FEASIBILITY REPORT

4 x 150 MW, SURGUJA THERMAL POWER PROJECT

Developer:

SURGUJA POWER PRIVATE LIMITED

DOC. NO. : SPPL/THERMAL/CHHATTISGARH/FR/R0 **February - 2017**

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

1.1 INTRODUCTION

Surguja Power Private Limited (SPPL), which is a 100% subsidiary of Adani Enterprises Limited (AEL) is planning to set up 600 MW (4 x 150 MW) Thermal Power Project based on CFBC Boiler using the Washery Rejects near the Parsa East and Kente Basan Coal Block at Udaypur Tehsil, Surguja District, Chhattisgarh.

The 4x150 MW Thermal Power Project, shall consist of four (4) CFBC steam generators each connected to a dedicated steam turbine generator along with all the required auxiliaries. The design power output of the each unit shall be 150 MW at 100% TMCR condition.

Adani Group, an US $10 billion company based in Ahmedabad, is one of the fastest growing Business House of the country with diverse interest in global trading, development and operation of Ports, IDC terminal, establishment of SEZ, oil refining, logistics, gas distribution, power generation, power transmission and power trading etc. ADANI Group is one of the leading business houses of the country with combined market capitalization of around US$ 14 billion, a sales turnover of US$ 9.4 billion, employing over 10,000 people.

Adani Power Limited, a subsidiary of Adani Enterprises Limited is developing a number of power projects along with its associated dedicated transmission systems.

Presently, Adani Power Limited is successfully operating 4620 MW Mundra Thermal Power Project (Stage I – 2 x 330 MW, Stage II - 2 x 330 MW, Stage III – 2 x 660 MW Stage IV – 3 x 660 MW) in Gujarat, 3300 MW Thermal Power Project at Tiroda, Maharashtra (Stage I – 2x660 MW, Stage II – 3x660 MW), 1320 MW Thermal Power Project at Kawai (2 x 660 MW), Rajasthan & 2x600 MW TPP in Udupi, Karnataka. In addition to the above group has also established 40 MW Solar Power project at Bitta, Gujarat, Solar PV based 648 MW project in Kamudhi, Tamil Nadu, and 100 MW Solar project at Bhatinda, Punjab.

Besides, these projects Adani Power Ltd. is also planning to develop 1600 MW (2X 800MW) Udupi Expansion at Udupi in Karnataka; 1600 MW (2X 800MW) at Godda in Jharkhand, 3200 MW (4x800 MW) at Dahej, Gujarat, 1320 MW (2x660MW) at Pench, Madhya Pradesh, (2x800 MW) Phase II at Kawai Rajasthan, and other large capacity projects. In Thermal Sector, The group is also developing a 10,000 MW Solar park in the state of Rajasthan.

1.2 LOCATION OF THE PLANT

The proposed site is located near Village Parsa, Tehsil Udaypur, district Surguja, in Chhattisgarh. The power plant is located within the mine lease area of Parsa East and Kete Basen coal blocks as per the Environment Clearance accorded to RRVUNL for the mining project.

1.3 TYPE OF PLANT

The proposed project comprises of Four (4) units each of 150 MW gross capacity. Washery Rejects is envisaged as the fuel for the plant. The plant will be designed for base load operation with minimum plant design life of 25 years.

1.4 ACCESS TO SITE

The Major National Highway, NH-111 connecting Bilaspur and Ambikapur is around 4 km away on the Northern side of the proposed site. The nearest railway station at Bisrampur is around 70 km from site on the Northern side. The nearest airport is Raipur which is located at 290 km away from the proposed site on the southern side. The nearest port is Paradip port, Odisha which is located at 700 km away from the project site on South Eastern side. Vishakhapatnam Port in Andhra Pradesh is also located at around 780 km south of project site.

1.5 PROJECT COST

The total cost of the project has been estimated at Rs. 4997.93Crores. The Project Cost estimate includes all expenses to be incurred towards the entire project development including Site Development Expenses, Payments to Contractors, Non EPC Expenses, Pre-Operating Expenses, Start-Up Fuel & Commissioning Expenses, Contingency and Financing Expenses including Interest during Construction (IDC). Project cost also includes the Transmission line and Raw water Intake system and Piping system.

1.6 PROJECT COMPLETION SCHEDULE

The project schedule is presented in Exhibit – 1. It is envisaged that the first unit would be put in to commercial operation in about 27 months reckoned from the Zero Date, which shall be defined as the start of construction activities at site. Subsequently, the second, third and fourth units will be put into commercial operation in 33, 39 and 45 months respectively.

1.7 LAND AVAILABILITY

The proposed site is located near Village Parsa, Tehsil Udaypur, district Surguja in Chhattisgarh. The power plant is located within the mine lease area of Parsa East and Kete Basen coal blocks.

RRVUNL has approved 47.5 ha of the land required for setting up the power plant within the Mining Project Area. 4 x 150 MW (600 MW) plant will be accommodated within the plot including provision of Raw water reservoir and greenbelt development as per pollution control norms will be provided.

The land of the project site is mainly constitutes of agricultural and forest land. There are no water bodies or major village roads within the project site. The land of the project site has been already acquired by Rajasthan Rajya Vidyut Utpadan Nigam Limited (RRVUNL) as part of the Parsa East and Kente Basen Coal Blocks. Environment clearance is issued by Ministry of Environment and Forest (MOEF) dated 21st December, 2011 to RRVUNL for open cast mine project.

1.8 FUEL AVAILABILITY

The fuel for the plant will be Washery rejects. The washery reject is transported to the project site through Belt conveyors from the washery reject storage bin located within mine area adjacent to the power plant boundary on the western side of the project site. Intermediate storage of washery reject is envisaged within the power plant boundary.

As per Environment clearance issued by MOEF for Open cast Mine project, the washery rejects generated from the washery plant is to be fully utilized in the proposed pithead FBC based Thermal power plant.

1.9 WATER AVAILABILITY

River water is proposed to be used for meeting the complete water requirement of the project. The water for the plant will be sourced from nearby Atem and Rehar River. Water allocation has been received from Water resources department, Raipur, Govt. of Chhattisgarh in March 2011. Raw water reservoir will be constructed within power plant to store the pumped water from the river to supply water throughout the year to the power station and the storage is envisaged for 20 days.

1.10 POWER EVACUATION

The total power generated from the power plant will be 600MW. After meeting the power requirement for the station auxiliaries remaining power will be available for export. Generated power will be stepped up to 400kV level by using step up generator transformers. To enable power evacuation, a 400kV gas insulated switchyard with one and half breaker arrangement will be provided. Power from the plant will be exported to the grid through 400 kV double circuit line

1.11 CONCLUSION

The adequate land for the project has been identified in the mining lease area of the Parsa East and Kente Basan Coal Block at Tehsil Udaypur, District Surguja, Chhattisgarh. RRVUNL has approved the land for the power plant within the Mining Project Area.

For the projected future power demand scenario in India, especially in the Western India and State of Chhattisgarh, installing a Power Plant of 4x150 MW capacity with CFBC technology

for utilization of washery reject as fuel with water cooled condenser, assured Water source, Fuel source, Transmission network is considered to be economically viable. The power plant concept and the technical features selected for the plant and equipment are standard and proven.

2.0 NECESSITY AND JUSTIFICATION OF THE PROJECT

2.1 INTRODUCTION

The power demand in India is increasing rapidly due to rapid industrial and infrastructure developments. The capacity addition at the present rate will not be able to meet the projected demand and would result in a huge power deficit. To mitigate the gap between demand and supply, Govt. of India is facilitating large scale capacity additions in shorter time through public and private investments. To enable larger participation by private sector, the concept of merchant power and power trading has been introduced.

With a view to participate and benefit from this initiative, Surguja Power Private Limited, 100 % subsidiary of Adani Enterprises Limited (AEL) has proposed to construct and operate a 4 x 150 MW TPP near Parsa village, Tehsil Udaypur, district Surguja in Chhattisgarh.

2.2 PRESENT POWER SECTOR POSITION IN INDIA

Over the years, the Electricity Industry has made significant progress, Installed capacity increased from 143061 MW (2008) to 304760 MW (Jul 2016). Annual per capita electrical energy consumption is increased to over 1048 kWh/annum (2015). The present growth rate in power generation is about 5.64%.

Installed Capacity in India

Type	Installed Capacity (MW)
Hydro	42888.43
Coal	186292.88
Gas	24643.63
Diesel	918.89
Nuclear	5780.00
Renewable	44236.92
Total	**304760.75**

Source: Central Electricity Authority-31.07.2016.

Actual Power Demand Vs Supply Position in India during last 7 years

Year	Demand (MW)	Supply (MW)	Deficit (%)
2009-10	119166	104009	-12.7
2010-11	122287	110256	-9.8
2011-12	130006	116191	-10.6
2012-13	135453	123294	-9.0
2013-14	135918	129815	-4.5
2014-15	148166	141160	-4.7
2015-16	153366	148463	-3.2
2016-17 *	152974	149971	-2

* Provisional
Source: Ministry of Power upto Jul 2016

All the three sectors namely Central, State and Private contribute to the availability of power in the country. States sector owns a share of about 34%, central sector owns a share of about 27% of installed capacity and the rest by private sector i.e. 39%. Major contribution of energy came from thermal followed by hydel energy.

The installed generating capacity has increased by more than hundred folds, annual electricity generation by more than ninety folds and annual per capita consumption of electricity by more than forty folds in the last 50 years. The size and expansion of transmission and distribution network has also increased substantially over the years.

The primary resources for electric power generation are water, fossil fuel (coal, lignite, oil and natural gas) and nuclear energy. These would continue to serve as major sources of power generation in the long run, though various forms of renewable sources viz, wind, bio-mass, tides, etc., will also contribute to meeting the demand.

Capacity addition in the successive Five year plan

Plan	Year	Target (MW)	Achievement (MW)
11th	2007-2012	78700	54964
12th	2012-2017	88537	86565.75*

Source: Central Electricity Authority-

* upto Jul 2016 includes spill over capacity of 11th Plan.

Based on the report of the Working Group on Power constituted by Planning Commission, a capacity addition of 78700 MW was targeted in 11th plan comprising 15627 MW of hydro, 59693 MW of thermal and 3380 MW of Nuclear. Out of the total thermal capacity of 59693 MW, the coal/lignite based capacity addition was 48534 MW during the 11th Plan.

As per Central Electricity Authority's (CEA) projection for the 12th Plan (2012-2017), the capacity addition requirement is 88537 MW comprising of 10897 MW of hydro, 72340 MW of thermal and 5300 MW of nuclear. Out of the total thermal capacity of 72340 MW, the coal/lignite based capacity shall be 69800 MW. This implies that the capacity addition has to be about 14500 MW per annum through coal/lignite alone.

The 12th five year plan calls for an additional 17000 MW to 18000 MW of power per annum, more than twice the figure achieved in each of previous years. The 12th five year plan program is comparatively large so as to provide not only for normal growth during the 12th plan period but also to compensate for shortfall in the capacity addition during the 11th plan period.

Keeping in view the huge power generation capacity requirement to be added during the 12th Plan period, a rapid capacity addition through large scale thermal power development

programme is planned. Total capacity of 50958 MW has been commissioned during 12th plan period so far.

2.3 POWER SUPPLY AND DEMAND POSITION IN CHHATTISHGARH AND WESTERN REGION

For the purpose of power planning and operation of the regional grid the western region consists of the following states:

- Chhattisgarh
- Gujarat
- Madhya Pradesh
- Maharashtra
- Goa
- Daman & Diu
- Dadra and Nagar Haveli

All the three sectors namely Central, State and Private contribute to the availability of power in the Western region. Coal based power plant occupy about 67% of installed capacity in this region.

Even though power generated from the proposed power project would be consumed by Chhattisgarh state, it is proposed that the remaining power would be sold to power deficit states in the Western region.

2.3.1 Present Power Scenario

The power scenario i.e. installed capacity & actual power supply position in Chhattisgarh state & Western region are given below.

2.3.1.1 Chhattisgarh

Installed Capacity (MW)

S.No	Sector	Hydro	Thermal	Nuclear	R.E.S.	Total
1	Private	0	10598	0	414.43	11012.43
2	State	120	2780	0	11.05	2911.05
3	Central	0	1574.54	47.52	0	1622.06

Total Installed Capacity as on 30.06.2016 is 15545.54 MW

Actual Power Supply Position

S.No	Period	Peak Demand (MW)	Peak Met (MW)	Deficit (MW)	% Deficit
1	2002-2003	1548	1492	-56	-3.6
2	2003-2004	1730	1566	-164	-9.5

S.No	Period	Peak Demand (MW)	Peak Met (MW)	Deficit (MW)	% Deficit
3	2004-2005	1893	1749	-144	-7.6
4	2005-2006	2133	1857	-276	-12.9
5	2006-2007	2631	1907	-724	- 27.5
6	2007-2008	2421	2188	-233	- 9.6
7	2008-2009	2887	2830	-57	- 2.0
8	2009-2010	2819	2703	-116	- 4.1
9	2010-2011	3275	2579	-696	- 21.2
10	2011-2012	3239	3093	-146	- 4.5
11	2012-2013	3271	3134	-137	- 4.2
12	2013-2014	3365	3320	-45	-1.3
13	2014-2015	3817	3638	-179	- 4.7
14	2015-2016	3875	3851	-25	-0.6

Source: Central Electricity Authority upto 30.06.2016.

2.3.1.2 Overview of Western Region

Installed Capacity (MW)

S.No	Sector	Hydro	Thermal	Nuclear	R.E.S.	Total
1	Private	447	40713	0	15003.73	56163.73
2	State	5480.50	26403.82	0	311.19	31835.31
3	Central	1520	16431.80	1840	0	19791.60

Total Installed Capacity as on 30.06.2016 is 107790.84 MW

Actual Power Supply Position

S.No	Period	Peak Demand (MW)	Peak Met (MW)	Deficit (MW)	% Deficit
1	2002-2003	28667	22853	-5824	-20.3
2	2003-2004	29704	23657	-6047	-20.4
3	2004-2005	31085	24128	-6957	-22.4
4	2005-2006	31772	25257	-6515	-20.5
5	2006-2007	36453	27463	-8990	-24.7
6	2007-2008	38227	29385	-8892	-23.2
7	2008-2009	37240	30154	-7086	-19
8	2009- 2010	39609	32586	-7023	-17.7
9	2010-2011	40210	34732	-5478	-13.6
10	2011-2012	42352	36509	-5843	-13.3
11	2012-2013	40075	39486	-589	-1.5

S.No	Period	Peak Demand (MW)	Peak Met (MW)	Deficit (MW)	% Deficit
12	2013-2014	41335	40331	-1004	-2.4
13	2014-2015	44166	43145	-1021	-2.3
14	2015-16	45369	44957	-412	-0.9

Source: Central Electricity Authority

2.3.2 Future Power Demand

CEA has made projections for the future demand of power in Chhattisgarh State (as per 18th EPS) and the same is compared with actual demand as follows:

YEAR	PEAK LOAD-MW		ENERGY-MU	
	Requirement as per 18th EPS	Actual Demand	Requirement as per 18th EPS	Actual Requirement
2010-11	3069	2759	15134	14959
2011-12	3293	3155	16368	16304
2012-13	3534	3424	17703	17697
2013-14	3792	3707	19146	19157
2014-15	4070	4016	20707	20756
2015-16	4367	4343	22396	22448
2016-17	4687		24222	

Source: Report on 18th Electric Power Survey of India and Power at a glance by CEA-Nov. 2012.

2.3.2.1 Chhattisgarh

The future demand in the State and in the Western region, up to 2021-22, as per the 18th Electrical Power Survey is given below:

Energy/Power	*Year*	*Chhattisgarh*
Peak Demand (MW)	2016-17	4687
	2021-22	6599
Energy Requirement (MU)	2016-17	24222
	2021-22	34106

The demand forecast for the Chhattisgarh state as per the 18th Electrical Power Survey, Gov. of India.

2.3.2.2 Western Region

Energy/Power	*Year*	*Western Region*
Peak Demand (MW)	2016-17	62015
	2021-22	86054
Energy Requirement (MU)	2016-17	394188
	2021-22	539310

The demand forecast for the Western Region as per the 18th Electrical Power Survey, Gov. of India.

2.4 CAPACITY ADDITION PLANNED

To mitigate the supply and demand, likely capacity addition planned during the 12th five year plan period is about 34772 MW in the western region.

The rapid pace of all round developments of the states in the region due to globalization of economy has seen the states in the region to be a few of the highest power consuming states in the country. The power demand and availability figures of the states exhibit a wide uncovered margin calling attention of the planners to accelerate the pace of growth in this core sector. With the present trend of growth rate ranging around 7-9% for the past two decades, the concern of State Government in the region can be gauged from the urgency with which they are exploring all possible means of augmenting the generating capacity.

