	179.90	179.90	269.85	269.85	269.85	359.80	359.80
Opening Balance	Equity	0.00	155.82	159.09	162.43	165.84	169.33	211.84	255.24	299.55	344.80	390.99	477.11	565.04	654.82	746.48	840.06	935.61	1033.17	1171.73	1313.20	1457.64	1644.07
	Debt	0.00	363.58	371.21	379.01	386.97	395.09	494.28	595.56	698.96	804.53	912.32	1113.26	1318.43	1527.91	1741.78	1960.15	2183.10	2410.73	2734.04	3064.13	3401.16	3836.16
Total Equity		154.20	155.82	159.09	162.43	165.84	207.87	250.39	293.79	338.10	383.35	468.09	554.21	642.14	731.92	823.58	917.16	1012.71	1148.82	1287.38	1428.85	1611.84	1798.27
Total Debt		359.80	363.58	371.21	379.01	386.97	485.04	584.23	685.51	788.91	894.48	1092.22	1293.16	1498.33	1707.80	1921.68	2140.04	2363.00	2680.58	3003.88	3333.98	3760.96	4195.96
IDC		5.40	10.91	11.14	11.37	11.61	13.20	16.18	19.22	22.32	25.49	30.07	36.10	42.25	48.54	54.95	61.50	68.19	76.37	86.07	95.97	107.43	40.16
Arrangement of Interest & Upfront payment from	Equity	1.62	3.27	3.34	3.41	3.48	3.96	4.85	5.76	6.70	7.65	9.02	10.83	12.68	14.56	16.49	18.45	20.46	22.91	25.82	28.79	32.23	12.05
	Debt	3.78	7.64	7.80	7.96	8.13	9.24	11.32	13.45	15.62	17.84	21.05	25.27	29.58	33.97	38.47	43.05	47.73	53.46	60.25	67.18	75.20	28.11
Closing Balance of	Equity	155.82	159.09	162.43	165.84	169.33	211.84	255.24	299.55	344.80	390.99	477.11	565.04	654.82	746.48	840.06	935.61	1033.17	1171.73	1313.20	1457.64	1644.07	1810.32
	Debt	363.58	371.21	379.01	386.97	395.09	494.28	595.56	698.96	804.53	912.32	1113.26	1318.43	1527.91	1741.78	1960.15	2183.10	2410.73	2734.04	3064.13	3401.16	3836.16	4224.07
Debt : Equity Ratio		2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33
Net Requirement of Fund	Equity	155.82	3.27	3.34	3.41	3.48	42.51	43.40	44.31	45.25	46.20	86.12	87.93	89.77	91.66	93.59	95.55	97.56	138.56	141.47	144.44	186.43	166.25
	Debt	363.58	7.64	7.80	7.96	8.13	99.19	101.27	103.40	105.57	107.79	200.95	205.17	209.47	213.87	218.37	222.95	227.63	323.31	330.10	337.03	435.00	387.91

TSGENCO
5X800 MW YADADRI THERMAL POWER PROJECT
DETAILED PROJECT REPORT

Base Case:	5x800 MW TPP
Plant Load Factor (PLF):	85%

Capacity (MW)	4000
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Project Cost	
US\$	0.00
Rs (Crores)	29965.48
Total Eq. Rs (Crores)	29965.48
FINANCING	
DEBT	
US\$ (Million)	0.00
Rs (Million)	20975.84
Total Debt Rs (Crores)	20975.84
EQUITY	
US\$ (million)	0.00
Rs (Crores)	8989.64
Total Equity Rs (Crores)	8989.64

70%

30%

Fuel	%	GCV	Price	Annual Esclation
Domestic Coal	100%	4550	3875	4.0%
Annual Esclation				
Fuel	Coal	Support fuel	HFO	
Price	3875 Rs/tonne	Price	55000 Rs/tonne	
GCV	4550 Kcal/Kg	GCV	10000 Kcal/Kg	
Transportation Charge (incl. Above)		Transportation charge(incl.above)		
SHR	2151.0 kCal/kWh	Oil Consumption	0.50 ml/kwh	
Aux. Cons	6.57%	Sp.Gr.	0.90	
Dep'tion for 1-12 years	5.28%			
Dep'tion for 13-25 years	2.05%			
Present				
exch. rate	64.50 Rs/US\$			
RoCE	13.65%			
Dis'ting				
Factor	13.10%			
Int. on				
Long term				
loan	12.50%			
O&M Cost	1.92%	4.00% Annual Esc.		

LEVELLIZED TARIFF AT 85% PLF
FIRST YEAR TARIFF AT 85% PLF

4.95
4.57

Rs/KWh
Rs/KWh

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
US\$ Exchange Rate	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50
Coal price Rs/tonne	3875.00	4030.00	4191.20	4358.85	4533.20	4714.53	4903.11	5099.24	5303.21	5515.33	5735.95	5965.38	6204.00	6452.16	6710.25	6978.66	7257.80	7548.11	7850.04	8164.04	8490.60	8830.23	9183.44	9550.77	9932.80
Transportation Cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coal price at site Rs/tonne	3875.00	4030.00	4191.20	4358.85	4533.20	4714.53	4903.11	5099.24	5303.21	5515.33	5735.95	5965.38	6204.00	6452.16	6710.25	6978.66	7257.80	7548.11	7850.04	8164.04	8490.60	8830.23	9183.44	9550.77	9932.80
Supp.Fuel price Rs/tonne	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00
Transportation Cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
supp.Fuel site price Rs/tonne	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00
Gross Units Generated	Million Units (MU)																								
PLF	85%	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00
Net Units Sent Out	Million Units (MU)																								
PLF	85%	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45	27826.45
Coal Charge Rs/Kwh	1.83	1.91	1.98	2.06	2.14	2.23	2.32	2.41	2.51	2.61	2.71	2.82	2.93	3.05	3.17	3.30	3.43	3.57	3.71	3.86	4.01	4.17	4.34	4.52	4.70
Total Variable Charge Rs/kwh	1.83	1.91	1.98	2.06	2.14	2.23	2.32	2.41	2.51	2.61	2.71	2.82	2.93	3.05	3.17	3.30	3.43	3.57	3.71	3.86	4.01	4.17	4.34	4.52	4.70
Total Variable Cost	Rs (Crores)																								
PLF	85%	5456.12	5674.36	5901.34	6137.39	6382.89	6638.20	6903.73	7179.88	7467.07	7765.76	8076.39	8399.44	8735.42	9084.84	9448.23	9826.16	10219.21	10627.97	11053.09	11495.22	11955.03	12433.23	12930.56	13447.78

Working Capital																									
Fuel Charges 85% (2 months)	909.35	945.73	983.56	1022.90	1063.81	1106.37	1150.62	1196.65	1244.51	1294.29	1346.06	1399.91	1455.90	1514.14	1574.71	1637.69	1703.20	1771.33	1842.18	1915.87	1992.50	2072.20	2155.09	2241.30	2330.95
Support fuel charges (2 Months)	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29
O&M (1 Month)	48.00	49.92	51.92	53.99	56.15	58.40	60.74	63.16	65.69	68.32	71.05	73.89	76.85	79.92	83.12	86.45	89.90	93.50	97.24	101.13	105.17	109.38	113.76	118.31	123.04
Maintenance spares	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65	299.65
Receivables (2 Months)	2117.94	2160.18	2207.10	2219.36	2233.46	2249.45	2267.42	2286.95	2309.12	2333.51	2433.90	2462.46	2327.06	2360.75	2397.16	2436.40	2478.57	2518.97	2601.64	2687.61	2777.03	2870.02	2966.73	3067.31	3171.91
Working Capital at 85%	3387.23	3467.77	3554.51	3608.19	3665.36	3726.16	3790.72	3858.71	3931.26	4008.06	4162.96	4248.20	4171.76	4266.76	4366.93	4472.48	4583.62	4695.74	4853.00	5016.55	5186.65	5363.54	5547.52	5738.85	5937.84

FINANCIAL ANALYSIS:Projected Profit & Loss account for 25 years at 85% PLF																										
All figures are in Rs (Crores)																										
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
1	Income from sale of power @ cost of annual generation	12887.50	13144.56	13430.03	13504.67	13590.43	13687.75	13797.11	13915.95	14050.83	14199.24	14810.11	14983.92	14160.01	14365.02	14586.57	14825.32	15081.95	15327.75	15830.78	16353.94	16898.02	17463.86	18052.34	18664.35	19300.85
2	Other Income	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	Total Income (1+2)	12887.50	13144.56	13430.03	13504.67	13590.43	13687.75	13797.11	13915.95	14050.83	14199.24	14810.11	14983.92	14160.01	14365.02	14586.57	14825.32	15081.95	15327.75	15830.78	16353.94	16898.02	17463.86	18052.34	18664.35	19300.85
4	Cost of fuel	5456.12	5674.36	5901.34	6137.39	6382.89	6638.20	6903.73	7179.88	7467.07	7765.76	8076.39	8399.44	8735.42	9084.84	9448.23	9826.16	10219.21	10627.97	11053.09	11495.22	11955.03	12433.23	12930.56	13447.78	13985.69
5	Operation & Maintenance	576.00	599.04	623.00	647.92	673.84	700.79	728.82	757.98	788.30	819.83	852.62	886.73	922.19	958.88	997.45	1037.34	1078.84	1121.99	1166.87	1213.55	1262.09	1312.57	1365.07	1419.68	1476.46
6	Earning before interest, depreciation,tax (EBDIT) (3-4-5)	6855.38	6871.16	6905.69	6719.35	6533.70	6348.76	6164.56	5978.10	5795.46	5613.65	5881.10	5697.75	4502.40	4321.10	4140.89	3961.81	3783.91	3577.78	3610.82	3645.17	3680.90	3718.06	3756.71	3796.90	3838.70
7	Depreciation	1582.18	1582.18	1582.18	1582.18	1582.18	1582.18	1582.18	1582.18	1582.18	1582.18	1582.18	1582.18	614.29	614.29	614.29	614.29	614.29	614.29	614.29	614.29	614.29	614.29	614.29	614.29	614.29
8	Earning before interest, tax (EBIT) (6-7)	5273.20	5288.98	5323.51	5137.18	4951.52	4766.58	4582.38	4395.92	4213.28	4031.48	4298.92	4115.58	3888.11	3706.81	3526.60	3347.52	3169.61	2963.49	2996.53	3030.88	3066.61	3103.77	3142.42	3182.61	3224.41
9	Interest on working capital	423.40	433.47	444.31	451.02	458.17	465.77	473.84	482.34	491.41	501.01	520.37	531.03	521.47	533.34	545.87	559.06	572.95	586.97	606.62	627.07	648.33	670.44	693.44	717.36	742.23
10	Interest on Long-term loan	2621.98	2621.98	2556.43	2381.63	2206.83	2032.03	1857.24	1693.36	1518.56	1343.76	1168.97	994.17	819.37	644.57	469.77	294.97	120.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	Profit before tax (PBT) (8-9-10)	2227.82	2233.53	2322.77	2304.52	2286.52	2268.78	2251.30	2220.22	2203.31	2186.71	2609.58	2590.38	2547.27	2528.90	2510.96	2493.49	2476.49	2376.53	2389.90	2403.81	2418.28	2433.33	2448.98	2465.25	2482.18
12	Tax (MAT @ 20.9605% on PBT for first 10 yrs)	466.96	468.16	486.86	483.04	479.27	475.55	471.88	465.37	461.83	458.34	887.00	880.47	865.82	859.57	853.48	847.54	841.76	807.78	812.33	817.06	821.97	827.09	832.41	837.94	843.69
13	Profit after tax (PAT) (11-12)	1760.86	1765.37	1835.90	1821.48	1807.25	1793.23	1779.42	1754.85	1741.49	1728.36	1722.59	1709.91	1681.45	1669.32	1657.49	1645.95	1634.73	1568.74	1577.57	1586.76	1596.31	1606.24	1616.57	1627.31	1638.48
DSCR Calculation																										
	EBDIT	6855.38	6871.16	6905.69	6719.35	6533.70	6348.76	6164.56	5978.10	5795.46	5613.65	5881.10	5697.75	4502.40	4321.10	4140.89	3961.81	3783.91	3577.78	3610.82	3645.17	3680.90	3718.06	3756.71	3796.90	3838.70
	Interest	2621.98	2621.98	2556.43	2381.63	2206.83	2032.03	1857.24	1693.36	1518.56	1343.76	1168.97	994.17	819.37	644.57	469.77	294.97	120.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Principal Repayment	0.00	0.00	1398.39	1398.39	1398.39	1398.39	1398.39	1398.39	1398.39	1398.39	1398.39	1398.39	1398.39	1398.39	1398.39	1398.39	1398.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	DSCR	2.61	2.62	1.75	1.78	1.81	1.85	1.89	1.93	1.99	2.05	2.29	2.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Average DSCR	2.01																								

[illegible]

Option - I			
50% Imported Coal + 50% Domestic Coal			
Unit	1 & 3	52	Months
Unit	2 & 4	58	Months
Unit	5	64	Months

TSGENCO
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DETAILED PROJECT REPORT

Exchange Rate: 1 USD = ₹ 64.50
* F.C- Foreign component in million US\$
** D.C Domestic Component in ₹ Crores

Sl. No.	DESCRIPTION	COMPLETED COST							
		EPC Cost		Non-EPC Cost		Total Cost		Grand Total	Cost/MW
		F.C.*	D.C**	F.C.*	D.C.**	F.C.*	D.C.**	₹ in crores	₹ in crores
1	Land & R&R issue				845.00		845.00	845.00	
2	Steam Generator, Turbine & generator with Auxiliaries (As per details at Sl. No. 1 - 5 of Mechanical Work)		8200.00		0.00		8200.00	8200.00	
3	Balance of Plant								
I)	Mechanical		1152.31		130.50		1282.81	1282.81	
II)	Electrical and C&I		840.00		5.50		845.50	845.50	
4	Sub Total of Equipment Cost		10192.31		136.00		10328.31	10328.31	
5	Initial Spares @4% of Sl.No. 4		407.69		5.44		413.13	413.13	
6	Equipment Cost including Spares		10600.00		141.44		10741.44	10741.44	
7	Custom Duty @26.53% of Sl. No. 6 on Foreign Component		0.00		0.00		0.00	0.00	
8	Excise Duty of Sl. No. 6 on Domestic Component		1325.00		17.68		1342.68	1342.68	
9	CST @2% of Sl. No. 6		212.00		2.83		214.83	214.83	
10	Equipment Cost incl. duties, taxes & spares		12137.00		161.95		12298.95	12298.95	
11	Freight (4%) & Insurance (1%) on Sl. No. 6		530.00		7.07		537.07	537.07	
12	Total Equipment Cost incl. Freight & Insurance		12667.00		169.02		12836.02	12836.02	
13	Erection, Testing & Commissioning @10% of Sl. No. 4		1019.23		13.60		1032.83	1032.83	
14	Civil Works		4150.00		927.50		5077.50	5077.50	
15	Excise Duty @12.50% on (40% of Civil Works)		207.50		46.38		253.88	253.88	
16	VAT@ 5% on (27% of civil cost) & Sl. No. 15		66.40		14.84		81.24	81.24	
17	Service Tax @12.36% of Sl. No. 11, 13 & (33% of Sl. No. 14).		360.76		40.39		401.14	401.14	
18	Total works Cost		5803.89		1042.70		6846.59	6846.59	
19	Contingency @2.5% of Total works i.e. Sl. No.18		145.10		26.07		171.16	171.16	
20	Sub Total - EPC & NON-EPC Cost		18615.98		2082.79		20698.77	20698.77	5.17
21	Establishment Costs including Head quarter charges @3% of Sl. No. 20				620.96		620.96	620.96	
22	Consultancy & Engineering				40.00		40.00	40.00	
23	Start up Fuel				50.00		50.00	50.00	
24	Operator training				6.00		6.00	6.00	
25	Total Hard Cost		18615.98		2799.75		21415.73	21415.73	5.35
26	IDC & Financing Cost								
I)	Financing Expenses @0.05% of Sl. No. 20				10.35		10.35	10.35	
II)	Interest During Construction				3572.94		3572.94	3572.94	
27	Margin Money				0.00		0.00	0.00	
28	CSR @0.4% of Total Project Cost				100.40		100.40	100.40	
29	Total Project cost including IDC & FC		18615.98		6483.44		25099.42	25099.42	6.27