Sl. No	Power Position – Western Region	Unit	Value
1	Present Installed Capacity	MW	107790.84
2	Present Peak Generation (Jun 2016)	MW	44957
3	Present peak availability (2)/(1)	%	41.70
4	Power demand forecast at the end of 12th Plan	MW	62015
5	Expected Load Factor (worst)-Refer (3)	%	41.70
6	Estimated Installed Capacity required at the end of 12th Plan (4)/(5)	MW	138157.25
7	Planned capacity addition during 12th Plan	MW	34772
8	Deficiency at the end of 12th Plan (6)-{(1)+(7)}	MW	2137.71

The power scenario in Western Region during 12th five year Plan is discussed in detail and need for the proposed station is studied in this section in the back drop of past and future power demands: viz:, present and future generation capacities planned for bridging the gap. In order to narrow down the gap between supply and demand, an urgent need is felt for a large scale thermal power development programme in an environment friendly manner.

2.5 CONFIGURATION & JUSTIFICATION

The power demand-supply scenario during 12th plan period on projections for the future demand (as per 18th EPS) as described above highlights the need for setting up a large capacity plants to match the demand in short time. It is therefore proposed to set up 4 x 150 MW thermal power plant in Chhattisgarh which will not only cater power to Chhattisgarh state but also will be utilized for supplying power to the power deficit western region and rest of India. The raw water for the plant will be sourced from nearby Atem and Rehar River for which water allocation has been received from Water resources department, Govt. of Chhattisgarh. The fuel for the proposed project is washery rejects from Parsa East & Kente Basen Coal Blocks which will be transported to the project site through Belt conveyors from the washery reject storage bin located adjacent to the power plant boundary on the western

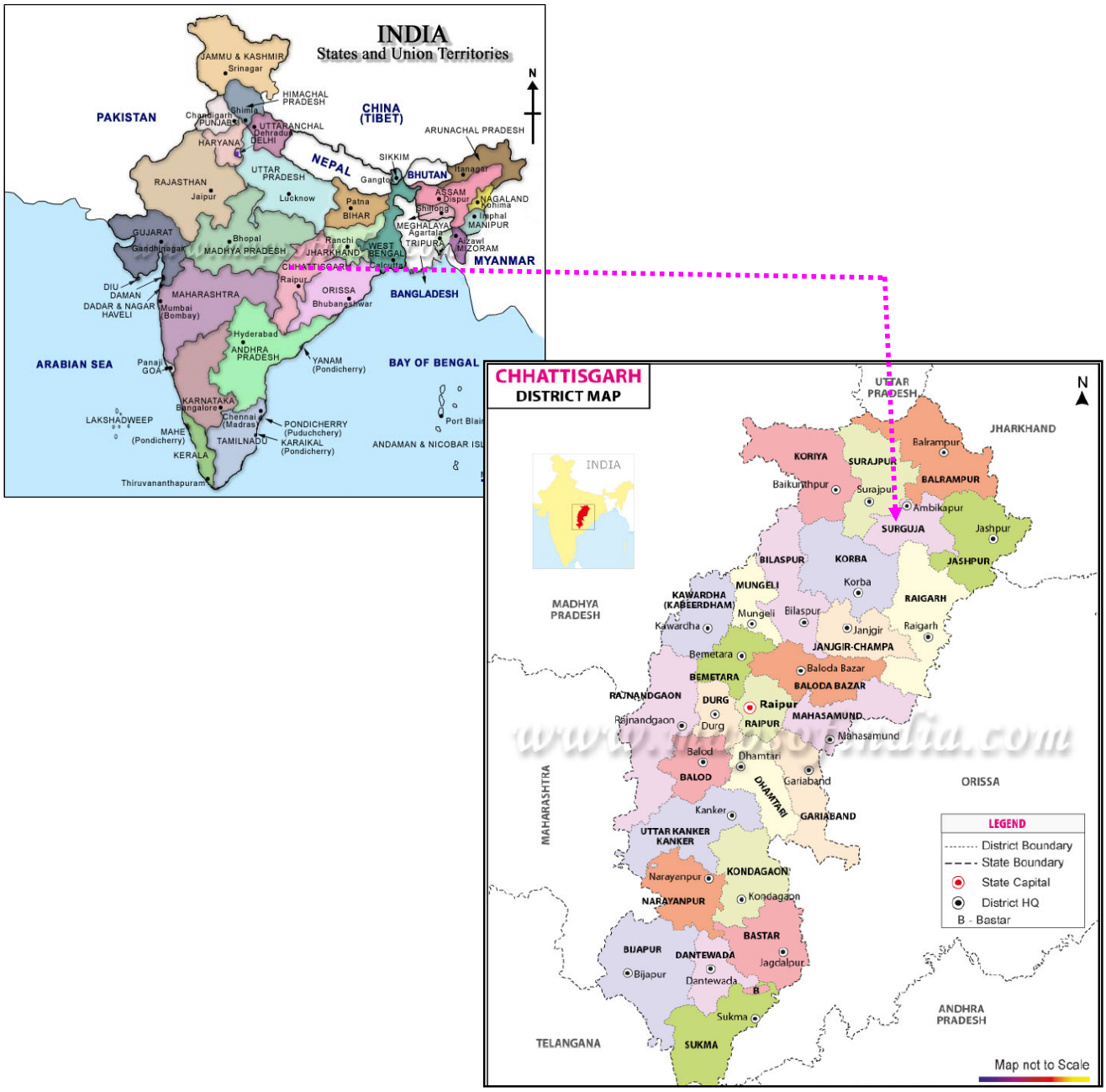
side of the project site. Taking all these into consideration, establishment of the proposed washery reject based Power Plant of 4 x 150 MW at this location is well justified.

3.0 LAND AVAILABILITY AND SITE SELECTION

3.1 LOCATION AND ACCESS

3.1.1 Location

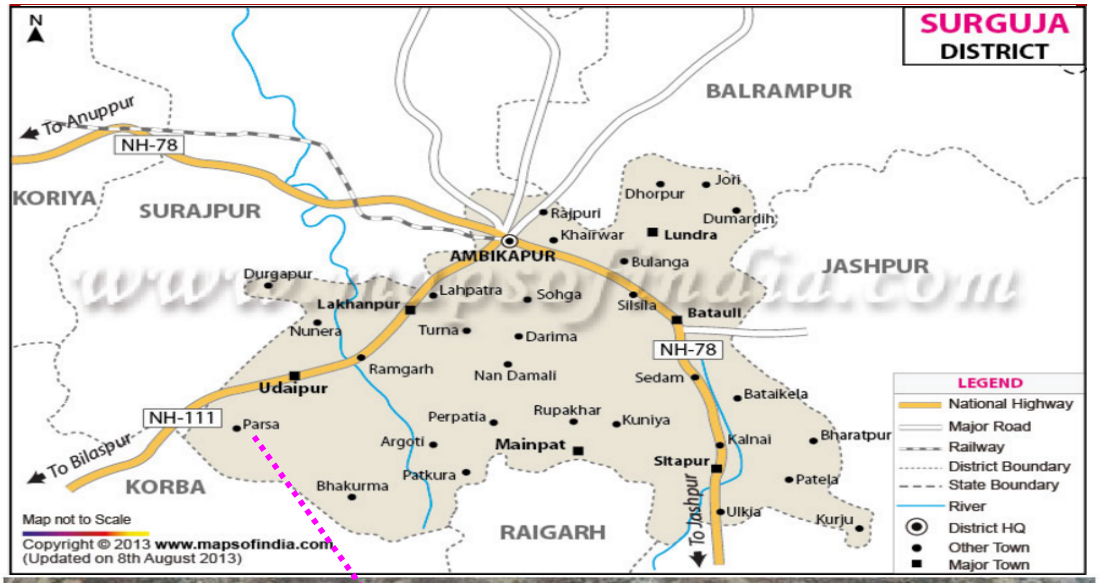
The proposed 4 x 150 MW Thermal Power Project is located near Village Parsa, Tehsil Udaypur, district Surguja Chhattisgarh. The power plant is proposed to be located within the mine lease area of Parsa East and Kete Basen coal blocks as per the Environment Clearance accorded to RRVUNL for the mining project.



3.1.2 Access

The Major National Highway, NH-111 connecting Bilaspur and Ambikapur is around 4 km away on the Northern side of the proposed site. The nearest railway station at Bisrampur is around 70 km from site on the Northern side. The nearest airport is Raipur which is located at 290 kms away from the proposed site on the southern side. The nearest port is Paradip port, Odisha which is located at 700 km away from the project site on South Eastern side. Vishakhapatnam Port in Andhra Pradesh is also located at around 780 km south of project site.

LOCATION OF PROPOSED SITE



3.2 CURRENT USAGE, LAND CLASSIFICATION & TOPOLOGY

The land-use of the project site is mainly constitutes of agricultural and forest land. There are no water bodies or major village roads within the project site. The land of the project site has been already acquired by Rajasthan Rajya Vidyut Utpadan Nigam Limited (RRVUNL) as part of the Parsa East and Kente Basen Coal Blocks. Environment clearance is issued by Ministry of Environment and Forest (MOEF) dated 21st December, 2011 to RRVUL for open cast mine project

RRVUNL has approved land required for setting up the power plant within the Mining lease Area.

The project is being set up on an already acquired land having no encumbrances.

The project area is located on a plateau and has mounts along its boundary having undulating terrain. The elevation of the site was found to vary between 524 m to 545 m AMSL within the project site area. The general slope of the site is towards the southern direction. The power plant layout will be developed with different grade level based on the topography in order to optimize the cutting and filling of the site during the construction. Trees, bush/grass growth shall be removed. No major HT lines / Power cables are passing through the proposed site..

3.3 SITE SELECTION

The following factors which influence the site selection are favorable to select this site.

a. The Fuel required for power station is washery reject from Parsa Kete Collieries Ltd Mines Washery which is available adjacent to the project site.
b. Availability of adequate consumptive water.
c. Availability of adequate land for locating the power plant with approach roads.
d. Proximity of National Highways, Transport of fuel & heavy equipment.
e. Facility for interconnection with 400 kV transmission systems for evacuation of power.
f. Availability of infrastructure facilities.

3.4 EXTENT OF LAND REQUIREMENT

The total available land area for power plant is around 106 acres. 4 x 150 MW (600 MW) plant will be accommodated within the plot including provision of Raw water reservoir and adequate area would be reserved for greenbelt development as per pollution control norms.

The land required for putting up the proposed 4 X 150 MW Thermal Power Project is summarized below:

Sl. No.	Description	Area in Acre
1	Power Block Area	24
2	Water system	27
3	Ash pond	Not applicable. Complete ash is proposed to be utilized for mine back filling.
4	Washery Reject handling system	10
5	Land for Green belt and other facilities including laydown area, roads & other misc.	55
	Total	106

3.5 FEATURES OF SELECTED SITE

3.5.1 Water

3.5.1.1 Raw Water

River water is proposed to be used for meeting the complete water requirement of the project. The water for the plant will be sourced from nearby Atem and Rehar River. The Atem river is around 5 km away from the project site on the Northern side and Rehar river is around 25 km on the eastern side of the site. The water for the power plant shall be drawn through Lipangi Tunnel of Rehar – Atem river link. Raw water reservoir will be constructed within power plant to store the pumped water from the river to supply water throughout the year to the power station and the storage is envisaged for 20 days. Water allocation has been received from Water resources department, Raipur, Govt. of Chhattisgarh in March 2011.

Raw water make-up will be made available by intake pumps located on the banks of the river. A pipeline will be laid to the project site from the proposed intake pump house to Raw water reservoir.

3.5.1.2 DM Water

The treated Water to cater the plant needs such as boiler make-up, CCW makeup (Primary circuit) shall be fed from a water treatment plant for the plant.

3.5.2 Fuel

The fuel for the plant will be Washery rejects sourced from the Coal washery plant at Parsa East & Kente Basen Coal Block. The reject is transported to the project site through Belt conveyors from the coal reject storage bin located adjacent to the power plant boundary on the western side of the project site. Intermediate storage of washery reject is envisaged within the power plant boundary.

As per Environment clearance issued by MOEF for Open cast Mine project, the Washery rejects generated from the washery plant is to be fully utilized in the proposed pithead CFBC based Thermal power plant.

3.5.3 Power Evacuation

The total power generated from the power plant will be 600MW. After meeting the power requirement for the station auxiliaries, remaining power will be available for export. Generated power will be stepped up to 400kV level by using step up generator transformers. To enable power evacuation, a 400kV gas insulated switchyard with one and half breaker arrangement will be provided. Power from the plant will be exported to the grid through 400 kV double circuit line.

3.5.4 Topographical and Geological Aspects

Topographical survey of the area indicating the spot levels, contours and permanent features are conducted at the site.Topography of the proposed site appears partly with steep slopes and partly flat with undulations. Foundation for power house building, main structures shall be based on geotechnical report. The Preliminary geo technical investigations for the proposed site completed and detailed geo tech is in progress.

3.5.5 Ecological Impact

There is no problem of displacement of population and no related impacts will be applicable to the site as the proposed site is an already acquired land and there are no habitations inside the site area. The site development will consider the recommendations of the local authorities as well as the guidelines of MOEF.

Suitable provisions will be incorporated in the design of buildings, structures and selection of equipment such that there are no adverse effects due to emissions, noise, and contamination of soil, water and air. The site development will consider the recommendation of the local environmental authorities as well as the guidelines of MOEF. A detailed EIA study has been carried out to assess the impacts in setting up power plant and the recommendations will be followed while establishing the project.

4.0 FUEL SOURCE & AVAILABILITY

4.1 SOURCE AND TYPE OF FUEL

4.1.1 Washery Reject

The fuel for the plant will be Washery rejects sourced from the Coal washery plant at Parsa East & Kente Basen Coal Block.

The GCV of washery reject will be in the range of 1800 to 2300 kcal/kg and shall be used in the proposed project.

4.1.2 Start-up Fuel

Light Diesel Oil (LDO) / High Speed Diesel (HSD) will be used for start-up fuel for the project. As the power plant is based on the CFBC technology of power generation, the fuel oil is required only for primary start-up and no fuel oil will be required for flame stabilization.. LDO/HSD will be received to the proposed plant by means of the road tankers and stored in fuel oil storage area.

4.2 MODE OF TRANSPORTATION FOR WASHERY REJECT

The washery rejects from the washing plant will be transported through belt conveyors and stored in storage Bins located adjacent to the power plant boundary on the western side of the project site. Conveyors will be provided for transporting the washery reject to power plant with intermediate storage within the power plant boundary.

4.3 ANNUAL FUEL REQUIREMENT

Washery Reject

The annual requirement of washery reject per Unit shall be about 1.135 MT at 75 % PLF and 100 % TMCR condition.

5.0 PLANT DESCRIPTION

5.1 GENERAL:

The proposed washery reject based power project consists of washery reject fired sub-critical steam generators connected to steam turbine generator along with all the required auxiliaries. The fuel to be used at the Power plant will be washery reject with GCV 2000 kcal/kg. for design condition.

5.2 PLANT LAYOUT

The power plant will make optimum use of land to minimize total life cycle costs.

Following site data, general principles and governing regulations shall be considered to establish the preferred plant layout.

5.2.1 Site Data

- Topography.
- Geotechnical conditions.
- Predominant wind direction.
- General Principles

In laying out the various facilities, consideration has been given to the following general principles.

- All facilities of the 4x150 MW units are in close proximity to each other to the extent practical so as to accommodate all facilities to meet their functional, operational and maintenance requirements.
- One(1) no. of multi-flue chimney (with four nos. of flues) of 275 m height
- Sufficient area in the turbine hall allowing the laydown of all turbine components during overhauls.
- Raw water storage requirements inside the plant boundary; Location of water source and method of drawl.
- washery reject receipt to power plant and washery reject storage requirement
- Method of ash disposal and ash disposal area requirement.
- Space for fuel oil receiving , storage and handling etc.,
- To facilitate movement of men and materials between the various facilities both during initial construction and also during subsequent operation and maintenance.
- Major external functional system are so oriented that any maintenance work as well as subsequent construction/expansion works can be carried out without any interference and/or hindrance to the operational units.
- Power evacuation corridor for connection to grid.
- Approach road to power plant from the state/National Highway.

- Wind direction – to minimise pollution, fire risk etc.
- Unit system concept will be adopted for following systems with no interconnection with other units of the plant:
  a) BTG system and equipment
  b) Steam water cycle system and equipment.
  c) Closed circuit equipment cooling water system.

Balance of Plant systems common to all 4 units:

a) Washery reject Handling system, Ash disposal, Fuel oil receiving & storage, Raw water Intake, Water treatment plant, DM plant, Waste water treatment plant, Fire Protection, Labs, Workshop, etc., Cooling and Auxiliary cooling water system will be common for four units. However the phasing of equipment, supply & erection will be as detailed under Project Implementation.

5.2.2 Governing Regulations

- Siting criteria prescribed by MoEF& Pollution Control Board on Environmental aspects.
- Green belt will be provided all around the plant boundary and as per the stipulations of MoEF.

5.3 MAIN PLANT

5.3.1 Steam Turbine and Accessories

5.3.1.1 Steam Turbine

The steam turbine would be 3000 rpm, tandem compound, single reheat, regenerative, condensing, horizontally split, with uncontrolled extractions for regenerative feed heating. The turbine would be designed for main steam parameters of 133 ata at 535 +/- 5°C before emergency stop valves of HP turbine and reheat steam parameters of around 32.76 ata and 535 +/- 5°C at inlet to IP turbine. The LP turbine will exhaust against a condenser pressure of 0.1 kg/cm^2 (abs). At turbine valve wide open (VWO) condition the turbo-generator set will be able to operate continuously with a throttle steam flow of about 105% Turbine MCR condition.

HP and LP turbine bypass station will be provided as a part of turbine package. The bypass station will act not only as a protection to the unit during pressure rise resulting from sudden load throw off but also enable operation of the unit at loads lower than the controllable range of load. This will also permit quick, repeated hot starts of the unit on its tripping. The bypass station will be sized for a flow corresponding to about 60% of Boiler MCR. Sufficient capacity electromechanical safety valves would be envisaged on super heater and reheater headers to prevent frequent operation of steam generator statutory safety valves during sudden load through off.

A fully automatic gland sealing system will be provided for the turbine which will have provision for receiving steam from auxiliary steam header during start-up and low load operation. The turbo-generator will be equipped with electro-hydraulic governing system ensuring stable operation under any grid fluctuation and load throw off condition. The turbo-generator will be equipped with an electric motor driven or hydraulic turning gear. The unit will also be provided with self-contained lubricating oil system for supplying oil to turbine and generator bearings. The lubricating oil will be cooled by Closed Circuit Cooling Water System utilising demineralised water as cooling medium.

The steam turbine generator will be connected to its own unit step up transformer through Generator Circuit Breaker (GCB). The auxiliary power requirement of the unit will be drawn from its unit auxiliary transformer tapped off from the generator bus-duct. The steam turbine generator will be suitable for tropical climate prevailing in India and indoor installations

The generator excitation system will be of brushless / Static Exciter type and capable of maintaining steady generator terminal voltage under variable load conditions. The excitation system will be complete with automatic voltage regulator and all necessary metering and supervision equipment.

All auxiliaries like turbine oil purification system, generator seal oil system etc. as well as necessary protective and supervisory system will be provided to ensure trouble-free, safe and efficient operation of the turbo-generator. The units will be guaranteed to generate 150 MW at generator terminals continuously at design ambient wet bulb temperature of 28°C. It shall also be capable of operating continuously under the HP feed water heaters out of service and generating 150 MW.

Design Criteria

i)	Turbine throttle steam pressure	:	133 ata
ii)	Turbine throttle steam temp.	:	535+/-5°C
iii)	Reheat steam temp. at turbine inlet	:	535+/-5°C
iv)	Output under Economic Maximum Continuous Rating (EMCR) at Generator terminals	:	150 MW
v)	Variations in rated steam temp. & Pressure	:	As per IEC 45 (variations applicable from the offered rated steam inlet parameters)
vi)	Pressure drop in reheat circuit, i.e. between H.P. turbine exhaust & IP turbine inlet	:	10% of H.P.T exhaust pressure.
vii)	Condenser pressure	:	0.1kg/cm² (abs)
viii)	Turbine speed	:	3000 rpm
ix)	Frequency variation range around rated	:	(-) 5 to (+) 3 % (47.5Hz to 51.5Hz)

	frequency of 50 Hz		
x)	DM water make up to thermal cycle under BMCR condition	:	Around 3% of BMCR steam flow
xi)	Final feed water temp. TMCR condition	:	Around 245°C
xii)	Turbine protection against water induction	:	As per ASME TDP-1 1985.
xiii)	Operation Capabilities	:	
	- Part load & start up operation	:	a) Turbine will be capable of operating on constant pressure mode during part load & start-up operation.
		:	b) TG set will be capable of being started from cold condition to full load operating conditions in as short time as possible.
	- House load operation	:	a) TG set will be capable of operating on house load during sudden total export load throw off using HP-LP bypass system. Unit will not trip on over speed in the event of total export load throw off.

The material of construction of the turbine will be as per the manufacturer's standard materials.

5.3.2 Condensing Equipment

Each unit shall be provided with a water cooled condenser. Condenser will be of two pass, divided water box designed with horizontal surface type with straight tubes and will be capable of maintaining the required vacuum while condensing steam at the maximum rating of the turbine and will also be designed for turbine bypass condition. The condenser will also be designed to handle the maximum of the following condition:

- MCR condition of the steam turbine
- VWO Condition
- HP heaters out condition
- HP/LP turbine bypass condition

Two (2x100%) Vacuum Pumps for each unit will evacuate the steam side of the condenser during start up and extract non-condensable gases during operation from the condenser. One (1) no. vacuum pump will be in normal operation, while the other one will be in standby. Both the vacuum pumps shall remain in parallel operation for a short duration during start-up.

5.3.3 Boiler feed pumps and drives

3 x 50%, horizontal, multistage, barrel casing, centrifugal type boiler feed pumps driven by electric motor, will be provided for each unit. Each boiler feed pump will have one (1) matching capacity single stage booster pump driven by the feed pump motor. The booster pump will take suction from feed water storage tank and discharge into the suction of corresponding main feed pump which in turn, will supply feed water to boiler through the high pressure heaters and feed control station. A variable speed hydraulic coupling or thyristor drive will be provided between the drive motor and the main feed pump of each set to regulate feed water flow to boiler. All the feed pumps will be provided with minimum flow recirculation control arrangement to protect the pump under low load operation. Two (2) pumps will normally operate while the other will be a standby.

Each pump will be provided with mechanical seals with proper seal cooling arrangement, self-contained forced lubricating oil system for supplying oil to the bearings, couplings etc. the lubricating oil and also sealing arrangement of the feed pumps will be cooled by closed water systems utilising demineralised water as cooling medium. All necessary protective and supervisory system will be provided to ensure safe and trouble-free operation of the feed pumps.

5.3.4 Deaerating heater and closed heaters

Each unit will be provided with a variable pressure type deaerating heater with a feed water tank of adequate capacity. Vent condenser (if applicable) will be provided with the deaerator to minimise wastage of steam. The deaerator will be spray or spray-cum-tray type and will be designed to deaerate all the incoming condensate and drain flow to keep the oxygen content of the condensate below the permissible limit.

Deaerator will normally operate by taking extraction steam from IP turbine casing. However, during low load operation and start-up, the deaerator will be pegged with steam drawn from auxiliary steam header. The deaerator will be placed at a suitable higher elevation to provide sufficient NPSH for the boiler feed booster pumps and considering the head available for the drain of the preceding HP heater to flow to the deaerator.

The feed water heaters will have both drain cooling and desuperheating zones in addition to the normal condensing zone as necessary. High pressure heaters and low pressure heaters will have individual bypassing arrangement in order to allow isolation and maintenance. The recommendations of ASME standard TWDPS-I will be followed for prevention of water damage to the turbine.

5.3.5 Condensate extraction pumps

The condensate extraction pumps (2x100%) will be vertical motor driven centrifugal can-type with flanged connection provided for each unit. The pumps will take suction from hot well and discharge through check valves and motor operated stop valves into a common discharge header to Deaerator.Suction basket strainer will be provided for each pump.

Connections for condensate supply to the following major services will be tapped off from this condensate discharge header:

- LP bypass de-superheating spray
- Turbine exhaust hood spray
- Gland sealing system de-superheating

The condensate will then pass in series through the gland steam condenser before being supplied to the low pressure feed water heaters.

5.3.6 Steam Generator and Accessories

5.3.6.1 Steam Generator

Steam generators of 4 x 150 MW configuration will be of semi outdoor type, sub critical pressure, natural circulation, single reheat and dry bottom type Circulating Fluidized Bed Combustion (CFBC) units. The steam generators which would be designed for firing 100% Washery reject would be radiant, reheat, natural circulation, single drum, balanced draft, semi-outdoor type of unit rated to deliver about 500 TPH of superheated steam at 139 ata (a), 540 °C when supplied with feed water at a temperature of 245.9 °C at the economiser inlet in BMCR condition.

Capacity of steam generating units would be so selected as to ensure adequate margin over the requirement of Turbine at 100% MCR in order to cater to auxiliary steam requirement during start up and service.

The steam generators would be designed to operate with “the HP Heaters out of service” condition (resulting in lower feed water temperature at Economiser inlet) and deliver steam to meet the turbo-generator requirement at base load. The steam generators are also designed to operate without trouble during HP/LP turbine bypass condition Economiser section of the boiler would be non-steaming type with provision for recirculation during start-up, chemical cleaning etc. Super heater section would be divided in convection and radiant zones and designed so as to maintain rated steam temperature of 540°C (±5°) at outlet over the range of 60% to 100% MCR load. Main steam desuperheating stations with provision for spraying water tapped off from feed water piping would be provided. Air preheaters, Tubular / rotary

type would be provided with a set of soot blowers of automatic sequential electrically operated type, arranged for on-load cleaning of the heat transfer surfaces.

The steam generating units will be provided with arrangement for start-up by LDO/HSD.

The drum level measurement will include Direct Level gauge glass, Bi-colour gauge glass, remote level indication and recording in plant control room etc.

The complete boiler will be top supported type and would be provided with all supporting steel structures, platforms, galleries, elevator and stairways for easy approach and maintenance of the unit. Adequate weather protection would be provided for instruments and operating personnel.

Necessary lining and insulation along with fixing materials to limit outside surface temperature to a safe level would be provided. Monorails and hoists required for handling heavy equipment, motors, fans etc. would be supplied along with the steam-generating units for ease of maintenance.

Design Criteria:-

i)	Steaming capacity of steam generator	:	Steam Flow at Super heater outlet at 100% Boiler Maximum Continuous Rating (BMCR) with rated steam parameters will be 1.02 x (Steam flow at HP turbine throttle inlet under turbine valve wide open (VWO) condition, condenser pressure with 3% cycle make-up and auxiliary steam requirement.

Furnace will combine with following requirements at 100% BMCR or HP heaters out conditions and with range of specified washery reject, under most stringent combination of operating conditions:

Basic parameters of Steam Generators (Indicative):-

Sl. No.	Description		100% BMCR	100% TMCR
i)	Steam flow of each boiler at final superheater outlet (TPH)	:	500	452.3
ii)	Pressure at superheater outlet (ata)	:	139	137.7
iii)	Steam temperature at final superheater outlet (°C)	:	540	540
iv)	Steam pressure at reheater inlet (ata)	:	39.98	35.59
v)	Steam temperature at reheater inlet (°C)	:	363.4	352.3
vi)	Steam pressure at reheater outlet (ata)	:	37.93	33.58

Sl. No.	Description		100% BMCR	100% TMCR
vii)	Steam temperature at reheater outlet (°C)	:	540	540
viii)	Temperature of feed water at economizer inlet (°C)	:	245.9	244.9

Furnace System

The Circulating Fluidized Bed Combustion Boiler's furnace consists of the following:

- Furnace Chamber.
- Bed Media and Fuel feed system
- Air system consisting of primary air and secondary air and its distribution system
- Ash and unburnt fuel recycle system consisting of a set of cyclone separators, recycling chute, ash siphon loop seal, etc.
- Bottom ash collection and cooling system.

Furnace Chamber

The furnace will have welded membrane construction of seamless tube water wall enclosure. The lower part of the furnace chamber will be provided with suitable refractory lining to protect membrane wall against corrosion and erosion. Inert material such as sized sand or bed ash will be fed for making the bed at the bottom of the furnace chamber.

The combustion system will be provided with over-bed washery reject feeding system along with grit re-firing arrangement to minimise unburnt carbon losses. Additionally, an effective ash cooling system will also be provided to minimise heat losses. The steam generators will be designed for continuous satisfactory operation with the range of washery reject expected for this station without any need for auxiliary fuel oil for fire stabilisation. The furnace would be conservatively designed to allow adequate residence time for fuel to burn completely. The design flue gas velocities would be carefully selected to minimise erosion of pressure parts and other vital components on account of ash. The steam generators would be designed in accordance with the latest provisions of Indian Boiler Regulations.

Air Supply and Distribution System

Draft system of each boiler would be provided with 2 x 60% Forced Draft and 2 x 60% Induced Draft Fans with suitable capacity and control arrangement, each independently capable of meeting the requirement at 60% boiler MCR load. The forced draft fans would control total air flow to boiler and the induced draft fans will control furnace draft of the boiler through automatic control loops. Each unit will be equipped with suitable washery reject firing system comprising air/washery reject conveying pipes/chutes to the furnace preferably with arrangement of volumetric/gravimetric measurement of washery reject, primary air fans and seal air fans, air pipes etc. as necessary. Staged combustion in CFBC boilers due to gradual

introduction of Secondary air and low combustion temperatures greatly reduces NOx formation.

Recycle (Circulation) System

In the combustion chamber the bed material with the fuel is fluidized with primary air which turbulently transports the solids upto the full height of the combustion chamber. Combustion of fuel takes places as it rises in the furnace chamber and heat is transferred to the membrane wall furnace and radiant super heater surfaces. The hot combustion gases containing unburnt fuel particles, ash and a small quantity of bed material pass through hot cyclone where the heavier unburnt fuel particles and bed material are separated and sent back to the furnace through siphon seals along with fresh fuel feed. The flue gas containing lighter ash particles go out of the boiler.

Furnace Ash Removal System

Excess ash in the furnace chamber will be removed from the bed. Bottom ash discharged in dry form from the furnace bottom would be conveyed to bottom ash storage silo by dry type conveying system. Before conveying bottom ash to the storage silo, ash will be passed through stationary ash bed heat exchanger (water cooled/air cooled) where its temperature will be reduced to the permissible limits.

Main Steam and Reheat Steam Temperature Control

For maintaining the steam temperature control range (rated steam temperature of 540 ± 5°C for Superheater and 540 ± 5°C for Reheater) within the prescribed limits at the outlet of superheater and reheater, desuperheating stations will be provided. The water required for desuperheating stations will be tapped off at the outlet of the boiler feed water pumps, to control the final steam temperature between 60% to 100% MCR load.

Soot Blowing System

The steam generator will be provided with a set of soot blowers fully automatic, sequentially controlled, microprocessor based system, arranged for on-line cleaning of heat transfer surfaces of superheater, reheater, economiser, air-preheater and will be complete with provision for individual operation of any soot blower pair & facility to bypass any soot blower will be provided. No soot blowers are envisaged in the furnace section of CFB boiler.

APH and SCAPH

2x 50% Air Preheater either of Rotary Regenerative (RAPH) or Tubular Type air preheater (TAPH) will be provided for the boiler for primary and secondary air heating. Steam Coil Air Pre-Heaters (SCAPH) will also be provided to maintain the cold end temperature above acid dew point temperature during boiler start-up and low load operations.

5.3.6.2 Electrostatic Precipitator

The Electrostatic Precipitator (ESP) will be designed to handle flue gases generated at BMCR condition with worst washery reject firing. Each ESP will have two or four parallel gas paths, any of which can be isolated for maintenance while the other path being in operation. Each path will comprise the required number of fields in series for collection of fly ash. The ESP will have efficiency of around 99.9%. The ESP will have adequate number of ash hoppers provided with electric heaters. The design of ESP will be such that the outlet dust burden or solid particulate matter (SPM) content at its outlet within the limits specified by the MoEF.

5.3.6.3 Chimney

A concrete chimney has been proposed for this project. A common chimney (Four Flues) for four units with height of 275 mtrs has been considered. The chimney will include openings sized and located to coordinate with the presently specified configuration of ESP. Suitable provisions shall be made available to fix continuously monitoring equipment for measuring pollutants as per Pollution Control Board norms.

5.4 WASHERY REJECT HANDLING SYSTEM

The annual washery reject shall be 1.135MP per unit based on gross calorific value of 2000 Kcal / Kg and 75% plant load factor. The envisaged mode of transportation of the washery rejects is conveyor belts from washery reject bin.

The Washery reject handling system in the power plant will be normally operational for two shifts a day with provision for third shift operation also. It is considered to have a twelve (12) hours storage capacity in the bunkers. The system shall be of 1405 TPH capacity with belt conveyors alongwith facilities for receiving, unloading, crushing and conveying crushed fuel to boiler bunkers and stacking.

SYSTEM DESCRIPTION

The rejects handling system comprises the following:

Incoming Conveying System

The proposed plant will draw washery reject from the washery reject bunker located adjacent to plant boundary. Washery reject will be conveyed either directly to the boiler bunkers or to stockpile by means of Tripper conveyor.

Crushing and Screening System

The Washery reject crushing and screening system consists of Primary screens, crushers and secondary screens. Considering the fines available in the incoming washery rejects, Primary screening arrangement is considered in order to reduce further fines generation in the crusher, in case of direct feeding to crushers.