**COST ESTIMATE
MECHANICAL WORKS**

FE Rate 1 US\$ = ₹ 64.50

Sl. No.	DESCRIPTION	EPC Cost	Non-EPC	Total Cost
		(₹ in Crores)	(₹ in Crores)	(₹ in Crores)
1	Steam Generator with associated auxiliaries	8200.00		8200.00
2	Electrostatic precipitators			
3	Turbine Generator with associated auxiliaries			
4	Power Cycle Equipment			
5	Power Cycle Piping			
6	Condensate Polishing Plant	55.00		55.00
7	EOT Cranes	5.00		5.00
8	C&I including DAS	125.00		125.00
9	Coal Handling System	350.00		350.00
10	Fuel Oil Handling System	45.00		45.00
11	Ash handling System	200.00		200.00
12	CW Pumps	100.00		100.00
13	Make up Water System	100.00		100.00
14	Cooling Towers (NDCT) fills, nozzles etc.	20.00		20.00
15	Water Treatment Plant	15.00		15.00
16	Compressed Air System	45.00		45.00
17	Effluent Treatment Plant	5.00		5.00
18	Miscellaneous Pumps	35.00		35.00
19	Hydrogen Generation Plant	20.00		20.00
20	Station Piping	50.00		50.00
21	Fire Protection System	40.00		40.00
22	Air Conditioning & Ventilation	32.00		32.00
23	Workshop & Lab Equipment	5.00		5.00
24	Hoisting Equipment	2.50		2.50
25	Diesel Generator	12.00		12.00
26	Equipment Cooling System	15.00		15.00
27	Weigh Bridge	0.81		0.81
28	Signaling & Telecommunication and Marshalling yard and Railway line		130.50	130.50
	TOTAL	9477.31	130.50	9607.81

**COST ESTIMATE
ELECTRICAL WORKS**

FE Rate 1 US \$ = ₹ 64.50

Sl. No.	DESCRIPTION	EPC Cost	Non-EPC Cost	Total Cost
		(₹ in Crores)	(₹ in Crores)	(₹ in Crores)
A	Electrical System			
1	Generator Transformers	60.00		60.00
2	Unit Transformers	15.00		15.00
3	Generator Circuit Breaker	30.00		30.00
4	LT Outdoor Transformers	10.00		10.00
5	LT Indoor Transformers			
6	Generator Bus Duct	70.00		70.00
7	HT Switch gear	150.00		150.00
8	HT Bus duct	45.00		45.00
9	LT Switch gear	55.00		55.00
10	D.C. Battery & Charger	25.00		25.00
11	Station lighting System	20.00		20.00
12	Control & Relay Panels	15.00		15.00
13	HT Power Cables.	140.00		140.00
14	LT Power Cables			
15	Control Cables			
16	Cabling, earthing & Lightning Protection	10.00		10.00
17	Unit Aux. Transformer	30.00		30.00
	Sub-Total (A)	675.00	0.00	675.00
B.	Switchyard (400 kv)	40.00		40.00
	Sub-Total (B)	40.00	0.00	40.00
C.	IT, SAP & Telecommunications including software development		5.50	5.50
	Sub-Total (C)	0.00	5.50	5.50
	TOTAL (A+B+C)	715.00	5.50	720.50

**COST ESTIMATE
PRELIMINARY & CIVIL WORKS**

(₹ in Crores)

Sl. No.	DESCRIPTION	EPC Cost	Non-EPC Cost	Total Cost
		(₹ in Crores)	(₹ in Crores)	(₹ in Crores)
1	Land & R&R issue		845.00	845.00
2	Survey & Soil Investigation		2.50	2.50
3	Site Clearance & Leveling	175.00		175.00
4	Roads, Bridges,Culverts, drains etc.	250.00		250.00
5	Marshalling yard and railway line		125.00	125.00
6	Boundary Wall (45 km) & Permanent fencing		45.00	45.00
7	Enabling Works (Site office, Construction power, Water etc.)		150.00	150.00
8	Permanent Township		300.00	300.00
9	Administrative & Service Buildings	50.00		50.00
10	Foundations	750.00		750.00
11	General Civil Works	350.00		350.00
12	Structural Steel Works	650.00		650.00
13	Chimney	400.00		400.00
14	Coal Handling System	375.00		375.00
15	Fuel Oil Handling System	55.00		55.00
16	CW System	125.00		125.00
17	External Water System including piping		150.00	150.00
18	Water Treatment Plant	65.00		65.00
19	Cooling Tower (NDCT)	525.00		525.00
20	Misc. Civil Works	80.00	5.00	85.00
21	Ash handling System	300.00		300.00
22	Ash pond		100.00	100.00
23	Green Belt & Other Soil Erosion mitigation measurs committed to forest department		50.00	50.00
	TOTAL	4150.00	1772.50	5077.50

TSGENCO
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Phasing of Expenditure & IDC Calculation

(All Figures in ₹)

Project Cost without IDC	21526.48	Crores
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Unit	₹	Project Cost without IDC	IDC	Project Cost with IDC
1 & 3	Crores	10763.24	1740.55	12503.79
2 & 4	Crores	6457.94	1083.22	7541.16
5	Crores	4305.30	749.17	5054.47
Total	Crores	21526.48	3572.94	25099.42

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Phasing of Expenditure & IDC Calculation

(All Figures in ₹)

Project Cost without IDC			10763.24	Crores		IDC 1740.55 Crores														
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TSGENCO
5X800 MW YADADRI THERMAL POWER PROJECT
DETAILED PROJECT REPORT

Phasing of Expenditure & IDC Calculation

(All Figures in ₹)

Project Cost without IDC			6457.94	Crores
Project Completion Period			58	months
Debt(%)			70	
Debt (including IDC)			5278.81	Crores
Equity(%)			30	
Equity			2262.35	Crores
Project Cost including IDC			7541.16	Crores
Rate of interest			12.00	%
No. of Installment/year			4	

IDC 1083.22 Crores 14.36%

Quarterly Installment		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Phased Expenditure(%)	Unit - 2 & 4	10			2.5	2.5	2.5	2.5	2.5	5	5	5	5	5	5	5	7.5	7.5	7.5	10	10
Total Phased Expenditure(%)		10.00	0.00	0.00	2.50	2.50	2.50	2.50	2.50	5.00	5.00	5.00	5.00	5.00	5.00	5.00	7.50	7.50	7.50	10.00	10.00
Phased Expenditure		645.79	0.00	0.00	161.45	161.45	161.45	161.45	161.45	322.90	322.90	322.90	322.90	322.90	322.90	322.90	484.35	484.35	484.35	645.79	645.79
Fund Requirement arranged from	Equity	193.74	0.00	0.00	48.43	48.43	48.43	48.43	48.43	96.87	96.87	96.87	96.87	96.87	96.87	96.87	145.30	145.30	145.30	193.74	193.74
	Debt	452.06	0.00	0.00	113.01	113.01	113.01	113.01	113.01	226.03	226.03	226.03	226.03	226.03	226.03	226.03	339.04	339.04	339.04	452.06	452.06
Opening Balance	Equity	0.00	195.77	199.88	204.08	257.31	311.66	367.14	423.80	481.64	589.64	699.91	812.49	927.44	1044.81	1164.63	1286.98	1460.83	1638.34	1819.57	2053.56
	Debt	0.00	456.80	466.40	476.19	600.39	727.20	856.67	988.86	1123.83	1375.83	1633.12	1895.82	2164.03	2437.88	2717.48	3002.95	3408.61	3822.79	4245.67	4791.63
Total Equity		193.74	195.77	199.88	252.52	305.74	360.09	415.58	472.23	578.51	686.51	796.78	909.36	1024.31	1141.68	1261.50	1432.28	1606.14	1783.64	2013.31	2247.30
Total Debt		452.06	456.80	466.40	589.20	713.40	840.21	969.69	1101.88	1349.86	1601.86	1859.15	2121.85	2390.06	2663.91	2943.51	3341.99	3747.65	4161.83	4697.73	5243.69
IDC		6.78	13.70	13.99	15.98	19.71	23.51	27.40	31.36	37.11	44.67	52.38	60.27	68.31	76.53	84.91	95.17	107.34	119.77	134.15	50.18
Arrangement of Interest & Upfront payment from	Equity	2.03	4.11	4.20	4.79	5.91	7.05	8.22	9.41	11.13	13.40	15.72	18.08	20.49	22.96	25.47	28.55	32.20	35.93	40.25	15.05
	Debt	4.75	9.59	9.79	11.19	13.79	16.46	19.18	21.95	25.97	31.27	36.67	42.19	47.82	53.57	59.44	66.62	75.14	83.84	93.91	35.12
Closing Balance of	Equity	195.77	199.88	204.08	257.31	311.66	367.14	423.80	481.64	589.64	699.91	812.49	927.44	1044.81	1164.63	1286.98	1460.83	1638.34	1819.57	2053.56	2262.35
	Debt	456.80	466.40	476.19	600.39	727.20	856.67	988.86	1123.83	1375.83	1633.12	1895.82	2164.03	2437.88	2717.48	3002.95	3408.61	3822.79	4245.67	4791.63	5278.81
Debt : Equity Ratio		2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33
Net Requirement of Fund	Equity	195.77	4.11	4.20	53.23	54.35	55.49	56.65	57.84	108.00	110.27	112.58	114.95	117.36	119.83	122.34	173.86	177.51	181.23	233.98	208.79
	Debt	456.80	9.59	9.79	124.20	126.81	129.47	132.19	134.97	252.00	257.29	262.70	268.21	273.85	279.60	285.47	405.66	414.18	422.88	545.96	487.18

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DETAILED PROJECT REPORT

Phasing of Expenditure & IDC Calculation

(All Figures in ₹)

Project Cost without IDC			4305.30	Crores
Project Completion Period			64	months
Debt(%)			70	
Debt (including IDC)			3538.13	Crores
Equity(%)			30	
Equity			1516.34	Crores
Project Cost including IDC			5054.47	Crores
Rate of Interest			12.00	%
No. of Installment/year			4	

IDC 749.17 Crores 14.82%

Quarterly Installment		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Phased Expenditure(%)	Unit - 5	10					2.5	2.5	2.5	2.5	2.5	5	5	5	5	5	5	5	7.5	7.5	7.5	10	10
Total Phased Expenditure(%)		10.00	0.00	0.00	0.00	0.00	2.50	2.50	2.50	2.50	2.50	5.00	5.00	5.00	5.00	5.00	5.00	5.00	7.50	7.50	7.50	10.00	10.00
Phased Expenditure		430.53	0.00	0.00	0.00	0.00	107.63	107.63	107.63	107.63	107.63	215.26	215.26	215.26	215.26	215.26	215.26	215.26	322.90	322.90	322.90	430.53	430.53
Fund Requirement arranged from	Equity	129.16	0.00	0.00	0.00	0.00	32.29	32.29	32.29	32.29	32.29	64.58	64.58	64.58	64.58	64.58	64.58	64.58	96.87	96.87	96.87	129.16	129.16
	Debt	301.37	0.00	0.00	0.00	0.00	75.34	75.34	75.34	75.34	75.34	150.69	150.69	150.69	150.69	150.69	150.69	150.69	226.03	226.03	226.03	301.37	301.37
Opening Balance	Equity	0.00	130.52	133.26	136.05	138.91	141.83	177.44	213.79	250.91	288.81	327.50	399.64	473.29	548.48	625.26	703.65	783.68	865.39	981.45	1099.95	1220.94	1377.09
	Debt	0.00	304.54	310.93	317.46	324.13	330.93	414.02	498.84	585.45	673.88	764.17	932.48	1104.33	1279.79	1458.93	1641.84	1828.59	2019.25	2290.06	2566.55	2848.85	3213.21
Total Equity		129.16	130.52	133.26	136.05	138.91	174.12	209.73	246.08	283.20	321.10	392.08	464.21	537.86	613.06	689.84	768.22	848.26	962.26	1078.32	1196.82	1350.09	1506.25
Total Debt		301.37	304.54	310.93	317.46	324.13	406.28	489.36	574.19	660.80	749.23	914.85	1083.17	1255.02	1430.48	1609.62	1792.52	1979.27	2245.28	2516.09	2792.58	3150.22	3514.58
IDC		4.52	9.14	9.33	9.52	9.72	11.06	13.55	16.10	18.69	21.35	25.19	30.23	35.39	40.65	46.03	51.52	57.12	63.97	72.09	80.39	89.99	33.64
Arrangement of Interest & Upfront payment from	Equity	1.36	2.74	2.80	2.86	2.92	3.32	4.07	4.83	5.61	6.40	7.56	9.07	10.62	12.20	13.81	15.45	17.14	19.19	21.63	24.12	27.00	10.09
	Debt	3.16	6.40	6.53	6.67	6.81	7.74	9.49	11.27	13.09	14.94	17.63	21.16	24.77	28.46	32.22	36.06	39.98	44.78	50.46	56.27	62.99	23.55
Closing Balance of	Equity	130.52	133.26	136.05	138.91	141.83	177.44	213.79	250.91	288.81	327.50	399.64	473.29	548.48	625.26	703.65	783.68	865.39	981.45	1099.95	1220.94	1377.09	1516.34
	Debt	304.54	310.93	317.46	324.13	330.93	414.02	498.84	585.45	673.88	764.17	932.48	1104.33	1279.79	1458.93	1641.84	1828.59	2019.25	2290.06	2566.55	2848.85	3213.21	3538.13
Debt : Equity Ratio		2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33
Net Requirement of Fund	Equity	130.52	2.74	2.80	2.86	2.92	35.61	36.35	37.12	37.90	38.69	72.14	73.65	75.20	76.78	78.39	80.03	81.71	116.06	118.50	120.99	156.15	139.25
	Debt	304.54	6.40	6.53	6.67	6.81	83.08	84.83	86.61	88.43	90.29	168.32	171.85	175.46	179.14	182.91	186.75	190.67	270.81	276.49	282.30	364.36	324.92

TSGENCO
5X800 MW YADADRI THERMAL POWER PROJECT
DETAILED PROJECT REPORT

Base Case:	5x800 MW TPP
Plant Load Factor (PLF):	85%

Capacity (MW)	4000
Project Cost	
US\$	0.00
₹	25099.42
Total Eq. ₹ (Crores)	25099.42
FINANCING	
DEBT	
US\$ (Million)	0.00
₹ (Million)	17569.59
Total Debt ₹ (Crores)	17569.59
EQUITY	
US\$ (million)	0.00
₹ (Crores)	7529.83
Total Equity ₹ (Crores)	7529.83

70%

30%

Fuel	%	GCV	Price	Annual Escalation
Domestic Coal	50%	3400	2050	5.0%
Imported Coal	50%	5700	5300	5.0%
Blended Coal	100%	4550	3675	5.0%
Annual Escalation				
Fuel	Coal		Support fuel	HFO
Price	3675 ₹/tonne	5.0%	Price	55000 ₹/tonne
GCV	4550 Kcal/Kg		GCV	10000 Kcal/Kg
Transportation Charge (incl. Above)			Transportation charge (incl. above)	
SHR	2109.4 kCal/kWh		Oil Consumption	0.50 ml/kwh
Aux. Cons	5.25%		Sp.Gr.	0.90
Dep'tion for 1-12 years	5.28%			
Dep'tion for 13-25 years	2.05%			
Present exch. rate	62.50 ₹/US\$			
RoCE	13.65%			
Dis'ting Factor	13.10%			
Int. on Long term loan	12.50%			
O&M Cost	2.29%	4.00% Annual Esc.		