The Washery rejects particle size of (-) 8 mm will be separated in the primary screen and is transferred directly to the bunkers through product conveyor. The rejects (+) 8 mm from the primary screen will be transferred to Impactor type crusher placed in the Crusher house for crushing to required size. To ensure the required Washery reject particle size of (-) 8 mm for the CFBC boiler, secondary screening arrangement is provided and the accepts will be transferred to Bunker through product conveyor and the reject will be recycled back to crusher for further crushing.

Conveying system for Direct Feeding to SG Bunkers

SG bunkers shall be filled by means of conveyors and bunker distribution is by V-Plough arrangement at respective Bunker top. The clearance between the bottom of the plough feeder floor and top of Washery reject bunker has to be provided with chute to avoid dust formation.

Washery reject stockpiles, stacking and reclaiming

Washery reject received at the plant will be stored in open stockpile. Motorized travelling tripper with three way chute is envisaged for stacking the coal for the proposed plant. Dozer will be used for formation of stockpile and also reclaiming the Washery reject from the stockpile. Adequate storage would be provided to meet the continuous requirement of the power plant. Stockpile will be of trapezoidal cross section. Dozers are capable of stacking the coal for the height of 5m.

Stacked Washery reject will be reclaimed by dozers into the reclaim hoppers and further feeds Primary screens, crushers and Secondary screens through conveyors.
Below each of the reclaim hoppers, unwashery rejecter will be provided for feeding washery reject to the belt conveyors.
Washery reject yards will be provided with plain water spray dust suppression system which would spray water on the stockpile wherever the Washery reject is being stacked and also dust control. The Washery reject yard would have a drainage system to drain out rain water.

5.5 ASH HANDLING SYSTEM

This section covers the provisions which will be made for the ash handling system for the proposed 4 x 150 MW units. washery reject will be used in the proposed power project. For design basis of ash handling system, worst washery reject will be considered. For designing the ash handling system, the following will be considered.

a. The maximum ash collection at various hoppers for design will be:

- Bed ash hopper : 40% (maximum)
- Economiser ash hoppers : 5% (maximum)
- Fly ash in ESP hoppers : 80% (maximum)

- APH hoppers : 5% (maximum)
- Stack hoppers : 0.5% (maximum)

b. The system adopted for bed ash will be mechanical drag chain conveyor for conveying up to intermediate bed ash silo and further conveyed to ash silos through by pressure conveying system.

c. Fly ash removal system will be done by pressure conveying system from fly ash hoppers to ash silos. Fly ash will be handled in dry / semi dry / slurry mode from silos. Fly ash will be transported in dry / semi dry mode by trucks to mine for back filling. In future, if required the fly ash may be transported to mines through high concentration slurry disposal system. Space provision for HCSD system will be provided near the ash silo area.

d. Pressure conveying system shall be common for both fly and bottom ash.

5.5.1 System Description

Ash formed due to combustion of washery reject in the circulating fluidized bed combustion steam generator will be collected partly as Bed Ash (BA) in the bed ash cooler and rest as Fly Ash (FA) in the fly ash hoppers. The bed ash will be collected in the intermediate bed ash hopper through Mechanical Drag Chain Conveyor. The fly ash will be collected at the, Economizer hoppers, Air Pre-heater (APH) hoppers, duct hoppers (if applicable), electrostatic precipitator (ESP) hoppers and stack hopper provided along the flue gas path. The descriptions of the ash removal and disposal systems are furnished below.

Bed Ash (BA) Handling System

Bed ash formed due to the combustion of washery reject in the SG will be collected in bed ash cooler and conveyed to bed ash intermediate hopper by Drag Chain Conveyor. Bed ash intermediate hopper will be provided with the following openings:

- One (1) no. opening for feeding screen to segregate the bed ash to (-) 4mm.
  The product (-) 4mm of bed ash from the screen will be fed to bed ash buffer hopper for further transporting to ash silos by Pressure Pneumatic system. The oversize bed ash from screen will be fed to the crusher where it will be reduced to (-) 4 mm size. The crushed bed ash will be feed to back to bed ash intermediate hopper.
- One (1) no. of outlet connection for unloading of bed ash to open truck through Dust conditioner.

Fly ash handling system

The fly ash handling system will be of Pressure Pneumatic system. The fly ash will be collected at the Economizer hoppers, Air Pre-heater (APH) hoppers, Duct hoppers (if applicable) and electrostatic precipitator (ESP) hoppers will be evacuated pneumatically. FA

collected in Stack hopper will be evacuated manually. Isolation valve below stack hopper will be operated from the floor level. Suitable chute will be provided to evacuate manually. The fly ash is sequentially extracted from these hoppers by pressurized pneumatic system and conveyed to Fly ash storage silos by conveying air compressors through denseveyor.

The fly ash removal system will be divided into numbers of parallel paths depending upon the ash collection in each field**.** Shifting of ash clearance cycle from one hopper to the next hopper will be automatic and will be based on ash collection level and time.

Ash storage silo and Disposal of ash from storage silo

There will be four numbers of fly ash storage. These silos will be common for four units. Each silo will be provided with 6 nos. of outlet connections for unloading of ash.

Ash slurry disposal system

Two number of discharge openings will be provided in each silo for facilitating the High Concentration Slurry Disposal system/Jumbo bagging system in future. Provision for HCSD pump house will be provided near the ash silo area.

5.6 RIVER WATER INTAKE SYSTEM

Raw water proposed to be used for meeting the complete water requirement of the project will be sourced from nearby Atem and Rehar River. The Atem river is around 5 kms away from the project site on the Northern side and Rehar river is around 25 kms on the eastern side of the site. The water for the power plant shall be drawn from Lipangi Tunnel of Rehar – Atem river link.

Water will be collected by appropriate system to a common sump at the intake sump where the pump will be located. The intake water pump house will be provided with intake water pumps, piping, valves, fittings, electrical, instrumentation and control. River water intake system shall be controlled from the dedicated PLC based system. The Raw Water Supply System will provide raw water from the river to the Raw Water Reservoir in the power plant area for treatment and subsequent use as circulating water makeup, supply to DM plant and other miscellaneous requirements.Make-up water system shall be designed for drawl and pumping of water to reservoir so that during lean season make-up water for the plant is made available on continuous basis.

The raw water intake pump structure will have three (3 x 50%) vertical raw water pumps installed on the sump in a wet pit type pump structure. The raw water pump shafts and column will be extended so that the motors will be located above the maximum flood elevation. The raw water intake pumps will withdraw raw water from the sump pit and discharge it to the Raw Water Reservoir. A pipeline will be laid to the project site from the proposed intake pump house to Raw water reservoir. The intake water pipelines shall be laid

below ground and shall be protected against corrosion using suitable coating. The Raw Water Supply System will operate prior to plant initial operation to provide water for reservoir filling to maintain adequate storage requirement and supply to the Pre-treatment Plant.

5.7 WATER TREATMENT PLANT

5.7.1 Raw water Storage system

Raw water will be supplied from raw water intake system and stored in Raw Water Reservoir. The raw water reservoir located in power plant area of earthen bund construction. The total capacity of this reservoir will be sufficient to hold the water required for 20 days.

Two (2 x 100%) Raw Water Pumps will be provided to feed raw water from the reservoir to raw water Clarifier.

5.7.2 Pre-Treatment Plant

The purpose of Pre-treatment System is to treat the raw water from raw water storage reservoir and reduce the suspended solids and any organics prior to downstream use. Raw water is pumped by means of 2 x 100% raw water pumps through 2 x 50 % Main Clarifier and 1 x100% DM Clarifier for reduction of suspended solids. The cascade aerator and stilling chamber will be common for both main and DM clarifier. The overflow of the main clarifier will be stored in Clarified Water Storage Tank for downstream use and overflow water from the DM clarifier will be stored in the DM clarified water storage tank. Clarified Water Storage Tank will be in two compartments and will have a total capacity of 4 hours consumptive requirements.DM clarified water storage tank will have a total capacity of 12 hours consumptive requirements and will be located along with main clarified water storage tank with partition wall.

Pre-treatment chemicals such as Coagulant and Coagulant aid will be dosed in the Clarifier. A sludge pit will be provided and the collected sludge will be treated further in sludge handling system. The sludge handling system consists of Sludge thickener. The overflow water from thickener will be led to the stilling chamber. The underflow sludge will be sent to the Ash handling plant. Raw water from raw water reservoir is chlorinated using gas chlorination plant provided for this purpose.

The Clarified water requirement will be based on downstream consumptions of systems. The Clarifiers will be sized for 100% clarified water requirement of 4x150 MW units with turbidity less than 10NTU. Sludge Pit will be sized for one hour clarifier sludge generation. Sludge Transfer Pumps will be sized for 2% sludge consistency of clarifier underflow and 100% standby.

5.7.3 DM Plant

The purpose of the DM plant is to produce Demineralized water of required quality and quantity for steam cycle and DMCW system. The DM Plant will treat clarified water to produce Demineralized water for make up to steam cycle, closed cooling water system and miscellaneous use during maintenance operation. 2x50% RO streams and Three 3 x 50% Mixed beds of total 72 m³/hr (Net Output Capacity) will be provided.

Each stream of DM Plant consists of Pressure sand filters, Ultra filtration modules, Cartridge filters, Reverse Osmosis unit, Degasser system and Mixed Bed Units. The DM Plant is located indoor. However, all acid and alkali equipment, regeneration equipment, degasser system are located outdoor.

Pressure sand Filter and Ultra filters removes the suspended solids completely from the feed water. Any colloidal particles presence in the raw water will be removed by Ultra filtration system. Cartridge filters prior to RO modules act as the final trap for any remaining suspended solids and act as a protective filter to RO membrane. Chemicals such as acid, scale inhibitor and sodium Meta bi sulphite are dosed for conditioning the water before it enters the RO train.

The water from cartridge filters is pumped by the High pressure pump through the RO train. The RO train consists of 8” polyamide membranes installed in pressure tubes. The permeate from the RO system is taken to the degasser for removal of Carbon di oxide.

Each Degasser Tower contains fill media (PP Raschig Rings) and air is blown from the bottom using 2 X 100% degasser air blowers. Here the unstable acids of bicarbonate are stripped into Carbon-di-Oxide and water. CO2 is vented out from the vent cowl on top of the Degasser. The degassed water is collected in a DG Water Storage Tank by gravity.

The water from DG water storage tank is then led to Mixed Bed Units by MB feed pumps.

The Mixed Bed Exchanger contains both Strong Acid Cation and Strong Base Anion resins. Any slip of cations and anions is exchanged and removed in Mixed Bed Exchanger, which acts as a polisher. The Mixed Bed Exchanger is sized for 72 hours of service run after which it is regenerated. Hydrochloric Acid and Sodium Hydroxide are used for regenerating Cation and Anion Resins respectively. The Demineralized water thus generated is stored in DM water storage tanks.

Regeneration system for the DM Plant consists of Acid and Caustic Storage Tanks, Acid and caustic measuring tanks, associated piping, ejectors etc. Air blowers are provided to mix the resin in the mixed bed exchangers. Wastewater generated is taken to the neutralizing pit for neutralization and disposal. The regeneration chemicals are Hydrochloric Acid (HCl) and Sodium Hydroxide (NaOH).

Two (2) nos. Hydrochloric acid unloading pumps are provided for unloading acid received in the tankers to bulk acid storage tank. Required quantity of Hydrochloric acid shall be drawn

from respective bulk storage tanks into respective measuring tanks and injected into the respective units through ejectors. The regeneration will be carried out automatically on initiation from the PLC.

Two (2) nos. Caustic unloading pumps are provided for unloading NaOH received in the tankers to bulk caustic storage tank. Required quantity of NaOH solution shall be transferred from storage tanks into respective measuring tanks and injected into the respective units through ejectors. The regeneration will be carried out automatically on initiation from the PLC.

Motive water for regeneration of MB shall be DM water from DM water tank.

The filter backwash and UF waste shall be led to the PTP stilling chamber and recycled through clarifier.

All chemical wastes shall be led to the neutralizing pit in lined trenches for further disposal. The regeneration waste from the DM Plant shall be generally self-neutralizing. The neutralizing pit is in two compartments with acid and alkali proof lining. Once a compartment of the neutralizing pit gets full, the neutralized effluent disposal pumps are started and kept in recirculation mode. pH of the effluent is measured and acid or alkali is added as required from the dedicated tanks provided at the neutralising pit. Once the pH value comes within the acceptable range, the neutralised effluent is disposed to guard pond by closing the recirculation valve and opening the disposal valve.

CW Treatment System

Cooling water treatment will be provided to limit the scale formation in the circulating water circuit by controlling the pH of water. Sulphuric acid of 98% concentration is dosed by means of dosing pumps to control the pH by reducing the alkalinity in water. Acid will be injected into fore bay. The sulphuric acid dosing pumps will start / stop based on set point pH from the instrument at CW pump discharge header.

Scale cum Corrosion inhibitor is dosed to control scaling and corrosion in Circulating Water cycle. Bio-dispersant is dosed to prevent organic fouling while Biocide shall be dosed once in a month to prevent biological growth. The scale cum corrosion inhibitor & Bio-dispersant will be directly dosed into the basin of the Cooling tower using dosing pumps, while the Biocide will be dumped into the fore bay. Chlorination is also done to control the biological fouling.

5.7.4 RW & CW Chlorination Systems

Chlorine will be dosed to remove organic matter present in the Circulating Water and to minimize biological growth on the Cooling tower fills and piping as such biological growth could promote corrosion, impair heat transfer and impair water distribution throughout the circulating water system. Chlorine will also be dosed in raw water in order to control organic

matter and ensure suitability of water for downstream use. Both Raw Water and CW Chlorinators draw Chlorine from Chlorine Ton containers.

The Chlorination Plant will be located in the CW Treatment Plant area.

Raw water chlorination will be done at the Stilling Chamber.

Suitable safety systems such as leak detector and leak absorption system will be provided.

5.7.5 Potable Water System

The purpose of potable water treatment system is to treat the water by filtering and disinfecting by dosing chlorine dosing and make it suitable for potable purposes. For potable water application tap-off from Ultrafiltration outlet will be considered and chlorine will be dosed in the discharge header of potable water transfer pumps. Two (2x100%) Potable water pump will be provided for supply of potable water to Potable Water Overhead tank.

Further distribution for various points of use will be done from this tank by gravity, except for boiler higher elevation for which the water will be pumped using booster pumps if required.

5.7.6 Service Water System

Clarified water will be used as service water. Service water will be pumped from the clarified water storage tank with the help of 2 x 100% service water transfer pumps to Overhead service water tank, and to the other plant requirements like HVAC makeup, Ash and Washery reject handling system.

Further distribution for various points of use will be done from this tank by gravity except for boiler floor wash for which the water will be pumped using booster pumps.

5.7.7 Waste Water Treatment Plant

The waste water plant designed considering the objective of Zero liquid discharge norms. The waste Water Treatment system envisaged will cover collecting system and blow down recycle plant. All the waste water will be fed to the Guard pond except cooling tower blow down and further re-used in Ash handling plant after adjusting the pH of the waste water.

The following are the various Waste Water sources and their treatments.

Oily Waste Water

Oil bearing effluent generated from fuel oil handling area, TG area and transformer area will be treated in oil / water separator to separate oil from water and the treated waste water is led to the Guard pond. The oily sludge will be collected and disposed offsite.

Side Stream filter back wash waste (SSF)

The filter back wash water collected from SSF will be led to Thickener for further treatment.

Various Floor drains

Non-oily waste collected from various floor drains will be led to Guard pond through Tube settler.

Boiler Blow down

The boiler blow down water will be sent to the Guard Pond and CT Blow down will be used as quenching water.

Clarifier Sludge

The sludge collected in the clarifier will be pumped to thickeners. Clear water from thickener will be reused and down flow sludge will be sent to the Guard pond.

Neutralised Waste Water

MB regeneration waste will be taken to neutralisation pit, neutralised with chemical and then transferred to Guard pond.

RO Reject

RO reject will be fed to Guard pond.

Filter Back wash and UF Waste

The waste generated from Filter and UF system will be led to Stilling chamber.

Cooling Tower Blow down Recycle Plant

The blow down Water will be treated and reused as Cooing tower make up. The Blow down recycle plant consists of Pressure Sand Filter, Ultrafiltration system and Reverse Osmosis. The permeate water collected from Reverse osmosis will be fed to cooling tower basin.

The sludge generated from the recycle plant will be treated in PTP sludge treatment plant.

The reject water will be led to the Guard pond.

5.7.8 Sewage Water from Toilets in the Power Plant, Canteens

The Sewage generated from the Power Plant, Canteen will be treated in a package type Sewage treatment plant and the no. of units of the STP will be decided based on the site condition. The treated effluent will be collected and used for Horticulture. Suitable arrangements for collection of sludge, its compaction and safe disposal will be provided.

5.8 MECHANICAL AUXILIARY SYSTEM

5.8.1 Cooling water system

The Cooling water system comprises of One (1) no. Induced Draft Cooling Tower (IDCT) for two units, One(1) no. Cooling Water (CW) pump will be provided for supplying cooling water

for each unit, with a common standby pump for all the four units. The Condenser Cooling Water pumps will be vertical wet-pit pumps of suitable capacity and duty.

The Cooling towers will be Induced Draft Type (IDCT), designed for a continuous duty to cool the hot water received from the condenser and the auxiliary cooling water system at the required design parameters. The hot water enters the tower at a suitable height and falls downward over film type fills of PVC construction and the cooled water exits from the cooling tower basin for further transportation to the condenser and the auxiliary cooling water system. The cooling tower would be designed for a cooling range of 9°C. The design hot and cold water temperatures of the cooling towers would be 42°C and 33°C respectively. Tower construction would be of RCC material with PVC film type fill.

To prevent scaling/corrosion arising due to the operation of CW system, chemical dosing system is envisaged. In order to prevent /minimize growth of algae in the CW system, Chorine dosing system is envisaged. Makeup water for the cooling tower will be clarified water.

The CW Blow down from cooling water system, after treatment will be sent to the Cooling tower basin. The CT blowdown will also be utilised for quenching the Boiler Blow Down water. Provisions will be provided for utilizing CW blowdown water for High Concentration Slurry Disposal system will be provided.

5.8.2 Auxiliary Cooling Water (ACW) and De-Min cooling Water (DMCW) System

In the Auxiliary Cooling Water System, demineralised water is circulated in the primary circuit and clarified water on the secondary circuit. Demineralised Cooling Water (DMCW) circulated in the primary circuit will supply cooling water to the steam generator auxiliaries, steam turbine generator auxiliaries and other auxiliary system coolers. The hot water from these auxiliaries is cooled in the plate type heat exchanger which is in turn cooled by the cooling water from ACW system.

ACW system shall supply cooling water to the Plate heat exchangers and the return water shall join the CW return line from the Condenser at suitable location. Auxiliary cooling water system consists of 1 no. ACW pump each unit. One (1) no. ACW pump will be provided as common standby. These pumps will be located in the CW pump house taking suction from the CW forebay. The operating temperature of the auxiliary cooling waterside of the PHE will be the same as the Condenser circulating water inlet temperature.

The DMCW system meets the cooling water requirements of all the auxiliary equipment of the steam generator & steam turbine generator units such as turbine lube oil coolers, generator air cooler, exciter air coolers, ID/ FD / PA fan bearing oil coolers, BFP auxiliaries such as lube

oil coolers, working oil coolers, drive motors, etc., condensate pump bearings, sample coolers and air compressors.

A closed loop system using passivated DM water is proposed for the DMCW system. The DMCW system for each 150MW unit is conceptualised as given below:

DMCW system for turbine and steam generator auxiliaries will consists of 2x100% capacity plate type heat exchanger out of which One will be working and one will be standby and 2x100% capacity DMCW pumps will be utilized.

An overhead expansion tank of adequate capacity is proposed to ensure positive suction to the DMCW pumps and also serve as the source of make-up to the DMCW system for the unit. Normal make-up to the DMCW expansion tank is provided from the condensate extraction pump discharge. Initial fill for the tank will be provided from the boiler fill pumps discharge.

5.8.3 Fire Fighting System

The design and installation of complete fire fighting system shall comply with recommendation of Tariff Advisory Committee (TAC) of Insurance Association of India/CEA guidelines/Indian Standards (IS), which are to be followed to obtain maximum rebate on Insurance Premiums from Insurance Companies. For areas not covered or inadequately covered by TAC / IS, the system shall be designed and installed in accordance with the requirements of the National Fire Protection Association (NFPA) Codes. For fuel oil storage and pumping areas, the requirements of Oil Industry Safety Directorate (OISD) shall be followed as applicable for power generating station. The fire fighting system shall be of proven reliability and complete in every respect. All the system components/equipment, special purpose fittings, couplings or accessories shall be approved and certified for use in fire fighting system application by TAC / UL / FM / VdS / LPCB approved.

- Hydrant System for entire area of power plant
- High Velocity Water Spray System (HVWS) for All oil filled transformer of rating 10 MVA and above, turbine lube oil canal pipe lines in main plant, Boiler burner front, Central Lube oil tanks (Both Clean oil & dirty oil units) and purifier units. Generator seal oil system tanks and its cooler assembly etc., Turbine lube oil system and Boiler Feed Pumps lube oil system.
- Medium Velocity Water spray system – All cable galleries/cable vault/cable spreader room, all washery reject conveyors, Fuel oil storage tanks and pump house and Diesel Generator room.
- Foam system for Fuel oil storage tanks
- Portable and mobile fire extinguishers for entire plant

- Fire tender
- Inert Gas System for Central Control Room, Control Equipment Room, Computer Room and UPS Room areas in the TG/CC building.
- Fire detection and alarm system provided for the entire plant area will be microprocessor based Intelligent Analogue Addressable type. Microprocessor based analogue addressable main fire alarm panel (MFAP) shall be provided in central control room with VDU computer and printer and one additional fire alarm and control panel in washery reject handling plant control room and repeater panel, which will be provided in the fire station building.
- All necessary instruction and warning plates.
- All necessary facemasks, fire jackets, breathing and resuscitation apparatus and/or other protection devices for optimal protection of the personnel.

Fire Water Reservoir

The source of water required for hydrant and spray system shall be from the reserve storage provided in the clarified water/fire water storage tank cum pump house. The tank shall have two equal compartments and both the compartments shall be connected to a common suction header of fire water pumps so that any fire pump can be fed by either fire water storage compartment as per TAC regulations.

Fire Water Pumping System

Two separate dedicated fire water ring main distribution system shall be provided for hydrant system and spray system as per TAC. The fire water pump capacity and head will be designed as per the system requirement. The fire hydrant system will have a dedicated fire water electrical driven main pumps and 50% standby diesel engine driven pump (No. of pumps and capacity will be firmed up during the detail engineering). Two (2) Nos. of these hydrant pumps will be main pumps driven by electric motor, One (1) will be diesel engine driven main pump for Hydrant system, Separate fire water pumping system pumps for spray system (One (1) will be electric motor driven main spray pump) and One (1) will be diesel engine driven common stand-by pump for Hydrant and Spray system. Automatic pressurisation system common for hydrant and spray system. The entire fire water network will be pressurized and maintained the hydro-pneumatic tank along with common jockey pumps and air compressors functions to make up the system leakage losses.

Two (2) nos. booster (Horizontal split casing centrifugal type) pumps of adequate capacity and minimum 50 mWC rated head. One (1) no. Electric and One (1) no. Diesel engine driven pump shall be provided for maintaining the minimum pressure in the topmost and remotest landing valve in the boiler area.

The fire water pumping system shall be provided with a dedicated Motor Control Centre (MCC) and a common control cum annunciation panel located within the fire water pump house.

The pump status annunciation in this panel shall be repeated to the Main Fire Alarm Panel in the Central Control Room. Critical signals from this system shall be hardwired to the DCS for monitoring.

5.8.4 Fuel Oil System

The steam generator will be designed for 100% washery reject firing. LDO/HSD will be used as ignition fuel for boiler start-ups and upto 25 % Boiler MCR load. Fuel Oil will be brought to plant by road tankers from the nearest oil terminal and will be unloaded and stored in Two (2) nos. 250 m^3 Fuel Oil storage tank by means of 2 x 100% unloading pumps.

Three nos. of (3x50%) Fuel Oil Forwarding pumps taking suction from the Fuel Oil storage tanks will be provided to supply Fuel Oil to the Steam generators.

Each of the unloading and forwarding pumps will be provided with Two (2x100%) Simplex Strainers. The primary operations and control of fuel oil unloading system shall be from a PLC based system. One no. Operator cum Engineering work station (OEWS) shall be provided for the control and monitoring of the Fuel Oil System.

The clean oil drains of the equipment and piping of fuel oil unloading area and pump house area will be collected in a separate drain oil tank housed inside the fuel oil unloading cum transfer pump house, which is pumped to the fuel oil storage tanks by 2x100% vertical drain oil pumps mounted on top of the drain oil tank.

The oily water drains from fuel oil unloading area, unloading cum transfer pump house and fuel oil dyke area will be collected by gravity in oily water collection sump of 40 m3 located near the fuel oil unloading cum transfer pump house. The collected oily waste is further pumped to an Oily-water separator by 2x100% vertical oily waste transfer pump. The oil separated in the oily water separator pit will be collected in trolley mounted barrels and the separated water will be pumped to the guard pond by two (2) nos. of (1W+1S) waste water transfer pump.

5.8.5 Compressed Air System

The plant will be provided with common compressed air system for both pneumatic controls and for general services requirement. These systems comprises of the instrument air system and service air system. Service air required for steam generator utilities like Fuel oil ignitor purging, air pre-heater (APH), auxiliary air motor, atomizing air for fuel oil firing, furnace temperature probe etc. as well as general service air for cleaning purpose. Instrument air is required for various pneumatically operated valves, transmitters and instruments and other users requiring dried air.

All the air compressors and air driers will be kept in TG Building Ground floor. The compressors will be provided with necessary lifting device to handle system components during maintenance. Air receivers will be placed outside the compressor building.

The Compressors will be non-lubricated, oil free, screw type, water cooled complete with suction filter cum silencer, inter-cooler, after-cooler, lube oil system, moisture separators, etc. Service air supply header will be provided with solenoid operated valve to shutoff in case of drop in instrument air header pressure.

The air dryers will be Heat of Compression type either “Twin Tower type” or “Rotary Drum type”. The drier will be complete with pre-filters (2x100%), after-filters (2x100%) (if applicable), desiccant chambers, interconnecting piping, valves, specialities, instrumentation and control cabinet all assembled on a floor mounted common supporting frame; Desiccant chamber will be filled with desiccant. Chamber construction will be such that desiccant (silica gel / alumina) can be conveniently removed and recharged. Flow rate through desiccant bed will be low enough to avoid displacement of bed. Chamber will be insulated. All the piping valves and specialities carrying hot air will be insulated. Two-way and four-way plug valves will be Teflon coated. Diaphragm, operated control valve will preferably have Teflon seat.

Instrument air receivers are provided at the downstream of air driers for the storage of instrument air. An electronic dew point meter will be provided at the outlet of each drier to monitor the quality of instrument air. The quality of instrument air at the outlet will conform to ISO 8573-1 standard. The service air will be taken from the common header at compressor outlet before ADP with Service air receivers for service air requirements of the plant.

Local air receivers for instrument air will be provided near each steam generator area if required to maintain the pressure.

5.8.6 Turbine Oil Purification System

Turbine oil purification plant will be provided for each unit consisting of centrifuge type oil purifier, indirect oil heater, dirty oil and clean oil pumps and polishing filter. This will be required to condition the turbine oil continuously on bypass mode, in order to remove water and other impurities from the system and to maintain the turbine oil at the optimum condition.

A common oil centrifuge shall be provided for Turbine oil purification system common for two units which shall be used when unit system centrifuge fails.

In addition to above, a common dirty turbine oil recovery system for two units will be installed inside the powerhouse building. This system will comprise of a dirty oil tank, a clean oil tank, a filter and transfer oil pump. This system will be called for in the event of draining of the main turbine oil tank.

5.8.7 Chemical Feed System

Although high purity water will be used as heat cycle make-up, careful chemical conditioning of the feed water, steam and condensate cycle is essential as a safeguard against corrosion and possible scale formation due to ingress of contaminants in the make-up system. Chemical feed system will comprise of the following:

a) LP dosing system (Hydrazine & Ammonia)

The most harmful contaminant, which is always present in the make-up water, causing serious corrosion in the high pressure boiler is dissolved oxygen. Hydrazine solution will be used as a de-oxygenator, to wipe off traces of dissolved oxygen left over in the feed water after deaerator.

Hydrazine solution will be prepared in a solution tank common for both the units. Water from the DM transfer pumps or condensate pump discharge header will be used as the diluting medium. Dosing pump will deliver hydrazine solution at controlled rates continuously at the boiler feed pump suction / discharge lines of respective unit. Two (2x100%) dosing pumps will be provided for each unit along with a preparation tanks sized for 24 hours requirement.

Ammonia will be dosed on the boost the PH to meet the requirement of Boiler feed water. Ammonia solution will be prepared in a solution tank common for both the units. Water from the DM transfer pumps or condensate pump discharge header will be used as the diluting medium. Dosing pump will deliver ammonia solution at controlled rates continuously at the boiler feed pump suction / discharge lines of respective unit. Two (2x100%) dosing pumps will be provided for each unit along with a preparation tanks sized for 24 hours requirement.

b) Phosphate Dosing System

The rate of corrosion on mild steel surface is lowest when the solution in contact has a pH within 9 to 10. Proper attention is required so that the alkalinity does not become excessive, as in such case the corrosion rate will go on increasing.

To impart desired alkalinity to boiler water and also to safely remove scale forming compound in water, if any, due to system contamination as non-adherent harmless precipitate, tri-sodium phosphate solution will be added in the boiler drum.

Phosphate solution will be prepared in a common tank. Water from the DM transfer pump/ condensate pump discharge header will be used as the solvent. The solution will be transferred to individual metering tanks, from which respective phosphate dosing pumps will inject the solution to respective boiler drums are required. Two (2x100%) dosing pumps will be provided for each unit along with a preparation tanks sized for 24 hours requirement.

5.8.8 Elevator

One (1) goods-cum-passenger elevator of 1500 kg carrying capacity for each boiler will be provided. Another passenger elevator of capacity 1360 kg (20 Persons) will be provided at the entrance of the power house building for movement of personnel. Separate passenger elevator shall be provided for the technical building. Rack and pinion type stack elevator is envisaged for the chimney.

5.8.9 Cranes & Hoisting Equipment

The following facilities are envisaged for hoisting and handling of various equipment in the plant:

- Two no. of 65/15 tonne capacity EOT cranes would be provided in the turbine hall in order to handle various power house equipment excluding the generator stator. The generator stator would be erected using jacking method or using mobile cranes. The EOT cranes shall be operated from the cabin as well as pendant push button station. In addition, an independent 15 tonne auxiliary hoist is provided to share lower loads handling and minimize the main crane usage.
- One no. pendant operated EOT crane would be provided in the ACW pump house.
- One no. tonne capacity EOT crane would be provided for the River water intake pump house.
- In all other areas, Cranes/ electrical hoists/ manual hoists, would be provided for handling various pumps, compressors, fans, Washery reject handling equipment, ash handling equipment, drive motors, fans, gates, screens, filters, heaters, etc. considering the following criteria:

  For handling equipment > 10 T - Double Girder EOT Cranes

  For handling equipment < 10 T - Single Girder overhead / under slung EOT Cranes

  For handling equipment > 2 T < 10 T - Electrical hoists with electric travelling trolley

  For handling equipment > 0.5 T < 2 T - Manual hoists

Electrical hoists shall be considered for hoisting any equipment more than 10 M.

5.8.10 Air Conditioning System

Various control rooms in power station, house a group of sophisticated and precision control panel and desks, which call for controlled environments for proper functioning. The objective of air-conditioning for control room is to maintain conditions suitable for satisfactory functioning of sophisticated equipment, accessories and controls and also for personnel comfort. Separate microprocessor based PLC control system shall be provided for AC plant in TG building & service Building and AC plant in ESP building. This PLC system shall have

panel mounted HMI of for operator interface to facilitate control and monitoring. Besides these, the service areas viz. instrument and relay testing laboratories chemical laboratory and a few offices are envisaged to be air-conditioned.

The following areas are proposed to be air conditioned:

a) Common control room, computer room, control equipment room, UPS room, Battery charger room, SWAS room (dry panel area only), conference room in the power house.
b) Service Building
c) Administration Building
d) Switchyard control rooms
e) CHP control rooms
f) AHP control rooms
g) ESP control building (2Nos)
h) Air compressor building control room
i) Water treatment plant building control room, office and laboratory
j) All other control rooms in ancillary buildings

To cater to the above requirement the following systems are proposed:

i. Common chilled water system will be provided for power house building and service building. The system shall comprise of compressor, condenser, direct expansion/flooded type evaporator, condenser, cooling water circulating pumps, cooling towers, chilled water circulating pumps, cooling water piping with valves, accessories, fitting etc. The chilled water produced will be circulated through the cooling coil of air handling units located near respective condition area.
ii. Separate Water cooled PAC units will be provided for Switchyard Control Room, CHP Control Room, AHP control room, Administration building, Water treatment plant building control room, office and laboratory.
iii. Separate Water cooled DX units will be provided for ESP control room.
Split type air conditioning system will be provided for all other control rooms requiring air conditioning.

5.8.11 Ventilation System

The ventilation system envisaged for the plant will achieve the followings:

i) Dust-free comfortable working environment.
ii) Scavenging out structural heat gain and heat load from various equipment, hot pipes, lighting etc.
iii) Dilution of polluted air due to generation of obnoxious gaseous/aerosol contaminants like acid fumes, dusts etc.