LEVELLIZED TARIFF AT 85% PLF
FIRST YEAR TARIFF AT 85% PLF

4.57 ₹/KWh
3.98 ₹/KWh

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
US\$ Exchange Rate	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	
Coal price ₹/tonne	3675.00	3858.75	4051.69	4254.27	4466.99	4690.33	4924.85	5171.09	5429.65	5701.13	5986.19	6285.50	6599.77	6929.76	7276.25	7640.06	8022.06	8423.17	8844.33	9286.54	9750.87	10238.41	10750.33	11287.85	11852.24	
Transportation Cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Coal price at site ₹/tonne	3675.00	3858.75	4051.69	4254.27	4466.99	4690.33	4924.85	5171.09	5429.65	5701.13	5986.19	6285.50	6599.77	6929.76	7276.25	7640.06	8022.06	8423.17	8844.33	9286.54	9750.87	10238.41	10750.33	11287.85	11852.24	
Supp. Fuel price ₹/tonne	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	
Transportation Cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
supp. Fuel site price ₹/tonne	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	
Gross Units Generated	Million Units (MU)																									
PLF	85%	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	
Net Units Sent Out	Million Units (MU)																									
PLF	85%	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	
Coal Charge ₹/Kwh	1.70	1.79	1.88	1.97	2.07	2.17	2.28	2.40	2.52	2.64	2.78	2.91	3.06	3.21	3.37	3.54	3.72	3.91	4.10	4.31	4.52	4.75	4.98	5.23	5.49	
Total Variable Charge ₹/kwh	1.70	1.79	1.88	1.97	2.07	2.17	2.28	2.40	2.52	2.64	2.78	2.91	3.06	3.21	3.37	3.54	3.72	3.91	4.10	4.31	4.52	4.75	4.98	5.23	5.49	
Total Variable Cost	₹ (Crores)																									
PLF	85%	5074.44	5328.16	5594.57	5874.30	6168.01	6476.41	6800.23	7140.24	7497.26	7872.12	8265.72	8679.01	9112.96	9568.61	10047.04	10549.39	11076.86	11630.70	12212.24	12822.85	13463.99	14137.19	14844.05	15586.26	16365.57

YEAR -->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Fixed cost ₹ (crores)																									
Interest on INR Loan	2196.20	2196.20	2141.29	1994.88	1848.47	1702.05	1555.64	1418.38	1271.97	1125.55	979.14	832.73	686.31	539.90	393.49	247.07	100.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Supp.fuel charge	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72
Depreciation	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25
O&M Charges	576.00	599.04	623.00	647.92	673.84	700.79	728.82	757.98	788.30	819.83	852.62	886.73	922.19	959.08	997.45	1037.34	1078.84	1121.99	1166.87	1213.55	1262.09	1312.57	1365.07	1419.68	1476.46
Return on Foreign Equity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RoCE @ 13.65%	3839.81	3852.43	3866.02	3716.23	3567.13	3418.75	3271.12	3124.23	2978.23	2833.10	2696.38	2553.07	2391.87	2250.62	2110.49	1971.53	1833.79	1696.79	1725.46	1755.55	1787.13	1820.27	1855.05	1891.55	1929.86
Tax On Income	354.94	355.22	370.09	366.74	363.41	360.10	356.80	351.09	347.83	344.58	341.33	338.08	334.83	331.58	328.33	325.08	321.83	318.58	315.33	312.08	308.83	305.58	302.33	299.08	295.83
Int. on Working Capital at 85%	378.9	390.4	402.9	412.1	422.0	432.5	443.8	455.7	468.4	481.9	503.1	518.3	517.1	534.1	552.2	571.4	591.7	612.6	638.9	666.4	695.3	725.7	757.5	791.0	826.0
Total Fixed cost at 85%	6169.72	6205.66	6258.07	6129.86	6003.34	5878.60	5755.70	5632.26	5513.32	5396.48	5611.12	5495.69	4552.26	4441.77	4333.92	4228.83	4126.61	4003.26	4078.06	4156.13	4237.62	4322.68	4411.47	4504.16	4600.91
Fixed Cost per Unit at 85%	2.19	2.20	2.22	2.17	2.13	2.08	2.04	2.00	1.95	1.91	1.99	1.95	1.61	1.57	1.54	1.50	1.46	1.42	1.45	1.47	1.50	1.53	1.56	1.60	1.63

Payment of Fixed Cost ₹ (Crores)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
85%	6169.72	6205.66	6258.07	6129.86	6003.34	5878.60	5755.70	5632.26	5513.32	5396.48	5611.12	5495.69	4552.26	4441.77	4333.92	4228.83	4126.61	4003.26	4078.06	4156.13	4237.62	4322.68	4411.47	4504.16	4600.91
85%	2.19	2.20	2.22	2.17	2.13	2.08	2.04	2.00	1.95	1.91	1.99	1.95	1.61	1.57	1.54	1.50	1.46	1.42	1.45	1.47	1.50	1.53	1.56	1.60	1.63
Levelling Fixed ₹/kWh																									
85%	2.19	1.94	1.73	1.50	1.30	1.13	0.97	0.84	0.73	0.63	0.58	0.50	0.37	0.32	0.27	0.24	0.20	0.17	0.16	0.14	0.13	0.12	0.10	0.09	0.08
85%	2.00																								
Payment of FC+VC ₹ (Crores)																									
85%	11244.15	11533.82	11852.64	12004.15	12171.35	12355.01	12555.94	12772.50	13010.57	13268.60	13876.84	14174.70	13665.22	14010.38	14380.96	14778.22	15203.47	15633.97	16290.30	16978.98	17701.61	18459.87	19255.52	20090.41	20966.48
₹/kwh																									
85%	3.98	4.09	4.20	4.25	4.31	4.38	4.45	4.53	4.61	4.70	4.92	5.02	4.84	4.96	5.10	5.24	5.39	5.54	5.77	6.02	6.27	6.54	6.82	7.12	7.43
Levelling Total Tariff																									
85%	3.98	3.61	3.28	2.94	2.64	2.37	2.13	1.91	1.72	1.55	1.44	1.30	1.11	1.00	0.91	0.83	0.75	0.68	0.63	0.58	0.53	0.49	0.45	0.42	0.39
85%	4.57																								

INR Loan	17569.59 ₹ (Crores)																							
Interest	12.50%																							
Repayment Period	15 YEARS + 2 Years Moratorium																							
Qtr-1																								
Outstanding loan	17569.59	17569.59	17569.59	16398.29	15226.98	14055.68	12884.37	11713.06	10541.76	9370.45	8199.14	7027.84	5856.53	4685.23	3513.92	2342.61	1171.31							
Interest	549.05	549.05	549.05	512.45	475.84	439.24	402.64	366.03	329.43	292.83	256.22	219.62	183.02	146.41	109.81	73.21	36.60							
Repayment				292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83						
Qtr-2																								
Outstanding loan	17569.59	17569.6	17276.8	16105.46	14934.2	13762.8	12591.5	11420.2	10248.93	9077.62	7906.32	6735.01	5563.70	4392.40	3221.09	2049.79	878.48							
Interest	549.05	549.0	539.9	503.30	466.7	430.1	393.5	356.88	320.28	283.68	247.07	210.47	173.87	137.26	100.66	64.06	27.45							
Repayment			292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83						
Qtr-3																								
Outstanding loan	17569.59	17569.59	16983.94	15812.64	14641.33	13470.02	12298.72	11127.41	9956.10	8784.80	7613.49	6442.18	5270.88	4099.57	2928.27	1756.96	585.65							
Interest	549.05	549.05	530.75	494.14	457.54	420.94	384.33	356.88	320.28	283.68	247.07	210.47	173.87	137.26	100.66	64.06	27.45							
Repayment			292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83						
Qtr-4																								
Outstanding loan	17569.59	17569.59	16691.11	15519.81	14348.50	13177.20	12005.89	10834.58	9663.28	8491.97	7320.66	6149.36	4978.05	3806.75	2635.44	1464.13	292.83							
Interest	549.05	549.05	521.60	484.99	448.39	411.79	375.18	338.58	301.98	265.37	228.77	192.17	155.56	118.96	82.36	45.75	9.15							
Repayment			292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83						
Total Interest	2196.20	2196.20	2141.29	1994.88	1848.47	1702.05	1555.64	1418.38	1271.97	1125.55	979.14	832.73	686.31	539.90	393.49	247.07	100.66							
Total Interest ₹ (Crores)	2196.20	2196.20	2141.29	1994.88	1848.47	1702.05	1555.64	1418.38	1271.97	1125.55	979.14	832.73	686.31	539.90	393.49	247.07	100.66							

Working Capital																									
Fuel Charges 85% (2 months)	845.74	888.03	932.43	979.05	1028.00	1079.40	1133.37	1190.04	1249.54	1312.02	1377.62	1446.50	1518.83	1594.77	1674.51	1758.23	1846.14	1938.45	2035.37	2137.14	2244.00	2356.20	2474.01	2597.71	2727.59
Support fuel charges (2 Months)	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29
O&M (1 Month)	48.00	49.92	51.92	53.99	56.15	58.40	60.74	63.16	65.69	68.32	71.05	73.89	76.85	79.92	83.12	86.45	89.90	93.50	97.24	101.13	105.17	109.38	113.76	118.31	123.04
Maintenance spares	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99
Receivables (2 Months)	1874.03	1922.30	1975.44	2000.69	2028.56	2059.17	2092.66	2128.75	2168.43	2211.43	2312.81	2362.45	2277.54	2335.06	2396.83	2463.04	2533.91	2605.66	2715.05	2829.83	2950.27	3076.65	3209.25	3348.40	3494.41
Working Capital at 85%	3031.05	3123.53	3223.07	3297.02	3375.99	3460.25	3550.04	3645.24	3746.94	3855.05	4024.76	4146.13	4136.49	4273.04	4417.73	4570.99	4733.24	4900.89	5110.94	5331.38	5562.72	5805.51	6060.30	6327.70	6608.33

FINANCIAL ANALYSIS: Projected Profit & Loss account for 25 years at 85% PLF																									
All figures are in ₹ (Crores)																									
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	Income from sale of power @ cost of annual generation																								
2	Other Income																								
3	Total Income (1+2)																								
4	Cost of fuel																								
5	Operation & Maintenance																								
6	Earning before interest, depreciation,tax (EBDIT) (3-4-5)																								
7	Depreciation																								
8	Earning before interest, tax (EBIT)																								
9	Interest on working capital																								
10	Interest on Long-term loan																								
11	Profit before tax (PBT) (8-9-10)																								
12	Tax (MAT @ 20.9605% on PBT for first 10 yrs)																								
13	Profit after tax (PAT) (11-12)																								
DSCR Calculation																									
EBDIT																									
Interest																									
Principal Repayment																									
DSCR																									
Average DSCR																									

FINANCIAL ANALYSIS : Profitability indicators																									
IRR Calculation																									
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Capital Expenditure	25099.42																								
EBDIT		5593.72	5606.62	5635.07	5481.94	5329.50	5177.80	5026.88	4874.28	4725.02	4576.65	4758.50	4608.97	3630.06	3482.69	3336.48	3191.49	3047.77	2881.27	2911.19	2942.58	2975.53	3010.11	3046.40	3084.48
Net Cash flow	-25099.42	5593.72	5606.62	5635.07	5481.94	5329.50	5177.80	5026.88	4874.28	4725.02	4576.65	4758.50	4608.97	3630.06	3482.69	3336.48	3191.49	3047.77	2881.27	2911.19	2942.58	2975.53	3010.11	3046.40	3084.48
IRR	20.19%																								

Option - II			
100% Imported Coal			
Unit	1 & 3	52	Months
Unit	2 & 4	58	Months
Unit	5	64	Months

TSGENCO
5X800 MW YADADRI THERMAL POWER PROJECT
DETAILED PROJECT REPORT

Exchange Rate: 1 USD = ₹ 64.50
* F.C- Foreign component in million US\$
** D.C Domestic Component in ₹ Crores

Sl. No.	DESCRIPTION	COMPLETED COST							
		EPC Cost		Non-EPC Cost		Total Cost		Grand Total	Cost/MW
		F.C.*	D.C.**	F.C.*	D.C.**	F.C.*	D.C.**	₹ in crores	₹ in crores
1	Land & R&R issue				845.00		845.00	845.00	
2	Steam Generator, Turbine & generator with Auxiliaries (As per details at Sl. No. 1 - 5 of Mechanical Work)		8200.00		0.00		8200.00	8200.00	
3	Balance of Plant								
I)	Mechanical		1152.31		130.50		1282.81	1282.81	
II)	Electrical and C&I		840.00		5.50		845.50	845.50	
4	Sub Total of Equipment Cost		10192.31		136.00		10328.31	10328.31	
5	Initial Spares @4% of Sl.No. 4		407.69		5.44		413.13	413.13	
6	Equipment Cost including Spares		10600.00		141.44		10741.44	10741.44	
7	Custom Duty @26.53% of Sl. No. 6 on Foreign Component		0.00		0.00		0.00	0.00	
8	Excise Duty of Sl. No. 6 on Domestic Component		1325.00		17.68		1342.68	1342.68	
9	CST @2% of Sl. No. 6		212.00		2.83		214.83	214.83	
10	Equipment Cost incl. duties, taxes & spares		12137.00		161.95		12298.95	12298.95	
11	Freight (4%) & Insurance (1%) on Sl. No. 6		530.00		7.07		537.07	537.07	
12	Total Equipment Cost incl. Freight & Insurance		12667.00		169.02		12836.02	12836.02	
13	Erection, Testing & Commissioning @10% of Sl. No. 4		1019.23		13.60		1032.83	1032.83	
14	Civil Works		4150.00		927.50		5077.50	5077.50	
15	Excise Duty @12.50% on (40% of Civil Works)		207.50		46.38		253.88	253.88	
16	VAT@ 5% on (27% of civil cost) & Sl. No. 15		66.40		14.84		81.24	81.24	
17	Service Tax @12.36% of Sl. No. 11, 13 & (33% of Sl. No. 14).		360.76		40.39		401.14	401.14	
18	Total works Cost		5803.89		1042.70		6846.59	6846.59	
19	Contingency @2.5% of Total works i.e. Sl. No.18		145.10		26.07		171.16	171.16	
20	Sub Total - EPC & NON-EPC Cost		18615.98		2082.79		20698.77	20698.77	5.17
21	Establishment Costs including Head quarter charges @3% of Sl. No. 20				620.96		620.96	620.96	
22	Consultancy & Engineering				40.00		40.00	40.00	
23	Start up Fuel				50.00		50.00	50.00	
24	Operator training				6.00		6.00	6.00	
25	Total Hard Cost		18615.98		2799.75		21415.73	21415.73	5.35
26	IDC & Financing Cost								
I)	Financing Expenses @0.05% of Sl. No. 20				10.35		10.35	10.35	
II)	Interest During Construction				3572.94		3572.94	3572.94	
27	Margin Money				0.00		0.00	0.00	
28	CSR @0.4% of Total Project Cost				100.40		100.40	100.40	
29	Total Project cost including IDC & FC		18615.98		6483.44		25099.42	25099.42	6.27

**COST ESTIMATE
MECHANICAL WORKS**

FE Rate 1 US\$ = ₹ 64.50

Sl. No.	DESCRIPTION	EPC Cost	Non-EPC	Total Cost
		(₹ in Crores)	(₹ in Crores)	(₹ in Crores)
1	Steam Generator with associated auxiliaries	8200.00		8200.00
2	Electrostatic precipitators			
3	Turbine Generator with associated auxiliaries			
4	Power Cycle Equipment			
5	Power Cycle Piping			
6	Condensate Polishing Plant	55.00		55.00
7	EOT Cranes	5.00		5.00
8	C&I including DAS	125.00		125.00
9	Coal Handling System	350.00		350.00
10	Fuel Oil Handling System	45.00		45.00
11	Ash handling System	200.00		200.00
12	CW Pumps	100.00		100.00
13	Make up Water System	100.00		100.00
14	Cooling Towers (NDCT) fills, nozzles etc.	20.00		20.00
15	Water Treatment Plant	15.00		15.00
16	Compressed Air System	45.00		45.00
17	Effluent Treatment Plant	5.00		5.00
18	Miscellaneous Pumps	35.00		35.00
19	Hydrogen Generation Plant	20.00		20.00
20	Station Piping	50.00		50.00
21	Fire Protection System	40.00		40.00
22	Air Conditioning & Ventilation	32.00		32.00
23	Workshop & Lab Equipment	5.00		5.00
24	Hoisting Equipment	2.50		2.50
25	Diesel Generator	12.00		12.00
26	Equipment Cooling System	15.00		15.00
27	Weigh Bridge	0.81		0.81
28	Signaling & Telecommunication and Marshalling yard and Railway line		130.50	130.50
	TOTAL	9477.31	130.50	9607.81

**COST ESTIMATE
ELECTRICAL WORKS**

FE Rate 1 US \$ = ₹ 64.50

Sl. No.	DESCRIPTION	EPC Cost	Non-EPC Cost	Total Cost
		(₹ in Crores)	(₹ in Crores)	(₹ in Crores)
A	Electrical System			
1	Generator Transformers	60.00		60.00
2	Unit Transformers	15.00		15.00
3	Generator Circuit Breaker	30.00		30.00
4	LT Outdoor Transformers	10.00		10.00
5	LT Indoor Transformers			
6	Generator Bus Duct	70.00		70.00
7	HT Switch gear	150.00		150.00
8	HT Bus duct	45.00		45.00
9	LT Switch gear	55.00		55.00
10	D.C. Battery & Charger	25.00		25.00
11	Station lighting System	20.00		20.00
12	Control & Relay Panels	15.00		15.00
13	HT Power Cables.	140.00		140.00
14	LT Power Cables			
15	Control Cables			
16	Cabling, earthing & Lightning Protection	10.00		10.00
17	Unit Aux. Transformer	30.00		30.00
	Sub-Total (A)	675.00	0.00	675.00
B.	Switchyard (400 kv)	40.00		40.00
	Sub-Total (B)	40.00	0.00	40.00
C.	IT, SAP & Telecommunications including software development		5.50	5.50
	Sub-Total (C)	0.00	5.50	5.50
	TOTAL (A+B+C)	715.00	5.50	720.50