The following areas are proposed to be ventilated:

- Power House building and tripper floor
- Electrical rooms of all buildings
- All pump house
- Air compressor rooms
- AC plant room
- Water treatment plant building
- All toilets, Pantry and Lockers.

5.8.12 Power Cycle Piping

The power cycle piping consists of the following

- Main steam piping
- Cold reheat steam piping
- Hot reheat steam piping
- HP & LP bypass piping
- Extraction steam piping
- Auxiliary steam piping
- Spray water piping
- Steam generator feed water piping
- Main condensate piping
- Heater drains and vents
- Blow down and Drain piping

5.8.13 Low Pressure Utility Piping

Low pressure utility piping will cover the following services

- Raw water / River water intake
- CW/ACW piping
- DMCW piping
- DM water
- Fire water
- Service / potable water
- Instrument air
- Service air

5.8.14 Thermal Insulation

Insulation will be provided wherever necessary to minimise heat losses from the equipment, piping and ducts and to ensure protection to personnel. Insulation will be held by adequate cleats, wire nets, jackets, etc. to avoid loosening. Insulation thickness will be so selected that

the covering jacket surface temperature does not exceed the surrounding ambient temperature by more than 20 °C above ambient. The turbine proper will be spray insulated as recommended by the turbine supplier.

5.8.15 Painting & Color Coding

All mechanical and electrical equipment including piping system and structures will be painted with international standards / IS standard colour code for ease of identification. The equipment exposed to will be painted / coated with suitable corrosion resistant paint such as polyurethane paint.

6.0 ELECTRICAL SYSTEM

Electrical system in the power plant comprises the following:

- Generation
- Power evacuation system
- Auxiliary power supply system

The following sections cover philosophy of various power supply system, design concept, control & protection system, layout aspects and salient particulars of various electrical equipment.

6.1 GENERATION

Power is generated from four (4) numbers synchronous generators, each rated for 150 MW, which are driven by respective steam turbine.

The generation voltage will be 15.75 kV or as per Manufacturer's standard voltage. The generator will be connected to 400kV switchyard through respective GCB and step-up Generator Transformer. Salient parameters of the generator are given below:

- Type : Synchronous generator
- Rated capacity : 150 MW to suit turbine rating at all operating conditions.
- Stator core cooling : By Air
- Stator winding cooling : By Air
- Rotor cooling : By Air
- Rated power factor : 0.85 lag
- Rated terminal voltage :15.75 kV (or as per manufacturer's standard voltage)
- Insulation class : F (Temperature rise limited to class 'B')
- Rated frequency : 50 Hz
- Frequency variation range : (-) 5% to (+) 3% (47.5 Hz to 51.5 Hz)
- Number of phases : 3
- Rated speed : 3000 rpm

Generators will be able to satisfy transmission load reactive requirements under all reasonable anticipated operating conditions. The generator will be provided with static excitation achieving high degree of operational reliability and minimum maintenance.

The generator winding will be star connected and all the six leads of the generator phase and neutral side will be brought out of the stator frame for connection to bus duct. The generator

will be non-effectively earthed through a single-phase distribution transformer provided along with secondary loading resistor.

6.2 POWER EVACUATION SYSTEM

Presently the highest network voltage available in the nearby grid is 400kV. Hence, power generated in the power plant will be stepped up to 400kV and exported to the grid substation.

The power generated from the projects shall be shared between Chhattisgarh and nearby grid region. Two numbers 400 kV overhead lines on double circuit tower is envisaged for evacuation of the Power from the project.

6.3 AUXILIARY POWER SUPPLY SYSTEM

The function of auxiliary power supply system is to provide power for all the drives and equipment in the power plant. Plant voltage levels are selected considering the rating of driven equipment.

6.6 kV power supply is envisaged to feed the motors rated above 200 kW. 415 V supply is envisaged to feed LT motors rated up to 200kW.

Auxiliary supply for unit auxiliaries will be derived from Unit Auxiliary Transformers by tapping from the main run of the isolated phase busduct and stepped down to 6.6 kV level to feed unit auxiliary switchboards. The power supply for station auxiliary transformers will also be tapped from the main run of the isolated phase busduct and stepped down to 6.6 kV level to feed station auxiliary switchboards. 415V supply will be derived from 6.6 kV Unit auxiliary boards or 6.6kV station auxiliary boards through service transformers.
For each unit, 2X100% unit auxiliary transformers will be provided considering redundancy. To feed station auxiliaries, 2X100% rated station auxiliary transformers will be provided powered from Unit-1 / Unit-2 generator bus.

6.4 START-UP SUPPLY

During plant start-up, power required for station auxiliaries and unit auxiliaries will be drawn from 400kV grid through switchyard. The power can be drawn through generator transformer (GT), unit auxiliary transformer through generator circuit breaker (GCB).

For pre-commissioning activities, power required for station auxiliaries and unit auxiliaries will be drawn from 132 kV Mining substation through 132kV Startup transformer.

6.5 ESSENTIAL SUPPLY SYSTEM

6.5.1 Emergency AC supply

Emergency AC supply will be required for safe shut down of the unit in the event of total black out. Emergency AC supply is envisaged for critical drives such as emergency oil pump, jacking oil pump, scanner air fan etc.), lighting, charger, UPS, elevators, etc.

DG set will be rated for standby duty. One DG set for each unit is proposed. Further a common DG set as standby to unit DG sets is envisaged as per CEA guidelines.

DG set is required to start up and come into operation automatically in the event of total power failure in the plant. Manual starting facility from remote location will also be provided.

Diesel engine will be suitable for HSD oil.

DG set will be installed indoor. Acoustic enclosure will be provided to meet norms of 'Pollution control board'.

Generator will be rated for 415V, class H insulated with IP 23 degree of protection. Neutral will be solidly grounded.

6.5.2 Station DC system

DC supply is envisaged for the control of EHV, MV & LV switchboards and control panels. Further, in case of failure of AC supply, to feed essential drives such as the emergency oil pumps, jacking oil pump, emergency DC lighting etc, 220V DC supply is envisaged.

DC supply will be derived through battery chargers, backed by DC Batteries. The batteries will be sized for the required load for one hour duty cycle. Battery will be of Ni-Cd type in the main plant and Battery will be of lead acid type in the off-site areas.

220V DC System will be provided for each Unit. It shall consist of redundant batteries with dedicated float cum boost chargers for each battery. For the Switchyard a separate 220V DC system is envisaged. 48V DC system is envisaged for PLCC communication. Similarly for off-site areas like Washery reject handling plant, AHP, exclusive 220V DC system is envisaged.

6.5.3 Uninterruptible power supply system

Uninterruptible power supply (UPS) system is required to provide a reliable true sine wave power to DCS/PLC and other vital equipment/ instrument/system.

230V AC single phase supply will be derived through UPS, backed by batteries. The batteries will be sized for one hour duty cycle.

Uninterruptible power supply (UPS) system will be provided for each unit in the main plant. For main plant area, UPS system will be parallel redundant with servo controlled voltage stabilizer. Battery will be of Ni-Cd type.

For other off site areas such as Washery Rejects Handling plant, AHP, WTP etc., dedicated parallel redundant UPS will be provided.

6.6 CONTROL, MEETING & PROTECTION SYSTEM

6.6.1 Protection system

For protection of equipment against abnormal system conditions, adequate protective devices will be installed in the respective switchgears and/ relay panels.

Each equipment will be provided with a primary as well as backup protection. Separate relays will be used for primary and backup protection.

For EHV overhead lines, Main-1 and Main-2 protection will be in separate relays having different configuration and will be non-switched scheme. Redundant busbar differential protection is envisaged for each EHV bus.

For generator protection, redundant multi-function numerical relays will be provided. Protections will include differential protection and other current based, voltage based, power based protections.

For generator step up transformer & EHV standby transformer multi-function numerical relays will be provided. Protections will include differential protection, restricted earth fault protection, over fluxing protection and other current based protections.

For Unit auxiliary transformer, Station auxiliary transformer and auxiliary transformer, multi-function numerical relays will be provided. Protections will include differential protection, restricted earth fault protection and other current based protections.

For service transformers, multi-function numerical relays will be provided to cover over current, earth fault and short circuit protection.

For HT motors and breaker operated LT motors, multi-function numerical relays will be provided to cover over load, over current, earth fault and short circuit protection. Motors rated above 1500 kW will be provided with differential protection.

Besides this, protection against lightning surges will be provided with lightning arresters at suitable locations for outdoor equipment connected by overhead lines. Further for protection against direct stroke shielding wires and lightning masts will be provided for outdoor equipment.

132 kV cable between AELM and power house, shall have dedicated current based differential protection.

6.6.2 Control system

Switchboards located in the power house building will be controlled from DCS through mimic screens in the VDU. Separate mimic screens will be provided for each Switchboard/System. Digital signals / Analog signals from the switchboards will be extended to DCS system. Sequence event recording will be provided for critical signals.

Switchyard will be controlled from substation automation system.

Generator circuit breaker will be controlled from generator control panel, which will have synchronizing equipment also.

Switchboards located in the off-site buildings will be controlled from respective PLC, wherever PLCs are envisaged for plant drives. Where PLCs are not envisaged, switchboards will be controlled from local only.

DG set will be controlled from DCS and local control panel.

For all motors, Local Pushbutton station (LPB) with latching emergency stop pushbuttons will be provided. Start push button will be provided based on process/control requirement.

6.6.3 Energy metering system

For energy measurement, energy meters will be provided at following locations as per CEA regulation:

- Import/export type, main meter and check meter of 0.2S class for each line feeder.
- Energy meter of 0.2S class on HV side of each generator transformer.
- Energy meter of 0.2S class on LV side of each unit auxiliary transformer / station auxiliary transformer.
- Energy meter of 0.5 class on HV side of service transformer.
- Energy meter of 0.5 class on LV side of each service transformer.
- Energy meter of 0.5 class for each HT motor.
- Energy meter of 0.5 class for each 6.6kV switchboard.

6.7 DESIGN CONCEPT

The design concept of the electrical system as a whole is based on the requirements for the safe and reliable performance of steam turbine generator set and the interconnected electrical system with provision for easy maintenance and overhauling. The design principles and standards delineated herein are generally in compliance with latest IS/IEC standards, Indian Electricity Rules, CEA regulations, Grid Code and other Code of Practices already established in the country.

For the purpose of design of all electrical equipment and system a design ambient of 50°C will be considered as per CEA's "Technical standards for Construction of Thermal Power plant".

6.8 SYSTEM NEUTRAL GROUNDING

Generator neutral will be earthed through distribution transformer and secondary resistor to limit the earth fault current to about 10 Amps.

400kV system neutral will be solidly earthed as per the current practices.

6.6kV system neutral will have medium resistance grounding, limiting ground fault current to 300 Amps. Resistance grounding has the following advantages:

- Electric shock hazards to personnel due to stray ground fault currents in the ground return path is reduced.
- Transient over voltages can be limited.
- Mechanical stresses in circuits and apparatus carrying fault current is reduced.
- Burning and melting effects in faulted electric equipment are reduced.

415V system neutral will be solidly earthed as per Indian Electricity Rule, Rule No. 61.
415V DG set neutral will be solidly earthed.
220V DC system will be unearthed.

6.9 FEATURES OF ELECTRICAL EQUIPMENT

6.9.1 Generator Circuit Breaker

a) The generator circuit breaker (GCB) will be provided between generator and generator transformer along IPB busduct.

b) The GCB will be of SF6, metal enclosed, indoor type with an operating duty of CO-30 min-CO for short circuit current and O-3min-CO-3 min-CO for load current. It will be provided with three pole gang operation and anti-pumping feature. The generator circuit breaker will use SF_6 gas both as its arc-extinguishing medium as well as for internal insulation.

c) GCB will consist of SF6 circuit breaker chamber, line disconnecting switch, earth switch, provision for starting switch in case of SFC connection, surge capacitors, surge arresters etc.

d) The GCB enclosure will be non-magnetic aluminium alloy, minimum flux, and isolated phase type with degree of protection IP-52.

e) A series disconnector will be fitted on the outgoing side of the circuit breaker and within the same enclosure. Earthing switches will be provided on both sides of the switchgear unit. A short circuiting disconnector will be provided to establish a three phase short circuit on to the generator connections during initial commissioning.

6.9.2 Generator Transformer

The generator transformer will be designed to deliver the total output of the generating unit into the system and will have the following salient technical features.

- Type : Oil filled, outdoor type, 3 phase, two winding
- Rating : 185 MVA rating
- Voltage ratio : 400 kV/ 15.75 kV (or as per generator voltage).

- Frequency : 50 Hz
- Vector group : YNd11
- Cooling : ONAN/ONAF/OFAF
- Taps type : OCTC
- Taps range : ±5% in steps of 2.5%

One common standby three phase transformer also proposed as spare.

On line gas analyzer is proposed to monitor the condition of the transformer.

6.9.3 Unit Auxiliary Transformer

Each generator will have two unit auxiliary transformers (UAT), rated to cater to plant auxiliary loads. The power supply for UAT will be tapped from the main run of the isolated phase bus duct from generator, between GCB and generator transformer. UAT will have the following salient technical features.

- Type : Oil filled, outdoor type, 3 phase, two winding
- Rating : 20 MVA rating (tentative)
- Voltage ratio : 15.75 kV (or as per generator voltage) / 6.9 kV
- Frequency : 50 Hz
- Vector group : Dyn1
- Cooling : ONAN/ONAF
- Taps type : OLTC
- Taps range : ±10% in steps of 1.25% (tentative)

6.9.4 Station Auxiliary Transformer

Two numbers station auxiliary transformers (SAT), envisaged to feed plant auxiliary station loads. The power supply for SAT will be tapped from the main run of the isolated phase bus duct from generator-1/2, between GCB and generator transformer. SAT will have the following salient technical features.

- Type : Oil filled, outdoor type, 3 phase, two winding
- Rating : 20 MVA rating (tentative)
- Voltage ratio : 15.75 kV (or as per generator voltage) / 6.9 kV
- Frequency : 50 Hz
- Vector group : Dyn1
- Cooling : ONAN/ONAF
- Taps type : OLTC
- Taps range : ±10% in steps of 1.25% (tentative)

6.9.5 Startup Transformer

For pre-commissioning activities, power required for station auxiliaries and unit auxiliaries will be drawn from 132 kV Mining substation through 132 kV Startup transformer and 400kV switchyard.

One number startup transformers (SUT) envisaged feed plant auxiliary loads. SUT will have the following salient technical features.

- Type : Oil filled, outdoor type, 3 phase, three winding, Bidirectional.
- Rating : 100 MVA rating (tentative)
- Voltage ratio : 400/132/6.9kV
- Frequency : 50 Hz
- Vector group : YN0yn0yn0
- Cooling : ONAN/ONAF
- Taps type : OLTC
- Taps range : ±10% in steps of 1.25% (tentative)

After commissioning, power required for 132 kV mining substation will be evacuated from power plant through 400 kV switchyard and 132 kV Startup transformer.

6.9.6 Auxiliary Transformers

Auxiliary transformers will be provided to cater power for 6.6kV switchgear and will be derived from 6.6 kV Unit /station auxiliary switchgear. For reliability 2x100% rated transformer is envisaged and is fed from separate 6.6 kV Unit/station auxiliary Switchgears. These transformers will be 3 phase, 2 winding, outdoor, oil immersed type with natural / air cooling.

6.9.7 LV Service Transformers

LV Service transformers will be provided to derive 415V supply. Each switchgear will be fed by two numbers 100 % rated transformers. Service transformer will be 3 phase, 2 winding type. Service Transformers feeding services located in the Power House building and other off site areas will be of dry type.

6.9.8 Isolated Phase Busduct

Generator busduct will be Isolated Phase Bus Duct (IPBD) type envisaged for the following.

- Between generator and GCB
- Between GCB and generator transformer
- Generator neutral side
- Tap off from main run to Unit auxiliary transformer and Station auxiliary transformer
- Tap off from main run to LAPT cubicle
- Tap off from main run to excitation transformer for static excitation system

The continuous current rating of the bus duct will be suitably selected to match with maximum output of the generator. The IPBD will be continuous type with aluminium alloy conductor and aluminium alloy enclosure. It will be natural air cooled pressurized with IP55 degree of protection for indoor and IP 55W for outdoor portions

6.9.9 Segregated Phase Busduct

Unit Auxiliary Transformers and Station Auxiliary Transformer will be connected to the 6.6 kV Switchgears by 6.6kV Segregated Phase Bus Duct (SPBD).

Ties between 6.6 kV Station auxiliary switchboard and 6.6 kV Unit auxiliary switchboard will also be through 6.6 kV SPBD. 6.6kV SPBD will have fault withstanding capability will be same as that of respective switchboard.