**COST ESTIMATE
PRELIMINARY & CIVIL WORKS**

(₹ in Crores)

Sl. No.	DESCRIPTION	EPC Cost	Non-EPC Cost	Total Cost
		(₹ in Crores)	(₹ in Crores)	(₹ in Crores)
1	Land & R&R issue		845.00	845.00
2	Survey & Soil Investigation		2.50	2.50
3	Site Clearance & Leveling	175.00		175.00
4	Roads, Bridges, Culverts, drains etc.	250.00		250.00
5	Marshalling yard and railway line		125.00	125.00
6	Boundary Wall (45 km) & Permanent fencing		45.00	45.00
7	Enabling Works (Site office, Construction power, Water etc.)		150.00	150.00
8	Permanent Township		300.00	300.00
9	Administrative & Service Buildings	50.00		50.00
10	Foundations	750.00		750.00
11	General Civil Works	350.00		350.00
12	Structural Steel Works	650.00		650.00
13	Chimney	400.00		400.00
14	Coal Handling System	375.00		375.00
15	Fuel Oil Handling System	55.00		55.00
16	CW System	125.00		125.00
17	External Water System including piping		150.00	150.00
18	Water Treatment Plant	65.00		65.00
19	Cooling Tower (NDCT)	525.00		525.00
20	Misc. Civil Works	80.00	5.00	85.00
21	Ash handling System	300.00		300.00
22	Ash pond		100.00	100.00
23	Green Belt & Other Soil Erosion mitigation measures committed to forest department		50.00	50.00
	TOTAL	4150.00	1772.50	5077.50

TSGENCO
5X800 MW YADADRI THERMAL POWER PROJECT
DETAILED PROJECT REPORT

Phasing of Expenditure & IDC Calculation

(All Figures in ₹)

Project Cost without IDC	21526.48	Crores
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Unit	₹	Project Cost without IDC	IDC	Project Cost with IDC
1 & 3	Crores	10763.24	1740.55	12503.79
2 & 4	Crores	6457.94	1083.22	7541.16
5	Crores	4305.30	749.17	5054.47
Total	Crores	21526.48	3572.94	25099.42

TSGENCO
5X800 MW YADADRI THERMAL POWER PROJECT
DETAILED PROJECT REPORT

Phasing of Expenditure & IDC Calculation

(All Figures in ₹)

Project Cost without IDC			10763.24	Crores		IDC 1740.55 Crores														
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TSGENCO
5X800 MW YADADRI THERMAL POWER PROJECT
DETAILED PROJECT REPORT

Phasing of Expenditure & IDC Calculation

(All Figures in ₹)

All Figures in ₹				
Project Cost without IDC			6457.94	Crores
Project Completion Period			58	months
Debt(%)			70	
Debt (including IDC)			5278.81	Crores
Equity(%)			30	
Equity			2262.35	Crores
Project Cost including IDC			7541.16	Crores
Rate of interest			12.00	%
No. of Installment/year			4	

IDC 1083.22 Crores

14.36%

No. or installment/year				4																	
Quarterly Installment		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Phased Expenditure(%)	Unit - 2 & 4	10			2.5	2.5	2.5	2.5	2.5	5	5	5	5	5	5	5	7.5	7.5	7.5	10	10
Total Phased Expenditure(%)		10.00	0.00	0.00	2.50	2.50	2.50	2.50	2.50	5.00	5.00	5.00	5.00	5.00	5.00	5.00	7.50	7.50	7.50	10.00	10.00
Phased Expenditure		645.79	0.00	0.00	161.45	161.45	161.45	161.45	161.45	322.90	322.90	322.90	322.90	322.90	322.90	322.90	484.35	484.35	484.35	645.79	645.79
	Equity	193.74	0.00	0.00	48.43	48.43	48.43	48.43	48.43	96.87	96.87	96.87	96.87	96.87	96.87	96.87	145.30	145.30	145.30	193.74	193.74
Fund Requirement arranged from	Debt	452.06	0.00	0.00	113.01	113.01	113.01	113.01	113.01	226.03	226.03	226.03	226.03	226.03	226.03	226.03	339.04	339.04	339.04	452.06	452.06
Opening Balance	Equity	0.00	195.77	199.88	204.08	257.31	311.66	367.14	423.80	481.64	589.64	699.91	812.49	927.44	1044.81	1164.63	1286.98	1460.83	1638.34	1819.57	2053.56
	Debt	0.00	456.80	466.40	476.19	600.39	727.20	856.67	988.86	1123.83	1375.83	1633.12	1895.82	2164.03	2437.88	2717.48	3002.95	3408.61	3822.79	4245.67	4791.63
Total Equity		193.74	195.77	199.88	252.52	305.74	360.09	415.58	472.23	578.51	686.51	796.78	909.36	1024.31	1141.68	1261.50	1432.28	1606.14	1783.64	2013.31	2247.30
Total Debt		452.06	456.80	466.40	589.20	713.40	840.21	969.69	1101.88	1349.86	1601.86	1859.15	2121.85	2390.06	2663.91	2943.51	3341.99	3747.65	4161.83	4697.73	5243.69
IDC		6.78	13.70	13.99	15.98	19.71	23.51	27.40	31.36	37.11	44.67	52.38	60.27	68.31	76.53	84.91	95.17	107.34	119.77	134.15	50.18
Arrangement of Interest & Upfront payment from	Equity	2.03	4.11	4.20	4.79	5.91	7.05	8.22	9.41	11.13	13.40	15.72	18.08	20.49	22.96	25.47	28.55	32.20	35.93	40.25	15.05
	Debt	4.75	9.59	9.79	11.19	13.79	16.46	19.18	21.95	25.97	31.27	36.67	42.19	47.82	53.57	59.44	66.62	75.14	83.84	93.91	35.12
Closing Balance of	Equity	195.77	199.88	204.08	257.31	311.66	367.14	423.80	481.64	589.64	699.91	812.49	927.44	1044.81	1164.63	1286.98	1460.83	1638.34	1819.57	2053.56	2262.35
	Debt	456.80	466.40	476.19	600.39	727.20	856.67	988.86	1123.83	1375.83	1633.12	1895.82	2164.03	2437.88	2717.48	3002.95	3408.61	3822.79	4245.67	4791.63	5278.81
Debt : Equity Ratio		2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33
Net Requirement of Fund	Equity	195.77	4.11	4.20	53.23	54.35	55.49	56.65	57.84	108.00	110.27	112.58	114.95	117.36	119.83	122.34	173.86	177.51	181.23	233.98	208.79
	Debt	456.80	9.59	9.79	124.20	126.81	129.47	132.19	134.97	252.00	257.29	262.70	268.21	273.85	279.60	285.47	405.66	414.18	422.88	545.96	487.78

TSGENCO
5X800 MW YADADRI THERMAL POWER PROJECT
DETAILED PROJECT REPORT

Phasing of Expenditure & IDC Calculation

(All Figures in ₹)

Project Cost without IDC			4305.30	Crores
Project Completion Period			64	months
Debt(%)			70	
Debt (including IDC)			3538.13	Crores
Equity(%)			30	
Equity			1516.34	Crores
Project Cost including IDC			5054.47	Crores
Rate of Interest			12.00	%
No. of Installment/year			4	

IDC 749.17 Crores 14.82%

Quarterly Installment		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Phased Expenditure(%)	Unit - 5	10					2.5	2.5	2.5	2.5	2.5	5	5	5	5	5	5	5	7.5	7.5	7.5	10	10
Total Phased Expenditure(%)		10.00	0.00	0.00	0.00	0.00	2.50	2.50	2.50	2.50	2.50	5.00	5.00	5.00	5.00	5.00	5.00	5.00	7.50	7.50	7.50	10.00	10.00
Phased Expenditure		430.53	0.00	0.00	0.00	0.00	107.63	107.63	107.63	107.63	107.63	215.26	215.26	215.26	215.26	215.26	215.26	215.26	322.90	322.90	322.90	430.53	430.53
Fund Requirement arranged from	Equity	129.16	0.00	0.00	0.00	0.00	32.29	32.29	32.29	32.29	32.29	64.58	64.58	64.58	64.58	64.58	64.58	64.58	96.87	96.87	96.87	129.16	129.16
	Debt	301.37	0.00	0.00	0.00	0.00	75.34	75.34	75.34	75.34	75.34	150.69	150.69	150.69	150.69	150.69	150.69	150.69	226.03	226.03	226.03	301.37	301.37
Opening Balance	Equity	0.00	130.52	133.26	136.05	138.91	141.83	177.44	213.79	250.91	288.81	327.50	399.64	473.29	548.48	625.26	703.65	783.68	865.39	981.45	1099.95	1220.94	1377.09
	Debt	0.00	304.54	310.93	317.46	324.13	330.93	414.02	498.84	585.45	673.88	764.17	932.48	1104.33	1279.79	1458.93	1641.84	1828.59	2019.25	2290.06	2566.55	2848.85	3213.21
Total Equity		129.16	130.52	133.26	136.05	138.91	174.12	209.73	246.08	283.20	321.10	392.08	464.21	537.86	613.06	689.84	768.22	848.26	962.26	1078.32	1196.82	1350.09	1506.25
Total Debt		301.37	304.54	310.93	317.46	324.13	406.28	489.36	574.19	660.80	749.23	914.85	1083.17	1255.02	1430.48	1609.62	1792.52	1979.27	2245.28	2516.09	2792.58	3150.22	3514.58
IDC		4.52	9.14	9.33	9.52	9.72	11.06	13.55	16.10	18.69	21.35	25.19	30.23	35.39	40.65	46.03	51.52	57.12	63.97	72.09	80.39	89.99	33.64
Arrangement of Interest & Upfront payment from	Equity	1.36	2.74	2.80	2.86	2.92	3.32	4.07	4.83	5.61	6.40	7.56	9.07	10.62	12.20	13.81	15.45	17.14	19.19	21.63	24.12	27.00	10.09
	Debt	3.16	6.40	6.53	6.67	6.81	7.74	9.49	11.27	13.09	14.94	17.63	21.16	24.77	28.46	32.22	36.06	39.98	44.78	50.46	56.27	62.99	23.55
Closing Balance of	Equity	130.52	133.26	136.05	138.91	141.83	177.44	213.79	250.91	288.81	327.50	399.64	473.29	548.48	625.26	703.65	783.68	865.39	981.45	1099.95	1220.94	1377.09	1516.34
	Debt	304.54	310.93	317.46	324.13	330.93	414.02	498.84	585.45	673.88	764.17	932.48	1104.33	1279.79	1458.93	1641.84	1828.59	2019.25	2290.06	2566.55	2848.85	3213.21	3538.13
Debt : Equity Ratio		2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33	2.33
Net Requirement of Fund	Equity	130.52	2.74	2.80	2.86	2.92	35.61	36.35	37.12	37.90	38.69	72.14	73.65	75.20	76.78	78.39	80.03	81.71	116.06	118.50	120.99	156.15	139.25
	Debt	304.54	6.40	6.53	6.67	6.81	83.08	84.83	86.61	88.43	90.29	168.32	171.85	175.46	179.14	182.91	186.75	190.67	270.81	276.49	282.30	364.36	324.92

TSGENCO
5X800 MW YADADRI THERMAL POWER PROJECT
DETAILED PROJECT REPORT

Base Case:	5x800 MW TPP
Plant Load Factor (PLF):	85%

Capacity (MW)	4000
Project Cost	
US\$	0.00
₹	25099.42
Total Eq. ₹ (Crores)	25099.42
FINANCING	
DEBT	
US\$ (Million)	0.00
₹ (Million)	17569.59
Total Debt ₹ (Crores)	17569.59
EQUITY	
US\$ (million)	0.00
₹ (Crores)	7529.83
Total Equity ₹ (Crores)	7529.83

70%

30%

Fuel	%	GCV	Price	Annual Escalation
Domestic Coal	0%	3400	2050	5.0%
Imported Coal	100%	5700	5300	5.0%
Blended Coal	100%	5700	5300	5.0%
Annual Escalation				
Fuel	Coal		Support fuel	HFO
Price	5300 ₹/tonne	5.0%	Price	55000 ₹/tonne
GCV	5700 Kcal/Kg		GCV	10000 Kcal/Kg
Transportation Charge (incl. Above)			Transportation charge (incl. above)	
SHR	2109.4 kCal/kWh		Oil Consumption	0.50 ml/kwh
Aux. Cons	5.25%		Sp.Gr.	0.90
Dep'tion for 1-12 years	5.28%			
Dep'tion for 13-25 years	2.05%			
Present exch. rate	62.50 ₹/US\$			
RoCE	13.65%			
Dis'ting Factor	13.10%			
Int. on Long term loan	12.50%			
O&M Cost	2.29%	4.00% Annual Esc.		

LEVELLIZED TARIFF AT 85% PLF
 FIRST YEAR TARIFF AT 85% PLF

4.98 ₹/KWh
 4.27 ₹/KWh

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
US\$ Exchange Rate	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50	62.50
Coal price ₹/tonne	5300.00	5565.00	5843.25	6135.41	6442.18	6764.29	7102.51	7457.63	7830.51	8222.04	8633.14	9064.80	9518.04	9993.94	10493.64	11018.32	11569.24	12147.70	12755.08	13392.84	14062.48	14765.60	15503.88	16279.08	17093.03
Transportation Cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coal price at site ₹/tonne	5300.00	5565.00	5843.25	6135.41	6442.18	6764.29	7102.51	7457.63	7830.51	8222.04	8633.14	9064.80	9518.04	9993.94	10493.64	11018.32	11569.24	12147.70	12755.08	13392.84	14062.48	14765.60	15503.88	16279.08	17093.03
Supp. Fuel price ₹/tonne	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00
Transportation Cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
supp. Fuel site price ₹/tonne	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00	55000.00
Gross Units Generated		Million Units (MU)																							
PLF	85%	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00
Net Units Sent Out		Million Units (MU)																							
PLF	85%	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34	28220.34
Coal Charge ₹/Kwh		1.96	2.06	2.16	2.27	2.38	2.50	2.63	2.76	2.90	3.04	3.19	3.35	3.52	3.70	3.88	4.08	4.28	4.50	4.72	4.96	5.20	5.46	5.74	6.02
Total Variable Charge ₹/kwh		1.96	2.06	2.16	2.27	2.38	2.50	2.63	2.76	2.90	3.04	3.19	3.35	3.52	3.70	3.88	4.08	4.28	4.50	4.72	4.96	5.20	5.46	5.74	6.02
Total Variable Cost		₹ (Crores)																							
PLF	85%	5841.75	6133.84	6440.53	6762.56	7100.68	7455.72	7828.50	8219.93	8630.93	9062.47	9515.60	9991.38	10490.94	11015.49	11566.27	12144.58	12751.81	13389.40	14058.87	14761.81	15499.90	16274.90	17088.64	17943.07

YEAR -->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Fixed cost ₹ (crores)																									
Interest on INR Loan	2196.20	2196.20	2141.29	1994.88	1848.47	1702.05	1555.64	1418.38	1271.97	1125.55	979.14	832.73	686.31	539.90	393.49	247.07	100.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Supp.fuel charge	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72	73.72
Depreciation	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25
O&M Charges	576.00	599.04	623.00	647.92	673.84	700.79	728.82	757.98	788.30	819.83	852.62	886.73	922.19	959.08	997.45	1037.34	1078.84	1121.99	1166.87	1213.55	1262.09	1312.57	1365.07	1419.68	1476.46
Return on Foreign Equity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RoCE @ 13.65%	3875.55	3889.96	3905.43	3757.61	3610.57	3464.36	3319.02	3174.52	3031.04	2888.55	2754.64	2614.23	2456.09	2318.06	2181.30	2045.87	1911.85	1778.76	1811.53	1845.92	1882.02	1919.90	1959.66	2001.39	2045.19
Tax On Income	355.74	356.06	370.97	367.67	364.38	361.11	357.87	352.21	349.01	345.82	342.63	339.44	336.25	333.06	329.87	326.68	323.49	320.30	317.11	313.92	310.73	307.54	304.35	301.16	297.97
Int. on Working Capital at 85%	411.6	424.8	439.0	450.0	461.8	474.3	487.6	501.7	516.7	532.7	556.4	574.3	595.9	617.1	640.8	663.1	687.7	717.7	749.2	782.2	816.9	853.3	891.6	931.7	971.8
Total Fixed cost at 85%	6206.26	6244.03	6298.36	6172.16	6047.76	5925.24	5804.67	5683.68	5567.31	5453.17	5329.17	5205.17	5081.17	4957.17	4833.17	4709.17	4585.17	4461.17	4337.17	4213.17	4089.17	3965.17	3841.17	3717.17	3593.17
Fixed Cost per Unit at 85%	2.20	2.21	2.23	2.19	2.14	2.10	2.06	2.01	1.97	1.93	1.90	1.86	1.82	1.78	1.74	1.70	1.66	1.62	1.58	1.54	1.50	1.46	1.42	1.38	1.34