Auxiliary transformers will be connected to the 6.6 kV Switchgears by 6.6kV Segregated phase bus duct (SPBD).

The SPBD will be with aluminum alloy conductor and aluminum alloy enclosure. It will be natural air cooled with IP 55 degree of protection for indoor and IP 55W for outdoor portions.

6.9.10 LV Busduct

Non-segregated phase Busduct are envisaged for connection between LV service Transformer and 415V PCC. The Busduct will be non-segregated type with aluminium conductor in aluminium enclosure. The Busduct will be natural air-cooled.

6.9.11 6.6 kV Switchgear

The 6.6kV Switchgear will be indoor, single front, single tier, metal clad, fully draw out type with IP4X degree of protection.
The buses will be of high conductivity copper / aluminium alloy conductor and will be designed to withstand, without damage, a fault of minimum 40 kA rms for 3 second.
The breakers will be of vacuum type. The 6.6kV breakers will have a rated interrupting current rating of 40 kA rms respectively. The duty cycle of the breakers will be 0-3 min-CO-3min-CO.

6.9.12 LV Switchgear

The LV switchgear will consist of Power Control Centre (PCC), Motor Control Centre (MCC), AC / DC Distribution Boards etc., and will be rated for 415 volts, 3-phase, 4 wire supply.

Power Control Centre (PCC) will have two bus sections and a bus coupler. Each section will have 100% rated incomer fed from service transformer. The PCCs will distribute power to breaker operated LT motors, motor control centers (MCC), Distribution Boards and higher capacity feeders.

The MCCs will distribute power to LT motors, Distribution boards and other feeders.

The 415 volt Distribution boards will distribute power to small 415V, 240V non motor loads.

The normal operating conditions for the PCC & MCC will be with both the incomers closed and bus coupler open. When one of the incomer is out of service, the other incomer will supply power to both the buses through the bus coupler.

Redundant mechanical loads will be fed from separate MCC buses.

PCC & MCC will be drawout type and distribution boards will be fixed type.

All motor starters will be 'Direct On Line' type conforming to 'type 2 co-ordination'. Motor feeders will be of conventional "MCCB – Contactor – Relay" combination type.

For breaker operated feeders, multifunction numerical relay will be provided.

6.9.13 Motors and actuators

All AC motors will be squirrel cage induction type rated for continuous duty. DC motors will be shunt wound type.

Power supply for AC motors will be as follows:

- Single phase motors (up to 0.2 kW) : 240V, 1 phase, 50 Hz
- Motors rated ≤200 kW : 415V, 3 phase, 50 Hz
- Motors rated >200 kW : 6.6kV, 3 phase, 50 Hz

Motors will be energy efficient type. LV motors will be of IE2 efficiency class.

All Motors will have IP 55 degree of protection. Motors located in hazardous area will have flame proof enclosure as per applicable standard.

Motors will be totally enclosed. Cooling method for LT motors will be TEFC and for HT motors it will be CACA/TETV/TEFC. For higher capacity motors such as CW pump motors and BFP motors, CACW cooling can also be considered. Motors will have insulation Class F with temperature rise limited to Class B.

Motor actuators will have integral starter.

6.9.14 Power and Control Cables

6.6kV cables will be of stranded aluminium conductor with heavy duty XLPE insulated, each core screened on conductor as well as on insulation, colour coded, and extruded PVC inner sheathed, armoured and overall FRLS PVC sheathed. These cables will be manufactured by triple extrusion process and dry cured and dry cooled. The cables will be suitable for unearthed system.

LT power cables will be 1100V grade with stranded conductor (minimum size will be 2.5 sq.mm, upto 6sq.mm will be copper and 6sq.mm & above will be aluminium), XLPE insulated, extruded PVC inner sheathed, armoured and overall FRLS PVC sheathed.

Control cables will be multicore 1100V grade, PVC insulated, PVC inner sheathed armoured and overall FRLS PVC sheathed with 2.5sq.mm stranded copper conductors.

All the cables will have Flame Retardant Low Smoke (FRLS) outer sheath.

6.9.15 Illumination System

The plant lighting system includes:

- Normal AC lighting and emergency AC lighting which contributes together 100% lighting.
- Emergency DC lighting in selected areas of the plant during plant emergency conditions.

Normal AC Lighting will be energised from 3-phase, 4-wire, 415V main lighting distribution boards and lighting panels.

The emergency AC lighting will provide about 20% of the total AC lighting in Main plant building and other select areas. Emergency AC lighting will be fed from DG set through emergency MCC.

Emergency DC lighting will be provided in specific areas such as control room, switchgear rooms, areas near local panels, staircases and other strategic areas. DC emergency lighting will normally be “OFF,” and upon loss of normal AC & emergency AC supply, DC lights will be turned “ON”.

LED light fittings will be of following types for the installations having room height of upto 5 metre:

- Industrial trough type for all industrial areas
- Corrosion proof type for lead acid battery room and chemical areas
- Anti-glare mirror optic type for Control rooms housing VDUs.
- Mirror optic type for other Control rooms.

LED fittings of well glass/medium bay type will be of following types for the installations having room height of above 5 metre:

- High bay (closed type) fitting for Turbine hall (operating floor), Pump houses.
- Well glass fitting with IP55 degree of protection for other floors of turbine hall, Boiler platforms, Conveyor galleries, WRHP/AHP area, DG room,

In areas with hazardous atmospheres such as Fuel oil pump house &, lighting and convenience outlets will be flame proof type.

70/150/250/400 Watts LED light fittings will be used outdoor installations.

Galvanised lighting poles will be provided for road lighting and area lighting.

High mast lighting will be provided in washery reject stock area and other open areas. High mast will have 20-30 M high, winch operated type and will be fabricated out of galvanized steel polygonal section.

For chimney which will be about 275 metres high, aviation obstruction lights will be provided on outer shell, to indicate presence of obstacles as per ICAO guidelines.

6.9.16 Plant Communication

Communication system will be provided to facilitate operations by establishing quick communications among the operating personnel stationed at various locations of the plant. The following systems are envisaged:

- Public address system with page and party line
- Telephone system
- Walkie-Talkie

6.9.17 Grounding and Lightning Protection

Buried earthing conductor will be of mild steel rod. Equipment earthing conductor installed above ground will be of galvanized steel.

For neutral earthing of each generator & transformer, 2 numbers treated earth pits will be provided as per IS-3043.

For DCS and PLC systems dedicated earth pits will be provided for electronic earthing.

Protection against lightning strokes will be provided for the power plant. The Lightning protection system will have horizontal/vertical air terminations on roof top, down conductors, test links and earth pits, Conductor material will be of galvanized steel.

6.9.18 Equipment for Hazardous Areas

Electrical equipment such as motors, push button stations, lighting fixtures, junction boxes etc. located in hazardous areas will be provided with increased safety or flameproof type enclosures as per relevant standards and area classification requirements.

6.10 LAYOUT ASPECTS

In the Power house building, BC bay will be utilized to accommodate Electrical and C&I equipment of the Main Plant. Cable spreader room will be provided for each Switchgear room and Control room / Control equipment room.

Transformer yard will be located adjacent to A row of the power house building. Generator Transformers, Unit Auxiliary Transformers and Station Auxiliary Transformers will be located in the Transformer Yard. Start-up Transformer will be located in the 132kV Switchyard.

Generally all Switchgear/MCC rooms in the main power house building will have cable spreader rooms. For cable spreader rooms, doors will be fire rated. For other offsite areas, switchgear room/control room can have underground cable trenches.

The batteries will be located in a separate ventilated room.

400kV GIS building and 132 kV Switchyard will be located in front of transformer yard. 400kV Overhead lines from the Switchyard will be tied to separate gantry in the transformer yard to facilitate tap off connection to Generator transformers.

For Interplant cabling, generally overhead cable rack will be provided. In the switchyard trenches will be provided for running the cables.

For ESP, Water treatment plant, Ash handling plant and Washery reject handling plant separate switchgear room will be provided in the respective area to accommodate various HV & LV switchboards. Cable vault will be provided below the switchgear room.

For the other off site areas such as fuel oil pump house, fire water pump house, CW pump house etc. a separate switchgear room will be provided in the respective area to accommodate various LV switchboards. Cable trench will be provided below the switchgear. Cables will be laid on overhead cable trays in general. Indoor cable trenches can be considered based on equipment layout.

In water treatment plants & Fuel oil pump house usage of cable trench will be avoided. Outdoor concrete trenches will be minimised. Cable routing will be designed to avoid directly buried cables.

In Electrical Switchgear / Panel rooms, Fire barriers/ Fire stops will be provided for all direct cable entries into electrical Switchgear / Panels from Cable Vault. Further, Fire barriers/stops will be provided for fire rated wall/floor penetrations. Cable trays will be of hot dip galvanised steel.

6.11 CONSTRUCTION POWER SUPPLY

For construction power, 33kV power supply from Mining substation is envisaged. The power will be received at one point and further distributed through 6.6 kV ring main system. LV distribution transformers will be provided at required locations to derive 415V power supply. In case of failure of power from mining substation, supply through local diesel generator sets located at various load centres are envisaged.

7.0 INSTRUMENTATION AND CONTROL

7.1 OBJECTIVE

The objective of this section of detailed project report is to outline the design philosophy to be adopted for Control and Instrumentation (C&I) systems and the extent of automation, for 4X150 MW units which covers BTG (Boiler, Turbine, Generator and their Auxiliaries) and BOP (Balance of the Plant) areas.

7.2 AUTOMATION LEVEL

- To allow safe start-up, synchronizing, shut-down, emergency tripping, control and monitoring of all major plant areas.
- To maximize the availability of plant
- To incorporate a maximum level of automatic control, thereby minimizing operator manning levels
- To provide facilities for comprehensive monitoring, storage and presentation of information concerning plant conditions
- To provide facilities for comprehensive testing and presentation of information concerning system and plant performance
- To centralize plant monitoring and control facilities within the central control Room
- Achieve maximum life span of equipment by condition monitoring systems.
- Optimization of the plant with high output and minimal consumption of fuel.

7.3 CONTROL SYSTEM DESIGN PHILOSOPHY

7.3.1 System controlled and monitored by BTG DCS

DCS controlled systems are as follows

- Steam generator & its auxiliaries
- Steam Turbine Generator & its auxiliaries
- Cooling water, Auxiliary Cooling water & DMCW
- Unit & station Electrical Systems

Steam Generator & auxiliaries, Steam Turbine Generator & its auxiliaries, Unit Electrical Systems are controlled form Unit DCS. Cooling water, Auxiliary Cooling water, DMCW and station Electrical Systems are controlled from Common DCS.

7.3.2 Unified - PLC for control and monitoring of BOP Systems

Unified PLC concept shall be adopted for control and monitoring of the BOP systems. All the offsite PLCs shall be connected to form a BOP PLC network which is further

extended to the Central control room for monitoring. Control, Operation & Monitoring shall be done from the respective local control rooms of the BOP packages. The following are the BOP Systems controlled and monitored by PLC.

- Washery reject handling system
- Water treatment Plant
- Ash handling plant
- AC & Ventilation system
- Fire protection system
- Fuel oil Unloading, storage and forwarding system
- ETP Recycle Plant
- River Water Intake system
- BOP electrical

7.3.3 Microprocessor based system

Microprocessor based system shall be envisaged for the following systems. Monitoring of critical parameters of these systems shall be envisaged in DCS.

- Fire Detection & Alarm System
- Emergency diesel generator
- Switchyard SCADA system
- Compressed air system
- ESP

7.3.4 Local control system

Standalone local control system is envisaged for the following offsite plants

- Chemical dosing system for CW/ACW treatment System
- Chlorination system for Raw water, CW/ACW water & Potable water

7.4 DISTRIBUTED CONTROL SYSTEM (DCS)

The control and monitoring of the power station process and electrical systems shall be undertaken by the use of modern well proven microprocessor based Distributed Control Systems. It shall perform the functions of monitoring, control, alarm, protection and interlock, diagnosing, performance monitoring and calculation, Management information system (MIS) and maintenance guidance of the unit to meet all requirements.

The DCS shall fulfil the following basic functions:

- Monitoring of all plant functions

- Collect and store data for trending of various plant functions. Keep track of various plant events and record them for historical purposes
- Perform required basic calculations for performance monitoring and optimization
- Produce operating logs for record purposes and post trip review reports
- Provide sequence of events monitoring and reporting
- Perform self-checking and self-diagnosis
- According to plant operation process, the DCS shall be divided into three control levels: Unit control level, Group control level and Subgroup / Drive control level
- The fundamental functions such as control, alarm, monitoring, interlock and protection shall be segregated, so that the failure of one does not result in the failure of other functions
- Alarm and Trending functions shall be realised through VDU
- Failure at any station shall not affect the normal operation of other stations or the communication system
- Redundancy and self-diagnosis shall be provided for the control system and communication network. The functions of a failed component shall be transferred automatically and bumpless to the standby processor. The failure message shall display in VDU

7.4.1 System Redundancy

Redundancy shall be provided such that single failure shall not affect the performance of the unit in any way. DCS shall have redundancy in the following levels as minimum:

- Processor
- I/O modules for critical I/O's
- Network interface module
- Communication cable
- Power supply.

Critical signals are to be triple redundant.

7.4.2 Human Machine Interface (HMI) and Printers

For all the Operator / Engineer stations colour VDU's shall be used. Colour VDU's shall be of 24" LED type suitable for continuous operation. Resolution shall be 1280 x 1024 pixels as minimum.

Two (2) nos. Large Video Screens (LVS) shall be considered for the unit DCS and one (1) no. LVS shall be considered for the common DCS. Each LVS screen size shall be of approximately 84" diagonally. Large Screen Graphics Wall in Control Room shall primarily be used:

- To provide real time clear luminous view to share information between operators
- To control /operate using a dedicated Keyboard / Optical mouse / Touch pad

Keyboards shall be of QWERTY Industrial grade type with Optical mouse.

Laser type printers shall be provided. Any printer can be specified as an alarm or report printer, and also respond to operators print request.

7.4.3 DCS Software

The latest release of software shall be used for Plant Automation. The software shall be user friendly and flexible so as to enable the user to modify the content to their requirements.

Scan time for Analog signals maximum 100 msec for critical closed loops, 250 msec for balance closed loops and 1 sec for measurement system parameters. For digital signals maximum 25-50 msec. For pulse signal max.100 msec. Turbine loop scan time shall be less than 10 milliseconds for critical loops.

Processor CPU loading shall not exceed 60%. RAM shall not be more than 50% utilized. Operator station CPU loading shall not exceed 50%. The DCS shall provide a historical data storage, configurable and retrieval.

7.4.4 System Communication

The redundant, high speed data highways shall be used to provide communications between the controllers, HMI, other processors or any other device connected to the data highway.

The transmission rate shall be minimum 1 GBPS or better as per IEEE 802.3 / 802.4/ 802.5.Communication sub-system shall be dual redundant, consisting of two separate communication buses and two separate communication interfaces for each node. The load rate of communication system shall not be more than 40-50% under the worst conditions.

7.4.5 Engineering Work Station (EWS)

Two (2) number EWS shall be provided for unit DCS and one (1) number EWS shall be provided for common DCS for fault finding and software programming. All necessary hardware and software shall be provided to allow engineering staff to trace faults in the system and applications software, to create control strategies, VDU screens and all other maintenance activities.

The EWS shall also be capable of doing operator functions.

The EWS shall have the following capability as a minimum:

- Database configuration for various displays
- Alarm inhibits for points under maintenance
- Configuration, re-configuration of alarm settings, their values, addition or deletion of any control block or component in control loop.
- Tuning of control loop parameters
- Compilation of graphic displays
- Calling of detailed self diagnostic displays for maintenance.

7.4.6 Sequence of Events Recording System

Separate microprocessor based Sequence of Events Recording system (SER) or integral to DCS shall be provided to log trips, cause of trips and other important faults, to diagnose the cause of the plant trip with a resolution of 1 millisecond. The system shall have sufficient capacity to record all the important events.

7.4.7 Management information System (MIS)

MIS shall be provided with all required software to provide the plant information. The data to be displayed shall be configurable by pooling data of the unit.

7.4.8 Master/Slave Clock (Global Positioning System) & Time Synchronization

Master/Slave Clock System shall be provided with necessary hardware & software to receive the synchronizing signals from remote satellite and provide outputs to synchronize all systems like DCS, PLC, SCADA, numerical relays etc. The Time Synchronization signals shall in NTP Protocol.
The master Clock shall be configured as Real Time Clock with display of time in 24 hrs format and date.

7.4.9 Performance Calculations

Performance calculations shall be provided as an integral feature in the DCS and retrieves data from the unit's data highway for performing calculations and other complex computations to determine equipment/process malfunctions and overall performance. Performance calculations shall be in line with the ASME PTC/DIN latest standard. Based on the results of these calculations appropriate logs and displays shall be provided to the operator for guidance.