Payment of Fixed Cost ₹ (Crores)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
85%	6206.26	6244.03	6298.36	6172.16	6047.76	5925.24	5804.67	5683.68	5567.31	5453.17	5329.17	5205.17	5081.17	4957.17	4833.17	4709.17	4585.17	4461.17	4337.17	4213.17	4089.17	3965.17	3841.17	3717.17	3593.17
85%	2.20	2.21	2.23	2.19	2.14	2.10	2.06	2.01	1.97	1.93	1.90	1.86	1.82	1.78	1.74	1.70	1.66	1.62	1.58	1.54	1.50	1.46	1.42	1.38	1.34
Levelling Fixed ₹/kWh																									
85%	2.20	1.96	1.74	1.51	1.31	1.13	0.98	0.85	0.74	0.64	0.59	0.51	0.37	0.32	0.28	0.24	0.21	0.18	0.16	0.15	0.13	0.12	0.11	0.10	0.09
85%	2.02																								
Payment of FC+VC ₹ (Crores)																									
85%	12048.01	12377.87	12738.89	12934.72	13148.44	13380.95	13633.18	13903.61	14198.23	14515.64	15187.49	15559.88	15110.21	15527.62	15974.07	16450.98	16959.87	17478.18	18226.73	19012.23	19836.52	20701.53	21609.26	22561.84	23561.48
₹/kwh																									
85%	4.27	4.39	4.51	4.58	4.66	4.74	4.83	4.93	5.03	5.14	5.38	5.51	5.35	5.50	5.66	5.83	6.01	6.19	6.46	6.74	7.03	7.34	7.66	7.99	8.35
Levelling Total Tariff																									
85%	4.27	3.88	3.53	3.17	2.85	2.56	2.31	2.08	1.88	1.70	1.57	1.42	1.22	1.11	1.01	0.92	0.84	0.76	0.70	0.65	0.60	0.55	0.51	0.47	0.44

INR Loan	17569.59 ₹ (Crores)																							
Interest	12.50%																							
Repayment Period	15 YEARS + 2 Years Moratorium																							
Qtr-1																								
Outstanding loan	17569.59	17569.59	17569.59	16398.29	15226.98	14055.68	12884.37	11713.06	10541.76	9370.45	8199.14	7027.84	5856.53	4685.23	3513.92	2342.61	1171.31							
Interest	549.05	549.05	549.05	512.45	475.84	439.24	402.64	366.03	329.43	292.83	256.22	219.62	183.02	146.41	109.81	73.21	36.60							
Repayment	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83							
Qtr-2																								
Outstanding loan	17569.59	17569.6	17276.8	16105.46	14934.2	13762.8	12591.5	11420.2	10248.93	9077.62	7906.32	6735.01	5563.70	4392.40	3221.09	2049.79	878.48							
Interest	549.05	549.0	539.9	503.30	466.7	430.1	393.5	356.88	320.28	283.68	247.07	210.47	173.87	137.26	100.66	64.06	27.45							
Repayment	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83							
Qtr-3																								
Outstanding loan	17569.59	17569.59	16983.94	15812.64	14641.33	13470.02	12298.72	11127.41	9956.10	8784.80	7613.49	6442.18	5270.88	4099.57	2928.27	1756.96	585.65							
Interest	549.05	549.05	530.75	494.14	457.54	420.94	384.33	347.72	311.11	274.50	237.89	201.28	164.67	128.06	91.45	54.84	18.23							
Repayment	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83							
Qtr-4																								
Outstanding loan	17569.59	17569.59	16691.11	15519.81	14348.50	13177.20	12005.89	10834.58	9663.28	8491.97	7320.66	6149.36	4978.05	3806.75	2635.44	1464.13	292.83							
Interest	549.05	549.05	521.60	484.99	448.39	411.79	375.18	338.58	301.98	265.37	228.77	192.17	155.56	118.96	82.36	45.75	9.15							
Repayment	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83	292.83							
Total Interest	2196.20	2196.20	2141.29	1994.88	1848.47	1702.05	1555.64	1418.38	1271.97	1125.55	979.14	832.73	686.31	539.90	393.49	247.07	100.66							
Total Interest ₹ (Crores)	2196.20	2196.20	2141.29	1994.88	1848.47	1702.05	1555.64	1418.38	1271.97	1125.55	979.14	832.73	686.31	539.90	393.49	247.07	100.66							

Working Capital																									
Fuel Charges 85% (2 months)	973.63	1022.31	1073.42	1127.09	1183.45	1242.62	1304.75	1369.99	1438.49	1510.41	1585.93	1665.23	1748.49	1835.92	1927.71	2024.10	2125.30	2231.57	2343.14	2460.30	2583.32	2712.48	2848.11	2990.51	3140.04
Support fuel charges (2 Months)	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29	12.29
O&M (1 Month)	48.00	49.92	51.92	53.99	56.15	58.40	60.74	63.16	65.69	68.32	71.05	73.89	76.85	79.92	83.12	86.45	89.90	93.50	97.24	101.13	105.17	109.38	113.76	118.31	123.04
Maintenance spares	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99	250.99
Receivables (2 Months)	2008.00	2062.98	2123.15	2155.79	2191.41	2230.16	2272.20	2317.27	2366.37	2419.27	2531.25	2591.81	2618.37	2687.94	2741.83	2826.64	2913.03	3037.79	3168.70	3306.09	3450.26	3601.54	3760.31	3926.91	
Working Capital at 85%	3292.91	3398.48	3511.77	3600.15	3694.29	3794.46	3900.96	4013.70	4133.83	4261.28	4451.51	4594.22	4606.99	4767.06	4936.46	5115.65	5305.13	5501.38	5741.45	5993.42	6257.86	6535.40	6826.69	7132.41	7453.27

FINANCIAL ANALYSIS: Projected Profit & Loss account for 25 years at 85% PLF																									
All figures are in ₹ (Crores)																									
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1 Income from sale of power @ cost of annual generation	12048.01	12377.87	12738.89	12934.72	13148.44	13390.95	13633.18	13903.61	14198.23	14515.64	15187.49	15550.88	15110.21	15527.62	15974.07	16450.98	16959.87	17478.18	18226.73	19012.23	19836.52	20701.53	21609.26	22561.84	23561.48
2 Other Income	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Total Income (1+2)	12048.01	12377.87	12738.89	12934.72	13148.44	13390.95	13633.18	13903.61	14198.23	14515.64	15187.49	15550.88	15110.21	15527.62	15974.07	16450.98	16959.87	17478.18	18226.73	19012.23	19836.52	20701.53	21609.26	22561.84	23561.48
4 Cost of fuel	5841.75	6133.84	6440.53	6782.56	7100.68	7455.72	7828.50	8219.93	8630.93	9062.47	9515.80	9991.38	10490.94	11015.49	11566.27	12144.58	12751.81	13389.40	14058.87	14761.81	15499.90	16274.90	17088.64	17943.07	18840.23
5 Operation & Maintenance	576.00	599.04	623.00	647.92	673.84	700.79	728.82	757.98	788.30	819.83	852.62	886.73	922.19	959.08	997.45	1037.34	1078.84	1121.99	1166.87	1213.55	1262.09	1312.57	1365.07	1419.68	1476.46
6 Earning before interest, depreciation, tax (EBDIT) (3-4-5)	5630.26	5644.99	5675.36	5524.24	5373.92	5224.44	5075.85	4925.70	4779.01	4633.34	4819.28	4672.78	3697.07	3553.05	3410.36	3269.06	3129.22	2966.80	3000.99	3036.87	3074.53	3114.06	3155.55	3199.09	3244.79
7 Depreciation	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	1325.25	514.54	514.54	514.54	514.54	514.54	514.54	514.54	514.54	514.54	514.54	514.54	514.54	514.54
8 Earning before interest, tax (EBIT) (6-7)	4305.01	4319.74	4350.11	4198.99	4048.67	3899.19	3750.60	3600.45	3453.76	3308.09	3494.03	3347.53	3182.53	3038.51	2895.82	2754.52	2614.69	2452.26	2486.45	2522.33	2560.00	2599.52	2641.01	2684.55	2730.25
9 Interest on working capital	411.61	424.81	438.97	450.02	461.79	474.31	487.62	501.71	516.73	532.66	556.44	574.28	575.87	595.88	617.06	639.46	663.14	687.67	717.68	749.18	782.23	816.92	853.34	891.55	931.66
10 Interest on Long-term loan	2196.20	2196.20	2141.29	1994.88	1848.47	1702.05	1555.64	1418.38	1271.97	1125.55	979.14	832.73	686.31	539.90	393.49	247.07	100.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11 Profit before tax (PBT) (8-9-10)	1697.20	1698.73	1769.85	1754.09	1736.42	1722.83	1707.34	1680.36	1665.07	1649.88	1658.45	1640.53	1920.35	1902.73	1885.28	1867.99	1850.89	1764.58	1768.77	1773.16	1777.76	1782.60	1787.67	1793.00	1798.59
12 Tax (MAT @ 20.9605% on PBT for first 10 yrs)	355.74	356.06	370.97	367.67	364.38	361.11	357.87	352.21	349.01	345.82	345.82	345.82	652.73	646.74	640.81	634.93	629.12	599.78	601.20	602.70	604.26	605.91	607.63	609.44	611.34
13 Profit after tax (PAT) (11-12)	1341.46	1342.67	1398.88	1386.42	1374.04	1361.72	1349.47	1328.15	1316.06	1304.06	1292.77	1280.94	1267.62	1255.99	1244.47	1233.06	1221.77	1164.80	1167.56	1170.46	1173.50	1176.69	1180.04	1183.56	1187.25
DSCR Calculation																									
EBDIT	5630.26	5644.99	5675.36	5524.24	5373.92	5224.44	5075.85	4925.70	4779.01	4633.34	4819.28	4672.78	3697.07	3553.05	3410.36	3269.06	3129.22	2966.80	3000.99	3036.87	3074.53	3114.06	3155.55	3199.09	3244.79
Interest	2196.20	2196.20	2141.29	1994.88	1848.47	1702.05	1555.64	1418.38	1271.97	1125.55	979.14	832.73	686.31	539.90	393.49	247.07	100.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Principal Repayment	0.00	0.00	1171.31	1171.31	1171.31	1171.31	1171.31	1171.31	1171.31	1171.31	1171.31	1171.31	1171.31	1171.31	1171.31	1171.31	1171.31	1171.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DSCR	2.56	2.57	1.71	1.74	1.78	1.82	1.86	1.90	1.96	2.02	2.24	2.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average DSCR	1.98																								

FINANCIAL ANALYSIS : Profitability indicators																									
IRR Calculation																									
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Capital Expenditure	25099.42																								
EBDIT		5630.26	5644.99	5675.36	5524.24	5373.92	5224.44	5075.85	4925.70	4779.01	4633.34	4819.28	4672.78	3697.07	3553.05	3410.36	3269.06	3129.22	2966.80	3000.99	3036.87	3074.53	3114.06	3155.55	3199.09
Net Cash flow	-25099.42	5630.26	5644.99	5675.36	5524.24	5373.92	5224.44	5075.85	4925.70	4779.01	4633.34	4819.28	4672.78	3697.07	3553.05	3410.36	3269.06	3129.22	2966.80	3000.99	3036.87	3074.53	3114.06	3155.55	3199.09
IRR	20.41%																								



ADDENDUM TO DETAILED PROJECT REPORT

1.0.0 INTRODUCTION

1.1.0 Telangana State Power Generation Corporation Limited (TSGENCO) is one of the pivotal organizations of Telangana, engaged in the business of Power Generation. Apart from operation & maintenance of the power plants it has undertaken the execution of the ongoing & new power projects scheduled under capacity addition programme and is also taking up renovation & modernization works of the old power stations.

TSGENCO came into existence on 19.05.2014 and commenced operations from 02.06.2014. This was a sequel to Government's reforms in power sector to un-bundle the activities relating to generation, transmission and distribution of power. All the Generating Stations owned by erstwhile APSEB in Telangana area were transferred under the control of TSGENCO.

1.2.0 The State of Telangana requires substantial addition to its power generating capacity to meet power demand of its rapidly growing industrial, agricultural and other sectors. A number of projects, including Yadadri Thermal Power Station (5x800 MW), have been identified by TSGENCO for augmentation of generating capacity.

1.3.0 TSGENCO has engaged the services of DESEIN PRIVATE LIMITED, Consulting Engineers, for the preparation of Detailed Project Report for 5x800 MW Yadadri Thermal Power Station in the year 2015. The final DPR was submitted by DESEIN at the same time.





It has become necessary to revalidate the total costing at par with present day costs of plant & machinery and financial analysis in line with Government of India (GoI)/Central Electricity Authority (CEA) and CERC/SERC norms considering the following:

- a) since about 2 years have passed from the date of original submission of the DPR
- b) New MOEF norms regarding SO_x and NO_x limitations,
- c) Per MW water consumption limitations,
- d) addition of few facilities considering 100% Indian coal with 0.7% Sulphur from SCCL instead of 50% domestic coal and 50% imported coal (as envisaged in the DPR) and
- e) Introduction of GST.





REVISED COST ESTIMATES

The revised cost estimates are based on the following:

- A. Ministry of Environment & Forests notification will be implemented with respect to water consumption, zero liquid discharge and revised environmental standards for particulate emission, SO_x, NO_x and mercury emissions as mentioned below:

Particulate Matter	-	30 mg/Nm ³
Sulphur Dioxide (SO ₂)	-	100 mg/Nm ³
Oxide of Nitrogen (NO _x)	-	100 mg/Nm ³
Mercury (Hg)	-	0.03 mg/Nm ³

- 1) **Particulate matter:** Particulate matter in the flue gas leaving the boiler will be limited to 30 mg/Nm³ by adding additional fields in the ESP.
- 2) **Sulphur Dioxide (SO₂) Control:** FGD System, lime based will be installed complete with necessary pumps, piping and valves, control and instrumentation and moisture separators for the flue gas to remove SO₂ for all load combinations from minimum continuous through BMCR to meet the limits.

FGD system shall be designed and constructed to operate as specified at maximum continuous rated load 24 hours per day, 7 days per week, 365 days per year, except during unit outages.

FGD system will include an emergency water quench system to protect absorber module, linings, and internals from damage in





the event of loss of water to scrubber module at normal flue gas temperature for a period of 30 minutes.

Adequately sized lime stone and gypsum handling facilities will be provided in the project.

3. Oxides of Nitrogen (Nox) Control:

DeNOx system will be provided for each Unit. The system will include the following to meet the specified NOx levels.

- a) SCR catalyst complete as a modular package.
- b) SCR reactor, including housing, flow straighteners and mixing devices (as required), module support structure, soot blowers, and ash hoppers (if applicable).
- c) Complete transition ductwork from steam generator economizer outlet flange to the reactor inlet and from reactor outlet to air heater inlet flange(s), including expansion joints, flow straightening devices, and supports, Economizer bypass duct & bypass damper from economizer inlet to SCR reactor inlet or any other suitable arrangement as per standard & proven practices to ensure appropriate gas temperature at SCR inlet at part load operation.
- d) Ammonia Injection grid and nozzle including support.





- e) Ammonia vaporization system complete with dilution air Blowers, inlet filters, silencer, electric/steam air heater(if applicable), adequately sized Accumulator for each unit, mixing chamber along with complete piping, valves & supports.

B. Coal Transportation, Unloading Facilities and Handling Plant

- a) The coal will be transported to power plant from Singareni coal mines through Indian Railways. A dedicated marshalling yard will be developed at the site to unload the coal from railway wagons.
- b) The coal handling system will be designed to operate throughout the year with coal having average gross calorific value of 3400 kcal/kg (instead of 4550Kcal/Kg.)
- c) Considering Gross Station Heat Rate of 2151 kcal/kwh, at full load, the coal requirement for each unit works out as:

i)	Tonnes per hour (TPH) per unit	$\frac{800 \times 2151}{3400}$ = 506.11
ii)	Tonnes per day (TPD) per unit	12146.82
iii)	Million tonnes per year per unit at 85% PLF (MPTA)	3.769

The coal handling system will be designed to convey coal @ 2500 TPH for Stage I and Stage II separately totaling to 5000 TPH for all 5x800 MW units.





A covered raw coal storage yard of 2.5 Lakh tonnes capacity is also envisaged for each stage with corresponding Emergency Reclaim Hopper.

Crushed coal storage yard will be paved to avoid loss of crushed coal while stacking and reclaiming from the stock pile near stacker re-claimer area. 3D coal stock pile measurement system will be provided in the crushed pile areas to measure accurately the available coal stocks.

Instead of 6 nos. 800 HP diesel locomotives, 6 nos. 1400 HP diesel Locomotives are envisaged to unload 15 full rakes of coal per day.

C. ASH HANDLING SYSTEM

Ash handling system of each unit will be designed considering 46% ash in the domestic coal having gross calorific value of 3400 kcal/kg.

Coal consumption at BMCR per unit	-	506.11 TPH
Ash content in coal @ 46% % per unit	-	232.81 TPH
Bottom ash hopper generated @ 20%	-	46.56 TPH
Ash generated in Eco hoppers @ 5 %	-	11.64 TPH
Ash generated in APH hoppers @ 5 %	-	11.64 TPH
Ash generated in Duct hoppers @ 5%	-	11.64 TPH
Fly ash in ESP & stack hoppers @ 85 %	-	197.89 TPH

System capacities: Bottom ash and economizer ash collected in BA Hopper will be evacuated at a rate of 270 TPH. Capacity of each jet pump will be 90 TPH.





APH and Duct hoppers ash slurry collected in Coarse ash tank will be evacuated at a rate of 180 TPH. Capacity of each jet pump will be 90 TPH.

Ash collected in ESP hoppers will be evacuated @ 300 TPH with 6 fly ash vacuum streams operating simultaneously. The removal rate of each vacuum stream will be 50 TPH. Dry fly ash from buffer hoppers to fly ash silos will be conveyed @ 300 TPH and removal capacity of each pressure conveying stream shall be 100 TPH with 3 fly ash pressure conveying streams operating simultaneously.

As per the MOEF norms 100% fly ash utilization shall be achieved within 4 years. The unutilized dry fly ash in the silos will be conveyed to the ash pond through HCSD system to minimize the water consumption.

D. Water Systems

Water system for the project will be provided with a concept of 2 stages. Stage I will cater to Units # 1 & 2 and Stage II will cater to Units # 3, 4 & 5. The system will be designed to restrict the specific water consumption to 2.5M³/MW by increasing COC in the CW system to a minimum value of 6.5 and providing side stream filters and RO system for treating the cooling tower blowdown water as applicable.



**E. Electrical, Control & Instrumentation Works**

The following equipment/systems are considered for the project and included in the basic project cost.

- a) Bus reactors: 2 nos. 125MVA bus reactors for 400 kV switchyard will be provided as envisaged by SRPC during the 39th meeting of standard Committee on Power systems planning of Southern region held on 28.12.2015 & 29.12.2015.
- b) 0.2S class metering CTs and CVTs will be provided for Generating Transformers and Station Transformers also for traffic metering as per the requirement of TSTRANSCO.
- c) Project progress will be monitored at TSGENCO head office also regularly by installing wireless CCTVs with wifi facility at strategic locations during construction phase.
- d) MIS system will be envisaged Unit wise instead of station wise to have wide connectivity





COST ESTIMATES AND FINANCIAL ANALYSIS

1.1 Cost Estimates

An estimate of the total cost of the project has been made. The estimate has been made under three heads, namely Civil, Mechanical and Electrical.

The following factors have been taken into account in the preparation of the cost estimates:

1. Freight and insurance @ 2% on the equipment cost have been taken.
2. Erection, testing, commissioning has been taken @ 10% of equipment cost.
3. Goods & Service tax (GST) @ 18% has been considered on equipment cost, civil works, erection, testing & commissioning and freight & insurance cost.
4. Repayment of long term loan has been considered 15 years on quarterly basis considering a moratorium period of 2 years after commercial operation.
5. Projection of project cost has been done for 25 years economic life of Power Plant.





1.2 Financing Structure

It is proposed to finance the project such that Capital structure is built up of:

Equity Capital	-	30%
Debt Capital	-	70%

The equity capital will be funded by TSGENCO.

The financing of debt capital, comprising loan capital and interest during construction will be arranged from Indian Financial institutions.

1.3 Interest During Construction (IDC)

An interest rate of 12% has been considered for pre- commission.

Also the payment of interest has been worked out at the end of each quarter of construction period in line with financial institutions' requirements.

1.4 Working Capital

Provision for working capital requirement has been made in line with CERC/APERC guidelines.

- i. 1 month O&M expenses
- ii. 2 months receivables
- iii. 2 months fuel charges (coal)
- iv. 2 months support fuel charges
- v. Maintenance spares





- 1.5 Discounting factor has been considered as 13.1%.
- 1.6 Project Competition Period will be **64 Months** from 'Zero Date'.
- 1.7 **Cost of Generation**

Indices for working out cost of generation are given below. GOI guideline, APERC & CERC indices, wherever utilized, are marked with asterisk.

➤ OPTION	(100% Indian Coal)
➤ Plant Capacity	5x800 MW
➤ Auxiliary Energy Consumption	6.57%
➤ Station Heat Rate (kcal/kwh)	2151.0
➤ Depreciation	For first 12 years – 5.28% & for balance 13 years – 2.05%
➤ O&M	1.92% escalated @ 4% every year
➤ Loan Repayment period	15 years
➤ Interest on Loan	12.50% per annum
➤ Loan repayment	60 equal quarterly installments with 2 year moratorium
➤ GCV of coal (Design)	4550 kcal/kg
➤ Present day Coal Price	Rs 3875/tonne on delivered basis with 4% annual escalation
➤ GCV of Support fuel	10,000 kcal/kg
➤ Support fuel present day price	Rs 55,000/tonne for HFO/LDO
➤ PLF	85%
➤ Return on Capital Employed (RoCE)	13.65%
➤ Completion Schedule	64 months
➤ Economic Life of plant	25 years



**1.8 Cost of the Project**

Cost of Project excluding IDC	Rs. 25699.85 Crores
Interest During Construction	Rs. 4265.63 Crores
Total Cost of Project including IDC	Rs. 29965.48 Crores
Cost per MW	Rs. 7.49 Crores

1.9 Tariff

Levellized tariff at 85% PLF	Rs. 4.95/ kwh
First year tariff at 85% PLF	Rs. 4.57/ kwh

1.10 Financial Evaluations

Internal Rate of Return (IRR)	20.85%
Average Debt Service Coverage Ratio (DSCR)	2.01

Capital cost and other financial computations are as per following tables.





TELANGANA POWER GENERATION CORPORATION LIMITED

**YADADRI THERMAL POWER STATION (5x800 MW)
VEERLAPALEM (V). DAMACHARLA (M), NALGONDA (DIST)**



ADDENDUM TO DETAILED PROJECT REPORT

JANUARY 2025



DESEIN PRIVATE LIMITED
DESEIN HOUSE,
GREATER KAILASH-II
NEW DELHI – 110 048

TELANGANA STATE POWER GENERATION CORPORATION LIMITED
YADADRI THERMAL POWER STATION (5 x 800 MW)
ADDENDUM TO DETAILED PROJECT REPORT

1.0 INTRODUCTION

- 1.1 Telangana Power Generation Corporation Limited (TGGENCO) is one of the pivotal organizations of Telangana, engaged in the business of Power Generation. Apart from operation & maintenance of the power plants it has undertaken the execution of new thermal power projects scheduled under capacity addition programme.

TGGENCO came into existence on 19th May 2014 and commenced operations from 02.06.2014. This was a sequel to Government's reforms in power sector to un-bundle the activities relating to generation, transmission and distribution of power. All the Generating Stations owned by erstwhile APGENCO in Telangana area were transferred under the control of TGGENCO.

- 1.2 The State of Telangana requires substantial addition to its power generating capacity to meet power demand of its rapidly growing industrial, agricultural and other sectors. TGGENCO has already commissioned 1 x 800 MW Unit at Kothagudem Thermal Power Station and 4 x 270 MW Units at Bhadradi Thermal Power Station after coming into existence. A number of projects, including Yadadri Thermal Power Station (5x800 MW) have been identified by TGGENCO for augmentation of generating capacity.

- 1.3 TGGENCO has engaged the services of **Desein Private Limited**, Consulting Engineers, for the preparation of Detailed Project Report for 5x800 MW Yadadri Thermal Power Station in the year 2015. The Final DPR was submitted by DESEIN at that time.

It has become necessary to revalidate the total costing at par with the present day costs of plant & machinery and financial analysis in line with Government of

India (Gol), Central Electricity Authority (CEA) and CERC/TGERC norms considering the following:

- a) Inclusion of township and associated financial charges.
- b) Interest rate for computing tariff for 25 years is considered as 12%.
- c) Landed cost of coal is considered at actuals as Rs. 6375/- (G9 coal @ Rs. 5575/- + Rs 800/- for transportation).
- d) Re-appropriation of the project cost.

2.0 COST ESTIMATES & FINANCIAL ANALYSIS

2.1 An estimate of the total cost of the project has been made. The estimate has been made under three heads, namely Mechanical, Electrical and Civil.

The following factors have been taken into account in the preparation of the cost estimates:

1. Freight and insurance @ 2% on the equipment cost.
2. Erection, testing, commissioning @ 10% of equipment cost.
3. Goods & Service tax (GST) @ 18% considered on equipment cost, civil works, erection, testing & commissioning and freight & insurance cost.
4. Repayment of long term loan has been considered 15 years on quarterly basis considering a moratorium period of 2 years after commercial operation.
5. Projection of project cost has been done for 25 years economic life of Power Plant.

2.2 Financing Structure

It is proposed to finance the project such that Capital structure is revised as :

Equity Capital	-	25%
Debt Capital	-	75%

The equity capital will be funded by TGGENCO.

The financing of debt capital, comprising loan capital and interest during construction will be arranged from Indian Financial institutions.

2.3 Interest During Construction (IDC)

An interest rate of 12% has been considered for pre-commissioning.

Also the payment of interest has been worked out at the end of each quarter of construction period in line with financial institutions' requirements.

2.4 Working Capital

Provision for working capital requirement has been made in line with CERC/SERC guidelines.

- i. 1 month O&M expenses
- ii. 45 days receivables
- iii. 20 days coal stock charges
- iv. 30 days coal charges for power generation
- v. 30 days support fuel charges
- vi. Maintenance spares @ 1% of opening gross assets (GFA) for the year.
- vii. MINUS 30 days payables for fuel.

2.5 Discounting factor has been considered as 13.10%.

2.6 Project Competition Period will be **92 Months** from 'Zero Date'.

2.7 Cost of Generation

Indices for working out cost of generation are given below. GOI guideline, TSPERC & CERC indices, wherever utilized, are marked with asterisk.

➤	Plant Capacity	5x800 MW
➤	Auxiliary Energy Consumption	6.40%
➤	Station Heat Rate (kcal/kwh)	2120.37
➤	Depreciation	3.6%
➤	O&M	Rs. 23.2 Lakhs/MW

➤	Loan Repayment period	15 years
➤	Interest on Loan	12% per annum
➤	Loan repayment	60 equal quarterly installments with 2 year moratorium
➤	GCV of coal (Design)	4550 kcal/kg
➤	Present day Coal Price	Rs. 6375/tonne on delivered basis with 4% annual escalation
➤	GCV of Support fuel	10,000 kcal/kg
➤	Support fuel present day price	65,000/tonnes for HFO/LDO
➤	PLF	85%
➤	Return on Equity(RoE)	15.50%
➤	Completion Schedule	92 months
➤	Economic Life of plant	25 years

2.8

Cost of the Project

Cost of Project excluding IDC	Rs. 27664.85 Crores
Interest During Construction	Rs. 8309.54 Crores
Total Cost of Project including IDC	Rs. 36131.99 Crores
Cost per MW	Rs. 9.03 Crores

2.9

Tariff

Levelling tariff at 85% PLF	Rs. 6.83/ kwh
First year tariff at 85% PLF	Rs. 5.99/ kwh

2.10

Financial Evaluations

Internal Rate of Return (IRR)	15.96%
Average Debt Service Coverage Ratio (DSCR)	1.53

Capital cost and other financial computations are as per following tables.

Option			
100% Domestic Coal			
Unit	1 & 2	87	Months
Unit	3 & 4	95	Months
Unit	5	95	Months

TGGENCO
5X800 MW YADADRI THERMAL POWER PROJECT
DETAILED PROJECT REPORT

Exchange Rate: 1 USD = RS 64.50

* F.C.- Foreign component in million US\$

** D.C Domestic Component in Rs Crores

Sl. No.	DESCRIPTION	COMPLETED COST							
		EPC Cost		Non-EPC Cost		Total Cost		Grand Total	Cost/MW
		F.C.*	D.C.**	F.C.*	D.C.**	F.C.*	D.C.**	Rs in Crores	Rs Crores
1	Land & R&R issue				628.14		628.14	628.14	
2	Steam Generator, Turbine & generator with Auxiliaries (As per details at Sl. No. 1 - 5 of Mechanical Work)		7900.00		0.00		7900.00	7900.00	
3	Balance of Plant								
I)	Mechanical		3902.30		185.00		4087.30	4087.30	
II)	Electrical and C&I		730.00		10.50		740.50	740.50	
4	Sub Total of Equipment Cost		12532.30		195.50		12727.80	12727.80	
5	GST @ 18% of S.No. 4		2255.81		35.19		2291.00	2291.00	
6	Initial Spares @4% of Sl.No. 4		300.78		4.69		305.47	305.47	
7	GST @ 18% of S.No. 4		54.14		0.84		54.98	54.98	
8	Equipment Cost including Spares		12833.08		200.19		13033.27	13033.27	
9	Equipment Cost incl. duties, taxes & spares		15143.03		236.22		15379.26	15379.26	
10	Freight & Insurance on Sl. No. 4		250.65		5.61		256.26	256.26	
11	Freight & Insurance on Sl. No. 6		6.77		0.14		6.91	6.91	
12	Total Equipment Cost incl. Freight & Insurance		15400.45		241.97		15642.43	15642.43	
13	GST @ 18% of S.No. 10		45.12		1.01		46.13	46.13	
14	GST @ 18% of S.No. 11		1.22		0.03		1.24	1.24	
15	Erection, Testing & Commissioning of Sl. No. 4		1697.44		19.55		1716.99	1716.99	
16	GST @ 18% of S.No. 15		305.54		3.52		309.06	309.06	
17	Civil Works		3160.00		3238.50		6398.50	6398.50	
18	GST @18% of Sl. No. 17		568.80		582.93		1151.73	1151.73	
19	Total works Cost		5778.11		3845.53		9623.65	9623.65	
20	Contingency		44.45		96.14		140.59	140.59	
21	Sub Total - EPC & NON-EPC Cost		21223.02		4811.79		26034.81	26034.81	6.51
22	Establishment Costs including Head quarter charges (including reappropriation of Rs 20.61+79.39 Crores)				884.08		884.08	884.08	
23	Consultancy & Engineering				40.00		40.00	40.00	
24	Start up Fuel				700.00		700.00	700.00	
25	Operator training				6.00		6.00	6.00	
26	Total Hard Cost		21223.02		6441.87		27664.89	27664.89	6.92
27	IDC & Financing Cost								
i)	Financing Expenses @0.05% of Sl. No. 21				13.03		13.03	13.03	
ii)	Interest During Construction				8309.54		8309.54	8309.54	
28	CSR @0.4% of Total Project Cost				144.53		144.53	144.53	
29	Total Project cost including IDC & FC		21223.02		14908.97		36131.99	36131.99	9.03

**COST ESTIMATE
MECHANICAL WORKS**

FE Rate 1 US\$ = Rs 64.50

Sl. No.	DESCRIPTION	EPC Cost	Non-EPC Cost	Total Cost
		(Rs Crores)	(Rs Crores)	(Rs Crores)
1	Steam Generator with associated auxiliaries	7900.00		7900.00
2	Electrostatic precipitators			
3	Turbine Generator with associated auxiliaries			
4	Power Cycle Equipment			
5	Power Cycle Piping			
6	Condensate Polishing Plant	55.00		55.00
7	EOT Cranes	5.00		5.00
8	C&I including DAS	100.00		100.00
9	Coal Handling System	350.00		350.00
10	Fuel Oil Handling System	45.00		45.00
11	Ash handling System	200.00		200.00
12	CW Pumps	100.00		100.00
13	Make up Water System	100.00		100.00
14	Cooling Towers (NDCT) fills, nozzles etc.	20.00		20.00
15	Water Treatment Plant	15.00		15.00
16	Compressed Air System	45.00		45.00
17	Effluent Treatment Plant	5.00		5.00
18	Miscellaneous Pumps	35.00		35.00
19	Hydrogen Generation Plant	20.00		20.00
20	Station Piping	50.00		50.00
21	Fire Protection System	40.00		40.00
22	Air Conditioning & Ventilation	32.00		32.00
23	Workshop & Lab Equipment	5.00		5.00
24	Hoisting Equipment	2.50		2.50
25	Diesel Generator	12.00		12.00
26	Equipment Cooling System	15.00		15.00
27	Weigh Bridge	0.80		0.80
28	Signaling & Telecommunication and Marshalling yard and Railway line		185.00	185.00
29	HCSD system for wet fly ash handling system	100.00		100.00
30	RO for treating cooling tower blow down water	50.00		50.00
31	SCR & FGD	2500.00		2500.00
	TOTAL	11802.30	185.00	11987.30

**COST ESTIMATE
ELECTRICAL WORKS**

FE Rate 1 US \$ = Rs 64.50

SI. No.	DESCRIPTION	EPC Cost	Non-EPC Cost	Total Cost
		(Rs Crores)	(Rs Crores)	(Rs Crores)
A	Electrical System			
1	Generator Transformers	60.00		60.00
2	Unit Transformers	15.00		15.00
3	Generator Circuit Breaker	30.00		30.00
4	LT Outdoor Transformers	10.00		10.00
5	LT Indoor Transformers			
6	Generator Bus Duct	70.00		70.00
7	HT Switch gear	150.00		150.00
8	HT Bus duct	45.00		45.00
9	LT Switch gear	55.00		55.00
10	D.C. Battery & Charger	25.00		25.00
11	Station lighting System	20.00		20.00
12	Control & Relay Panels	15.00		15.00
13	HT Power Cables.	140.00		140.00
14	LT Power Cables			
15	Control Cables			
16	Cabling, earthing & Lightning Protection	10.00		10.00
17	Unit Aux. Transformer	30.00		30.00
	Sub-Total (A)	675.00	0.00	675.00
B.	Switchyard (400 kv)	40.00		40.00
	Bus reactors	15.00		15.00
	Sub-Total (B)	55.00	0.00	55.00
C.	IT, SAP & Telecommunications including software development		5.50	5.50
D.	CCTV & Wi-Fi facility		5.00	5.00
	Sub-Total (C)	0.00	5.50	10.50
	TOTAL (A+B+C+D)	730.00	10.50	740.50

**COST ESTIMATE
PRELIMINARY & CIVIL WORKS**

Sl. No.	DESCRIPTION	EPC Cost	Non-EPC Cost	Total Cost
		(Rs Crores)	(Rs Crores)	(Rs Crores)
1	Land & R&R issue		628.14	628.14
2	Survey & Soil Investigation		2.50	2.50
3	Site Clearance & Leveling	341.00		341.00
4	Roads, Bridges,Culverts, drains etc.		680.00	680.00
5	Marshalling yard and railway line		500.00	500.00
6	Boundary Wall (45 km) & Permanent fencing		50.00	50.00
7	Enabling Works (Site office, Construction power, Water etc.)		150.00	150.00
8	Permanent Township		1101.70	1101.70
9	Foundations	375.00		375.00
10	General Civil Works	250.00		250.00
11	Structural Steel Works	425.00		425.00
12	Chimney	375.00		375.00
13	Coal Handling System	350.00		350.00
14	Fuel Oil Handling System	30.00		30.00
15	CW System	125.00		125.00
16	External Water System including piping		354.30	354.30
17	Water Treatment Plant	50.00		50.00
18	Cooling Tower (NDCT)	500.00		500.00
19	Civil work for FGD, SCR & ESP etc.	150.00		150.00
20	Ash handling System	150.00		150.00
21	Ash pond		230.00	230.00
22	Green Belt & Other Soil Erosion mitigation measurs committed to forest department		120.00	120.00
23	RCC Pavement for crushed coal storage yard	39.00		39.00
24	Raw Coal Storage yard		50.00	50.00
	TOTAL	3160.00	3866.64	7026.64

TGGENCO
5X800 MW YADADRI THERMAL POWER PROJECT
DETAILED PROJECT REPORT

Base Case:	5x800 MW TPP
Plant Load Factor (PLF):	85%

Capacity (MW)	4000
---------------	------

Project Cost	
US\$	0.00
Rs (Crores)	36131.99
Total Eq. Rs (Crores)	36131.99
FINANCING	
DEBT	
US\$ (Million)	0.00
Rs (Million)	27098.99
Total Debt Rs (Crores)	27098.99
EQUITY	
US\$ (million)	0.00
Rs (Crores)	9033.00
Total Equity Rs (Crores)	9033.00

75

25

Fuel	%	GCV	Price	Annual Esclation
Domestic Coal	100%	4550	6375	4.0%
Fuel	Coal	Annual Esclation	Support fuel	HFO
Price	6375 Rs/tonne	4.0%	Price	65000 Rs/tonne
GCV	4550 Kcal/Kg		GCV	10000 Kcal/Kg
Transportation Charge (incl. Above)			Transportation charge(incl.above)	
SHR	2120.37	kCal/kWh	Oil Consumption	0.50 ml/kwh
Aux. Cons	6.40%		Sp.Gr.	0.90
Dep'tion for 1-10	3.60%		Transit Loss (Coal)	0.80 %
Dep'tion for 11-25	3.60%			
Present				
exch. rate	64.50	Rs/US\$		
ROE	15.5 %			
Dis'ting				
Factor	13.10%			
Int. on				
Long term				
loan	12.00%			
O&M Cost	23.2	Lacs/MW	5.25%	Annual Esc.

LEVELLIZED TARIFF AT 85% PLF
FIRST YEAR TARIFF AT 85% PLF

6.83
5.99

Rs/KWh
Rs/KWh

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
US\$ Exchange Rate	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50	64.50
Coal price Rs/tonne	6375.00	6630.00	6895.20	7171.01	7457.85	7756.16	8066.41	8389.07	8724.63	9073.61	9436.56	9814.02	10206.58	10614.84	11039.44	11481.01	11940.26	12417.87	12914.58	13431.16	13968.41	14527.15	15108.23	15712.56	16341.06
Transportation Cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coal price at site Rs/tonne	6375.00	6630.00	6895.20	7171.01	7457.85	7756.16	8066.41	8389.07	8724.63	9073.61	9436.56	9814.02	10206.58	10614.84	11039.44	11481.01	11940.26	12417.87	12914.58	13431.16	13968.41	14527.15	15108.23	15712.56	16341.06
Supp.Fuel price Rs/tonne	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00
Transportation Cost	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
supp.Fuel site price Rs/tonne	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00	65000.00
Gross Units Generated	Million Units (MU)																								
PLF	85%	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00	29784.00
Net Units Sent Out	Million Units (MU)																								
PLF	85%	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82	27877.82
Coal Charge Rs/kwh	2.99	3.11	3.24	3.37	3.50	3.64	3.79	3.94	4.10	4.26	4.43	4.61	4.79	4.99	5.19	5.39	5.61	5.83	6.07	6.31	6.56	6.82	7.10	7.38	7.68
Total Variable Charge Rs/kwh	2.99	3.11	3.24	3.37	3.50	3.64	3.79	3.94	4.10	4.26	4.43	4.61	4.79	4.99	5.19	5.39	5.61	5.83	6.07	6.31	6.56	6.82	7.10	7.38	7.68
Total Variable Cost	Rs (Crores)																								
PLF	85%	8905.42	9262.82	9650.02	10037.21	10424.40	10841.38	11288.14	11734.90	12211.44	12687.98	13194.31	13730.42	14266.54	14862.22	15457.90	16053.58	16708.82	17364.07	18078.89	18793.70	19538.30	20312.69	21146.64	21980.59



TELANGANA STATE POWER GENERATION CORPORATION LIMITED

ABSTRACT

Yadadri Thermal Power Station (5x800 MW) – Revised Administrative Approval - Accorded.

T.G.O.O.No. 664/Coal & Commercial/2017

Date: 23.12.2017

Read the following:

1. T.G.O.O.No.210/Coal & Commercial/2015, Dt: 29.08.2015
2. Proceedings No.CE(Coal & Commercial)/SE(Plg)/YTPS/D.No.231/16, Dt: 06.07.2016
3. The minutes of 28th Board meeting of TSGENCO held on 15.12.2017.

* * *

ORDER:

An Administrative approval for Yadadri Thermal Power Station (5x800 MW) was issued vide reference 1st cited for the project cost of Rs.25099.42 Crores including IDC & Financial charges with the approval of TSGENCO Board during the 12th Board meeting held on 19.08.2015. Further, Re-appropriation of the Administrative approval was issued for the project with the same Project Cost of Rs.25099.42 Crores including IDC & Financial charges as per the request of the Chief Engineer/TPC, vide reference 2nd cited above.

The MoEF & CC and TSPCB have put forth certain conditions in the orders issued for Environmental Clearance and Consent for the Establishment respectively for the Project. Accordingly, revised Detailed Project Report has been prepared by duly incorporating the conditions of MoEF & CC and TSPCB and certain additional facilities which were not envisaged in earlier approved DPR. The revised project cost as per the revised DPR (i.e., Addendum to DPR) after incorporating the above is Rs.29965.48 Crores including IDC & Financial charges.

A detailed note has placed before TSGENCO Board during 28th TSGENCO Board meeting held on 15.12.2017 for issuing Revised Administrative Approval for Yadadri Thermal Power Station (5x800 MW) with a Capital Cost of Rs.29965.48 Crores including IDC & Financial charges. In the reference 3rd cited, TSGENCO Board accorded approval for the same.

After careful consideration cited, Revised Administrative Approval for Yadadri Thermal Power Station (5x800 MW) is hereby issued with an estimated Capital Cost of Rs.29965.48 Cr (Rupees Twenty Nine Thousand, Nine Hundred and Sixty Five point Four Eight Crores Only) including IDC and financing charges as per the Annexure.

This Order is issued with the concurrence accorded by the Board of Directors during 28th Board meeting of TSGENCO held on 15.12.2017.

(BY ORDER AND IN THE NAME OF THE TELANGANA STATE POWER GENERATION CORPORATION LIMITED)

Encl: Annexure

K. ANANDAM
CHIEF ENGINEER
(COAL & COMMERCIAL)

Annexure
Yadadri Thermal Power Station (5x800 MW)
Detailed Revised Project Cost

(INR in Crores)

Sl.No	Description	EPC	Non-EPC	Total
1	Land & R&R Issue		845.00	845.00
2	Steam Generator, Turbine and Generator and auxiliaries a) Steam Generator with associated auxiliaries b) Electrostatic precipitators c) Turbine Generator with associated auxiliaries d) Power cycle equipment e) Power cycle piping	7900.00		7900.00
3	Balance of Plant			
(i)	Mechaical	3902.30	185.00	4087.30
(ii)	Electrical & C&I	730.00	10.50	740.50
4	Sub Totla of Equipement cost	12532.30	195.50	12727.80
5	GST @18% of SI.No.4	2255.81	35.19	2291.00
6	Initial Spares	300.78	4.69	305.47
7	GST @18% of SI.No.6	54.14	0.84	54.98
8	Equipement cost including spares	12833.08	200.19	13033.27
9	Equipment cost including duties, taxes & Spares	15143.03	236.22	15379.26
10	Freight & Insurance on SI.No.4	250.65	5.61	256.26
11	Freight & Insurance on SI.No.6	6.77	0.14	6.91
12	Total equipement cost including Freight & Insurance	15400.45	241.97	15642.43
13	GST @ 18% of SI.No.10	45.12	1.01	46.13
14	GST @ 18% of SI.No.11	1.22	0.03	1.24
15	Unloading at site, site handling, Erection, Testing & Commissioning	1697.44	19.55	1716.99
16	GST @ 18% of SI.No.15	305.54	3.52	309.06
17	Civil Works	3160.00	1897.50	5057.50
18	GST @ 18% of SI.No.17	568.80	341.55	910.35
19	Total Works Cost	5778.11	2263.15	8041.27
20	Contingency @2.5% of Total works i.e. Sl. No.19	144.45	56.58	201.03
21	Sub Total - EPC & NON-EPC Cost	21323.02	3406.71	24729.73
22	Establisheemnt cost including headquarter charges @ 3% of SI.No.21		741.89	741.89
23	Consultancy & Engineering		40.00	40.00
24	Startup Fuel		50.00	50.00
25	Operator Training		6.00	6.00
26	Total Hard Cost	21323.02	4244.60	25567.62
27	IDC & Finacing Cost			
(i)	Financing expences @ 0.05% of SI.No.21		12.36	12.36
(ii)	Intrest During Construction		4265.63	4265.63
28	CSR @ 0.4% of Total Project cost		119.86	119.86
29	Total Project cost including IDC & FC	21323.02	8642.46	29965.48

K. ANANDAM
CHIEF ENGINEER
(COAL & COMMERCIAL)

FORWARDED BY ORDER


Divisional Engineer (Planning)



TELANGANA STATE POWER GENERATION CORPORATION LIMITED

ABSTRACT

Yadadri Thermal Power Station (5X800 MW)-Revised Administrative Approval (Rev-2)- Accorded.

T.G.O.O.No.301/Planning/2023

Date:31-03-2023

Read the following:

1. T.G.O.O.No.210/Coal & Commercial/2015, Dt: 29.08.2015
2. Proceedings No.CE(Coal&Comm)/SE(Plg)/YTPS/D.No.231/16,Dt: 06.07.2016
3. T.G.O.O.No.664/Coal & Commercial/2017, Dt: 23.12.2017
4. Proceedings No.CE/Planning/SE(Planning)/YTPS/D.No.136/22, Dt: 11.07.2022
5. The minutes of 57th Board meeting of TSGENCO held on 23.03.2023

ORDER:

Administrative approval was issued for establishment of Yadadri Thermal Power Station (5X800 MW) at Damarcherla, Nalgonda Dist., with an estimated Project Cost of Rs.25099.42 Crores including IDC & Financial charges vide reference (1) cited with the approval of TSGENCO Board during the 12th Board meeting held on 19.08.2015. Re-appropriation of the Administrative approval was issued vide ref 2nd cited, for the same Project Cost of Rs.25099.42 Crores including IDC & Financial charges as per the request of the Chief Engineer/TPC.

Further, MoEF & CC and TSPCB have put forth certain conditions in the orders issued for Environmental Clearance and Consent for the Establishment of the Project. Accordingly, revised administrative approval was issued with revised project cost of Rs.29965.48 Crores, duly incorporating the conditions of MoEF & CC and TSPCB and certain additional facilities which were not envisaged in the earlier approved DPR vide reference 3rd cited with the approval of TSGENCO Board during the 28th Board meeting, held on 23.12.2017. Re-appropriation of the revised administrative approval (RA-2) was issued vide ref 4th cited, for the same project cost of Rs.29,965.48 Crores including IDC & Financial charges as per the request of the Chief Engineer/TPC and the Chief Engineer/Civil/Thermal/TSGENCO .

The Chief Engineer / TPC / TSGENCO has requested for further revision of the project cost to Rs. 34,542.94 Crores due to enhancement of IDC, additional budget for civil works & for startup oil as follows:

- i) An additional amount of Rs.60Cr for Civil works (i.e., increased from Rs.2076.80Cr to Rs.2136.80Cr)
- ii) An additional amount of Rs.650Cr for the startup oil (i.e., from Rs.50Cr to 700Cr.)
- iii) An additional amount of Rs.3,834.37Cr towards IDC (i.e., from Rs.4,265.63 Cr to Rs.8100 Cr.)
- iv) Due to increase in IDC, Civil works, GST on the Civil works and Start up oil, the heads such as Contingency, Establishment costs including Head quarter charges, financial expenses and CSR on the above has been increased from Rs.1309.8 Cr to Rs.1342.9Cr i.e.,Rs.33.1Cr.
- v) The total project cost with the present proposal will increase from Rs.29, 965.48Cr to Rs.34,542.94Cr

Accordingly, Addendum to Detailed Project Report of Yadadri TPS (5x800 MW) has been prepared duly incorporating the above facilities. The revised project cost as per the Addendum to DPR after incorporating the above is **Rs.34,542.95 Crores** including IDC & Financial charges.

A detailed note has placed before TSGENCO Board during 57th TSGENCO Board meeting held on 23.03.2023 for issuing Revised Administrative Approval (Rev-2) for Yadadri Thermal Power Station (5X800 MW) with a Capital Cost of **Rs.34,542.95 Crores** including IDC & Financial charges. In the reference 5th cited, TSGENCO Board accorded approval for the same.

After careful consideration cited, Revised Administrative Approval (Rev-2) for Yadadri Thermal Power Station (5X800 MW) is hereby issued with an estimated Capital Cost of **Rs.34,542.95 Crores (Rupees Thirty Four Thousand, Five Hundred and Forty Two point Nine Five Crores Only)** including IDC and financing charges as per the Annexure.

This Order is issued with the concurrence accorded by the Board of Directors during 57th Board meeting of TSGENCO held on 23.03.2023.

(BY ORDER AND IN THE NAME OF THE TELANGANA STATE POWER GENERATION CORPORATION LIMITED)

Encl: Annexure

Sd/-
K. ANANDAM
CHIEF ENGINEER/PLANNING

To:

The FA&CCA(Audit) & CFO/TSGENCO, Vidyut Soudha, Hyderabad-82
The Chief Engineer/TPC/ TSGENCO, Vidyut Soudha, Hyderabad-82
The Chief Engineer/Civil/Thermal/ TSGENCO, Vidyut Soudha, Hyderabad-82
✓ The Chief Engineer/Coal&Commercial, TSGENCO, Vidyut Soudha, Hyderabad-82
The Chief Engineer/Generation/ TSGENCO, Vidyut Soudha, Hyderabad-82
The FA & CCA/Accounts, TSGENCO, Vidyut Soudha, Hyderabad-82
The FA & CCA/Resources, TSGENCO, Vidyut Soudha, Hyderabad-82
The Superintending Engineer/TPC-IV, TSGENCO, Vidyut Soudha, Hyderabad-82
The Dy.CCA(Resources), TSGENCO, Vidyut Soudha, Hyderabad-82
Pay officer/TSGENCO, Vidyut Soudha, Hyderabad-82

Copy to:

CE/T to Chairman & Managing Director, TSGENCO, Vidyut Soudha, Hyderabad-82
DE/T to Director (Project), TSGENCO, Vidyuth Soudha, Hyderabad-82
DE/T to Director (Thermal), TSGENCO, Vidyut Soudha, Hyderabad-82
DE/T to Director (Hydel), TSGENCO, Vidyut Soudha, Hyderabad-82
DE/T to Director (HR), TSGENCO, Vidyut Soudha, Hyderabad-82
AS to Director (Commercial&Fuel), TSGENCO, Vidyut Soudha, Hyderabad-82
AEE/T to Director (Civil), TSGENCO, Vidyut Soudha, Hyderabad-82
ADE to CGM/Adm, TSGENCO, Vidyut Soudha, Hyderabad-82
PO to Director (Finance), TSGENCO, Vidyut Soudha, Hyderabad-82
Company Secretary, TSGENCO, Vidyut Soudha, Hyderabad-82

FORWARDED BY ORDER


Divisional Engineer (Planning)

ANNEXURE

TOTAL COST ESTIMATES OF YTPS(5X800 MW) (Rev-2)

Rupees in Crores

SI.No	Description	EPC	Non-EPC	Total
1	Land & R&R Issue		628.14	628.14
2	Steam Generator, Turbine and Generator and auxiliaries (As per the details of SI.Nos 1- 5 of Mechanical work)	7900.00	0.00	7900.00
3	Balance of Plant			
	Mechaical	3902.30	185.00	4087.30
	Electrical & C&I	730.00	10.50	740.50
4	Sub Total of Equipement cost	12532.30	195.50	12727.80
5	GST @18% of SI.No.4	2255.81	35.19	2291.00
6	Initial Spares @4% of SI.No.4	300.78	4.69	305.47
7	GST @18% of SI.No.4	54.14	0.84	54.98
8	Equipement cost including spares	12833.08	200.19	13033.27
9	Equipment cost including duties, taxes & Spares	15143.03	236.22	15379.26
10	Freight & Insurance on SI.No.4	250.65	5.61	256.26
11	Freight & Insurance on SI.No.6	6.77	0.14	6.91
12	Total equipement cost including Freight & Insurance	15400.45	241.97	15642.43
13	GST @ 18% of SI.No.10	45.12	1.01	46.13
14	GST @ 18% of SI.No.11	1.22	0.03	1.24
15	Erection, Testing & Commissioning of SI.No.4	1697.44	19.55	1716.99
16	GST @ 18% of SI.No.15	305.54	3.52	309.06
17	Civil Works	3160.00	2136.80	5296.80
18	GST @ 18% of SI.No.17	568.80	384.62	953.42
19	Total Works Cost	5778.11	2545.53	8323.64
20	Contingency @2.5% of Total works i.e. SI. No.14	144.45	63.64	208.09
21	Sub Total - EPC & NON-EPC Cost	21323.02	3479.28	24802.30
22	Establishemnt cost including Headquarter charges @ 3% of SI.No.16		744.07	744.07
23	Consultancy & Engineering		40.00	40.00
24	Startup Fuel		700.00	700.00
25	Operator Training		6.00	6.00
26	Total Hard Cost	21323.02	4969.35	26292.37
27	IDC & Finacing Cost			
	Financing expences @ 0.05% of SI.No.21		12.40	12.40
	Intrest During Construction		8100.00	8100.00
28	CSR @ 0.4% of Total Project cost		138.17	138.17
29	Total Project cost including IDC & FC	21323.02	13219.92	34542.95

(Rupees Thirty Four Thousand Five Hundred and Forty Two point Nine Five Crores Only)

Sd/-

CHIEF ENGINEER /PLANNING

FORWARDED BY ORDER


Divisional Engineer (Planning)



TELANGANA POWER GENERATION CORPORATION LIMITED

ABSTRACT

Yadadri Thermal Power Station (5X800 MW)-Revised Administrative Approval (Rev-3) with Revised Project Cost of Rs. 36,131.99 Crores including IDC & Financing costs - Accorded.

T.G.O.O.No.179/Planning/2024

Date:20-03-2025

Read the following:

1. T.G.O.O.No.210/Coal & Commercial/2015, Dt: 29.08.2015
2. Proceedings No.CE(Coal&Comm)/SE(Plg)/YTPS/D.No.231/16,Dt: 06.07.2016
3. T.G.O.O.No.664/Coal & Commercial/2017, Dt: 23.12.2017
4. Proceedings No.CE/Planning/SE(Planning)/YTPS/D.No.136/22, Dt: 11.07.2022
5. T.G.O.O.No.301/Planning/2023, Dt: 31.03.2023
6. Proceedings No.CE/Planning/SE(Planning)/YTPS/D.No.223/2024, Dt:20.11.2024
7. Proceedings No.CE/Planning/SE(Planning)/YTPS/D.No.262/2024, Dt:24.12.2024
8. The minutes of 70th Board meeting of TGGENCO held on 12.02.2025

ORDER:

Administrative approval was issued for establishment of Yadadri Thermal Power Station (5X800 MW) at Damarcherla, Nalgonda Dist., with an estimated Project Cost of **Rs.25,099.42 Crores** including IDC & Financial charges vide reference (1) cited with the approval of TGGENCO Board during the 12th Board meeting held on 19.08.2015. Re-appropriation of the Administrative approval was issued vide ref 2nd cited, for the same Project Cost of Rs.25,099.42 Crores including IDC & Financial charges as per the request of the Chief Engineer/TPC.

Further, MoEF & CC and TSPCB have put forth certain conditions in the orders issued for Environmental Clearance and Consent for the Establishment of the Project. Accordingly, revised administrative approval was issued with revised project cost of **Rs.29,965.48 Crores**, duly incorporating the conditions of MoEF & CC and TSPCB and certain additional facilities which were not envisaged in the earlier approved DPR vide reference 3rd cited with the approval of TGGENCO Board during the 28th Board meeting, held on 23.12.2017. Re-appropriation of the revised administrative approval (RA-2) was issued vide ref 4th cited, for the same project cost of **Rs.29,965.48 Crores** including IDC & Financial charges as per the request of the Chief Engineer/TPC and the Chief Engineer/Civil/Thermal/TGGENCO.

Further, the Chief Engineer / TPC /TGGENCO has requested for further revision of the project cost to **Rs. 34,542.94 Crores** due to enhancement of IDC, additional budget for civil works & for startup oil excluding township. Accordingly, the Revised Administrative Approval (Rev-2) was issued vide ref 5th cited, with the revised project cost of **Rs. 34,542.95 Crores** including IDC & Financial charges, with the approval of TGGENCO Board during the 57th Board meeting, held on 23.03.2023. As per the request of the Chief Engineer/TPC, re-appropriations of the revised administrative approval RA-3 & RA-4 have been issued vide ref 6th & 7th cited, for the same project cost of **Rs. 34,542.95 Crores** including IDC & Financial charges duly re-appropriating Rs. 100 Crores From "Contingency of EPC" to "Establishment cost including head quarter charges under Non-EPC".

Now, the Chief Engineer/TPC/TGGENCO has informed that, approval was accorded by the Principal Secretary to Government, Energy Department, GoTG vide G.O.Rt.No.52, Dt:17.10.2024, for revision of the Project Cost of (5x800 MW) Yadadri TPS from Rs. 34,542.95 Crs to **Rs.36,131.99 Crs** i.e. an increase of Rs. 1,589.04 Crs as detailed below:

- a) Inclusion of the cost of construction of quarters, other Non-residential buildings & infrastructural works of the township at Rs.1,300 Crores.

- b) IDC on house loan and contingency & establishment cost etc., at Rs.289.04 Crs.
- c) Approval from the State Government for undertaking the above proposed Housing scheme at YTPS and raising of loan from HUDCO, Hyderabad for a total amount of Rs.1,300 Crores.

Accordingly, Addendum to Detailed Project Report of Yadadri TPS (5x800 MW) has been prepared duly incorporating the above facilities. The revised project cost as per the Addendum to DPR after incorporating the above is **Rs.36,131.99 Crores** including IDC & Financial charges.

A detailed note has placed before TGGENCO Board during 70th TGGENCO Board meeting held on 12.02.2025 for issuing Revised Administrative Approval (Rev-3) for Yadadri Thermal Power Station (5X800 MW) with a Capital Cost of **Rs.36,131.99 Crores** including IDC & Financial charges. In the reference 8th cited, TGGENCO Board accorded approval for the same.

After careful consideration, Revised Administrative Approval (Rev-3) for Yadadri Thermal Power Station (5X800 MW) is hereby issued with an estimated Capital Cost of **Rs.36,131.99 Crores (Rupees Thirty Six Thousand One Hundred and Thirty One point Nine Nine Crores Only)** including IDC and financing charges as per the Annexure.

This Order is issued with the concurrence accorded by the Board of Directors during 70th Board meeting of TGGENCO held on 12.02.2025.

(BY ORDER AND IN THE NAME OF THE TELANGANA POWER GENERATION CORPORATION LIMITED)

Encl: Annexure

Sd-

P.RATNAKAR
CHIEF ENGINEER/PLANNING

To:

The FA&CCA (Audit) & CFO/TGGENCO, Vidyut Soudha, Hyderabad-82
The Chief Engineer/TPC/ TGGENCO, Vidyut Soudha, Hyderabad-82
The Chief Engineer/Civil/Thermal/ TGGENCO, Vidyut Soudha, Hyderabad-82
The Chief Engineer/Coal&Commercial, TGGENCO, Vidyut Soudha, Hyderabad-82
The Chief Engineer/Generation/ TGGENCO, Vidyut Soudha, Hyderabad-82
The FA & CCA/Accounts, TGGENCO, Vidyut Soudha, Hyderabad-82
The FA & CCA/Resources, TGGENCO, Vidyut Soudha, Hyderabad-82
The Superintending Engineer/TPC-IV, TGGENCO, Vidyut Soudha, Hyderabad-82
The Dy.CCA (Resources), TGGENCO, Vidyut Soudha, Hyderabad-82
Pay officer/TGGENCO, Vidyut Soudha, Hyderabad-82

Copy to:

AS&PS to Chairman & Managing Director, TGGENCO, Vidyut Soudha, Hyderabad-82
DE/T to Director (Project), TGGENCO, Vidyut Soudha, Hyderabad-82
DE/T to Director (Thermal), TGGENCO, Vidyut Soudha, Hyderabad-82
DE/T to Director (Hydel), TGGENCO, Vidyut Soudha, Hyderabad-82
DE/T to Director (HR), TGGENCO, Vidyut Soudha, Hyderabad-82
AS to Director (Commercial&Fuel), TGGENCO, Vidyut Soudha, Hyderabad-82
AEF/T to Director (Civil), TGGENCO, Vidyut Soudha, Hyderabad-82
ADE/T to CGM/Adm, TGGENCO, Vidyut Soudha, Hyderabad-82
PO to Director (Finance), TGGENCO, Vidyut Soudha, Hyderabad-82
Company Secretary, TGGENCO, Vidyut Soudha, Hyderabad-82

CE(Plg)/SE(Plg)/DE(Plg)/YTPS/94/2025

//FORWARDED:: BY ORDER//


Divisional Engineer (Planning)

ANNEXURE

YADADRI THERMAL POWER STATION (5X800 MW)-Cost Estimates (Rev-3)


Sl.No	Description	Rupees in Crores		
		EPC	Non-EPC	Total
1	Land & R&R Issue		628.14	628.14
2	Steam Generator, Turbine and Generator and auxiliaries (As per the details of Sl.Nos 1- 5 of Mechanical work)	7900.00	0.00	7900.00
3	Balance of Plant			
	Mechanical	3902.30	185.00	4087.30
	Electrical & C&I	730.00	10.50	740.50
4	Sub Total of Equipment cost	12532.30	195.50	12727.80
5	GST @18% of Sl.No.4	2255.81	35.19	2291.00
6	Initial Spares	300.78	4.69	305.47
7	GST @18% of Sl.No.6	54.14	0.84	54.98
8	Equipment cost including spares	12833.08	200.19	13033.27
9	Equipment cost including duties, taxes & Spares	15143.03	236.22	15379.26
10	Freight & Insurance on Sl.No.4	250.65	5.61	256.26
11	Freight & Insurance on Sl.No.6	6.77	0.14	6.91
12	Total equipment cost including Freight & Insurance	15400.45	241.97	15642.43
13	GST @ 18% of Sl.No.10	45.12	1.01	46.13
14	GST @ 18% of Sl.No.11	1.22	0.03	1.24
15	Erection, Testing & Commissioning of Sl.No.4	1697.44	19.55	1716.99
16	GST @ 18% of Sl.No.15	305.54	3.52	309.06
17	Civil Works	3160.00	3238.50	6398.50
18	GST @ 18% of Sl.No.17	568.80	582.93	1151.73
19	Total Works Cost	5778.11	3845.53	9623.65
20	Contingency	44.45	96.14	140.59
21	Sub Total - EPC & NON-EPC Cost	21223.02	4811.79	26034.81
22	Establishment cost including Headquarter charges (including re-appropriation of Rs. 100 Crs. from Contingency)		884.08	884.08
23	Consultancy & Engineering		40.00	40.00
24	Startup Fuel		700.00	700.00
25	Operator Training		6.00	6.00
26	Total Hard Cost	21223.02	6441.87	27664.89
27	IDC & Financing Cost			
	Financing expences @ 0.05% of Sl.No.21		13.03	13.03
	Interest During Construction		8309.54	8309.54
28	CSR @ 0.4% of Total Project cost		144.53	144.53
29	Total Project cost including IDC & FC	21223.02	14908.97	36131.99

(Rupees Thirty Six Thousand One Hundred and Thirty One point Nine Nine Crores Only)

Sd/-

CHIEF ENGINEER /PLANNING

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 Divisional Engineer (Planning)