7.4.10 Historical Data Storage and Retrieval System

The Historical Data Storage and Retrieval System shall collect and store data of plant operating parameters including trends, alarms and events from the DCS database and periodically and automatically replicate this data on to removable storage drives such as magneto-optic disks for long term archival and retrieval

7.4.11 Data Acquisition Sub-System

The data acquisition system shall be capable of performing the following alarm check functions as a minimum:

a) Input open check
b) Velocity alarm check
c) Deviation alarm check
d) High/low/high high/low low limit alarm check
e) Alarm bypass

All open loops analog inputs used in DAS shall be scanned at a maximum of 250 ms interval. It shall be possible to display all variables of the data acquisition sub system on the operator consoles by addressing from the keyboard.

7.5 STEAM GENERATOR CONTROLS

7.5.1 Burner Management system (BMS)

BMS control, interlock & monitoring shall be envisaged either in DCS or through proprietary Microprocessor based control system of boiler vendor which shall be seamlessly integrated with the DCS through soft communication link.

The BMS shall perform the following functions:

- Furnace auto purging
- Auto ignition
- Burner management
- Flame monitoring
- Main Fuel Trip (MFT)
- Furnace pressure protection
- Washery reject feeder start-up/shut-down
- Boiler protection

7.5.2 Soot Blower system

Soot blower control system shall be implemented in DCS with independent controller with redundancy in processor, I/O and field instruments. The soot- blower control system shall perform the following functions:

- Soot-blowers shall be sequence-controlled. This sequence can also be programmed by the operator based on the need.
- Manual initiation of automatic cycle
- Manual blow of any selected soot-blower
- Blowing failure alarm
- Forward and reverse travel indication for long retractable soot-blowers
- Automatic retract of soot-blowers upon motor overload
- Condensate draining system based on temperature indication etc.

Necessary hardware/software provision for intelligent selection of soot blowing operations is envisaged.

7.5.3 Furnace Temperature Probe

A retractable type of furnace temperature measurement is provided one on each side of left and right side of the boiler at the furnace outlet.
This will have the following features:

- Manual initiation from the control room.
- Probe failure alarm.
- Auto retract when temperature exceed the limit.
- Position indication at the control room.

7.6 STEAM TURBINE CONTROLS

Steam Turbine control, interlock & monitoring shall be a proprietary control system of Turbine vendor which shall be seamlessly integrated with the DCS through soft communication link. The Steam Turbine control system shall be a fail-safe system with redundancy at processor modules, communication modules, data bus, power supply and I/O modules.

The steam Turbine control systems perform following control functions suiting to grid demand.

- Speed control
- Load control
- Isochronous control
- Pressure control

7.6.1 Turbine Protection System (TPS)

The Turbine protection system puts the Turbine out of operation by closing the emergency stop valves, Interceptor valves and control valves as soon as operating

conditions occur that can no longer be safely maintained. The system protection circuitry ensures protection in case of safe components.

7.6.2 Automatic Turbine Run-Up System (ATRS)

The ATRS shall envisage the system to run-up the Turbine automatically to synchronize and load the unit as required in case of a cold, warm or hot start-up. ATRS shall also suitably co-ordinate with the steam generator and HP-LP bypass system and is also be capable of automatic controlled shut -down of the plant.

7.6.3 Automatic Turbine Testing System (ATT)

Automatic Turbine tester is used to check / test at a regular interval the function of the safety devices without causing any unintentional shut down of the unit. It covers two electrical remote solenoid valves trip, two over speed trip devices, hydraulic low vacuum trip device. It shall also be provided with an auto tester for emergency stop valve.

7.6.4 Turbine Stress Controller (TSC)

The Turbine shall be equipped with Turbine Stress Controller to assist in attaining optimized start-up, operation and shutdown without impairing the expected operating life. The main task of microprocessor based Turbine Stress Controller is online monitoring and evaluation of Turbine components with respect to material fatigue and life expectancy. It allows Turbine operation within permitted stress types or loading combinations.

7.6.5 Turbine Supervisory System (TSS)

The Turbine supervisory system shall be provided for continuous monitoring of the healthiness of components of the Turbine. It shall provide adequate warning of the development of potentially dangerous steam Turbine conditions. All the necessary sensors shall be mounted on the Turbine with flexible leads for connection to junction boxes, circuit for processing with power supply monitoring, signal level monitors, test circuits etc.

7.7 FIELD INSTRUMENTS

Adequate number of local instruments shall be provided to guide the local operator in his activities.

For pressure, flow, level and differential pressure measurement, electronic transmitters with an output of 4-20 mA DC shall be provided.

All transmitters shall be of SMART type.

All electronic transmitters, local gauges / indicators / other field instruments shall have IP-65 enclosure.

All local instruments shall be mounted at a convenient height of about 1.5 metres above ground or platform.

For temperature measurement in the range of 0-300°C Platinum Resistance Thermometer shall be used and in the range of 300°C to 1400°C, thermocouples shall be used. All T/C and RTD shall be of Duplex type.

Flow nozzles shall be used for feed water flow and other critical measurements where weld-in construction is required. Orifice plates shall be used for other flow measurements where flanged construction is acceptable. Mass flow measurement shall be used for oil flow.

All control valves shall be provided with pneumatic/smart valve Positioner, local position indicator, and hand wheel, isolating and bypass valves. Wherever necessary, position transmitter for remote indication shall also be provided.

Various switches for temperature, pressure and level as per requirements shall be provided for alarms/Trips.

7.8 STEAM AND WATER ANALYSIS SYSTEM (SWAS)

Analytical instruments shall be provided for continuous monitoring quality of steam, Condensate and feed water.

A centralised analyser room for steam / Condensate / feedwater sampling shall be provided at a suitable location.

The room shall house (i) Dry panel comprising electronics/transmitters for analyser, (ii) Wet panel comprising different stream processing equipment and measuring cells. SWAS panel shall be hooked up with DCS for monitoring.

7.9 CONTINUOUS EMISSIONS MONITORING SYSTEM (CEMS)

Continuous emission monitoring system shall comprise of Flue gas monitoring Stack Emission Monitoring, Ambient Air Quality Monitoring and Meteorological Monitoring System

Stack Emission Monitoring system shall be provided to monitor the plant stack emissions. It is recommended to use “INSITU” type of measurement for O2, SOx and

NOx. Concentrations of gases in the stack shall be continuously monitored and recorded in the DCS and shall include the following, as a minimum:

- Flue gas O_2.
- Carbon Monoxide (CO)
- Sulphur Dioxide (SOx)
- Oxides of Nitrogen (NOx)
- Stack Opacity.

7.10 VIBRATION MONITORING AND ANALYSIS SYSTEM (VMAS)

Vibration Monitoring and Analysis system shall provide condition monitoring of all the critical machines/equipments with HT drives and their driven equipment of main plant that includes Turbine, Generator, Boiler Feed Pumps and Motors, Condensate Extraction Pumps and Motors, CW pumps and Motors, ID Fans, FD Fans and PA Fans . Vibration, axial displacement and speed monitoring system shall be based on non-contacting type sensing probe, unless otherwise specified.

7.11 CABLES

Instrumentation & Control cables shall be 1100V grade. Individual pair and overall shield twisted pair copper cables shall be used for analog signals and overall shielded cables shall be used for digitals cables. All these cables shall be armoured and all the insulation including overall sheath shall be FRLS quality.

7.12 FIRE DETECTION & ALARM SYSTEMS

A fire detection system as per National Fire Protection Association standards recommended practices shall be provided. All the detectors shall be intelligent microprocessor based addressable detectors.

Manifestation of fire shall be sensed by the following methods:

- Ultra Violet (U.V.) light detectors
- Photoelectric smoke detectors
- Multi sensor type smoke detectors
- Thermal/heat detectors. Both the type of detectors shall be addressable from the panel and operator interface.

7.13 CCTV MONITORING SYSTEM

Plant operators are provided with an overview of the important plant equipments so that they can ascertain that there are no obvious mechanical problems. lP-based

CCTV monitoring system shall be provided in common central control room, operation in- charge room & security rooms. The monitoring system in the security room is provided only with an overview of the perimeter surveillance (compound wall), entry –exit point, stores main gate, Steel stockyard, washery reject stock yard etc. from the security point of view to track the intruders.

Closed Circuit Television System (CCTV) with all equipment and accessories shall be provided for the purpose of surveillance of major electrical drive areas e.g. Boiler feed Pumps, ID Fans, FD and PA fans, Condensate Extraction Pumps and critical areas like Turbine hall, firing floor, CW/ACW Pump House, Ash Plant areas etc. so that, by and large, all important areas & equipment can be brought under surveillance. Also, cameras shall be installed at the Main Gate and other common auxiliary plants.

7.14 INSTRUMENT WORKSHOP AND LABORATORY

Design and construction of an instrument workshop & Laboratory, complete with tools and test equipment/devices of proven type and latest design required to maintain the instruments and control devices shall be provided.

7.15 POWER SUPPLY

230 V, 1P, 50 c/s UPS power supply shall be used for DCS. Redundant UPS shall be provided for all the DCS/PLC cabinets and 24V DC shall be derived from 2x100% rated lead acid battery banks with chargers. The capacity and voltage level of UPS shall be decided during detailed engineering. For details of UPS refer electrical section.

7.16 INSTRUMENT & SERVICE AIR SUPPLY

Moisture and oil free Instrument air at 7~8 Kg/cm² (80~100 psi) pressure shall be used for Instrument & Service air supply.

7.17 CONTROL ROOMS

The Control Room shall be designed to accommodate the control and monitoring equipments. The control room shall include Central Control Room (CCR), Control Equipment Room (CER) and Computer Room. The Central control room (CCR) and be common for all four units and Control Equipment room (CER) shall be separate for each unit adjacent to CCR with glass partition for each unit.

8. CIVIL WORKS

8.1 CIVIL STRUCTURAL AND ARCHITECTURAL WORKS

This section shall cover design and construction of all civil works, including site formation, foundations, super-structure, all required buildings, building services, all necessary infrastructural works required and associated works that are necessary for the construction, operation and maintenance of the Power Plant

The section includes all excavation, back filling, concrete work (plain and reinforced), structural steel work, water proofing, architectural work, sanitary, plumbing roads, paving, drainage and finishes including and other building services as required for the Project.

8.2 GEO- TECHNICAL INVESTIGATIONS

The sub soil profiles based on the preliminary Geotechnical investigations carried out at the site during May 2012 is as furnished below.

The overburden soil at site, consist of silty sand for a depth of approximately 5.0m underlain by completely weather rock formation. The thickness of layer varies at different locations as indicated in the report & open –isolated / combined / raft foundation is recommended to suit the loading and site conditions.

The cost estimate is based on the assumption that open foundation is provided for the major plant and equipment of the project.

However, during project implementation of 4x150 MW units, the detailed geo-technical investigation shall be carried out to obtain all data necessary for foundation design and engineering.

8.3 TOPOGRAPHICAL SURVEY

Thermal Power Project is proposed near village Parsa Tehsil: Udaipur, District Surguja in Chhattisgarh. The proposed power plant site is located adjacent to the National Highway (NH-111) which connects Bilaspur with Ambikapur which is located 4 km due north from the proposed site. The nearest Major town is Ambikapur which is about 70 km from the proposed site. The site latitude is 22°50’11” N to 22°50’24” N and longitude is 82°48’46”E to 82°49’22”E.

The site falls into different segments, namely the power block, switchyard, Washery reject stockyard, balance of plant area, ash handling area. Topographical survey of this area indicating the spot levels, contours and permanent features are available in the survey drawing which had been carried out at the site.

8.4 SITE LEVELING WORK

Topography of the proposed site appears undulating involving, huge filling/cutting works. From the contour data available it is observed that the site level varies from RL (+) 545.0 m to RL (+) 524.0 m to optimize the cost of levelling works, terraced grading is proposed to be adopted considering the process & access requirements. The plant shall be provided with varying grade levels namely, RL(+) 544.00 m (IDCT/Switch yard) , RL(+)541.00 m (Washery reject handling), RL(+) 540.00 m (Power house and Transformer yard) & RL (+) 536.50 m (Boiler, ESP, WTP,AHP) to minimise the cutting , filling and disposal of earth. The power house finished floor level shall be 0.5 m above the finished ground level to be adopted in the power house building area as mentioned above.

8.5 APPROACH ROAD/ ROADS AND CULVERTS

The approach road to the proposed Power Plant to access the site is from the near-by NH-111. An access road of the highway of Class “AAA” category shall be laid. The Approach roads would initially be of wet-mix macadam type with shoulders on either side of carriage width. After major construction activities are completed, these would be surfaced with bituminous carpet. Culverts would be provided for road crossings over the drains. All culverts would be designed for the Class – AA loading conditions, but shall be checked for heaviest equipment loads that may come to this plant.

8.6 PLANT ROADS AND CULVERTS

All plant roads will be flexible type pavement with bitumen topping while the heavy traffic roads will be rigid type pavement. Roads leading to Washery reject stock pile and ash silo shall be RCC pavement.

The main plant road on the western side of the power block area shall be 10.5 m wide whereas on the eastern side shall be 7.5m wide. Roads around the Chimney shall be 10.5 m wide & all approach roads to the buildings shall be 3.75m wide. Shoulder of 1.5 m width shall be provided on both sides of 10.5m wide and 7.5m wide roads whereas shoulder width of 1.0m shall be provided on either side of 3.75m wide road. Culverts would be provided for road crossings over the drains. All culverts would be designed for the Class – AA loading conditions.

Rain water for the power plant areas shall be collected through a network of drains and will be fully utilised for rain water harvesting and the excess available shall finally discharge into the regular drainage facility available in the area. As per the preliminary geotechnical investigation report weathered rock is encountered at shallow depth of about 5.0 m hence rain water harvesting (deep aquifer recharge) as well as shallow recharge by having pond / tank shall be selected based on feasibility and costing.

Surface drains planned inside the plant area will be open RCC drain having rectangular cross section. The RC drains in the power plant area where movement of vehicles is expected and those around buildings shall be covered with pre-cast concrete slabs.

8.7 WATER INTAKE

The water for the plant will be sourced from nearby Atem and Rehar River. The Atem river is around 5 kms away from the project site on the Northern side and Rehar river is around 25 kms on the eastern side of the site. The water for the power plant shall be drawn from Lipangi Tunnel of Rehar – Atem river link. Raw water reservoir will be constructed within power plant site to store the pumped water from the river to supply water to the power station and the storage is envisaged for 20 days. Raw water make-up will be made available by intake pumps located on the banks of the river. A pipeline will be laid to the project site from the proposed intake pump house to raw water reservoir. The proposed project will not extract groundwater and hence there will be no impact on ground water.

8.8 SEWERAGE SYSTEM

Skid mounted Sewage treatment plant shall be considered at strategic locations taking in to consideration of toilet facilities provided in buildings, sewage pipe routing and site contour. The effluent from sewage treatment plants shall be pumped to the Effluent treatment plant for treatment and the treated effluent shall be utilized for irrigation of the landscape areas.

8.9 MAIN PLANT BUILDING/ POWER BLOCK AREA

Main Plant building / power block area shall comprise of:

(i) Main power house building (turbo-generator bay, and Electrical bay/ Boiler Feed Pump, Heater and de-aerator bay) shall be a non-basement structure. The steam Turbine Generator and auxiliary equipment will be located in the A-B bay of the building. The B-C bay will house the heaters and de-aerator. The unloading cum maintenance area is located at one end of the building.

The turbine - generator bay will have three floors - ground floor, mezzanine floor and operating floor as per equipment supplier requirements. Localised O&M platforms at required levels are provided for maintenance. The de-aerator & heaters is located in B-C bay above the operating floor. Road access would be provided to the unloading and maintenance bays for unloading & maintenance of TG components and auxiliary equipment.

Control room is also accommodated in the main power house building in the operating floor level along B-C bay. The control room houses the Control desks, cubicles and all electronic equipment's. It also houses batteries, battery charger, A/C plant equipment, etc.

The building shall be of steel-framed structures with concrete block wall up to 3.0 m high from FFL and permanent color coated sandwich insulated metal cladding from 3.0 m to roof. EOT cranes of suitable capacity shall be provided in the TG Bay.

The building shall rest on suitable foundation system depending upon the recommendations of soil report. The roof of Power House building shall be provided with cast-in-situ RCC slab on permanent color coated galvanized MS troughed metal deck sheet supported on purlins and trusses. Floor slab shall also be provided with cast-in-situ RCC on permanent color coated galvanized MS troughed metal deck sheet supported on structural steel beams. Flooring and other finishing works of the building shall confirm to the specified requirements.

(ii) Boiler Foundations/ ESP Foundations

Four nos. of boiler and ESP's shall be located on south side of the power house building. These structures shall rest on suitable foundation.

(iii) Water Cooled Condenser

Induced draft Cooling Towers & Cooling water channel shall be located North of Main power house building near the transformer Area & CW/ACW Pump House.

8.9.1 AUXILIARY BUILDINGS

Auxiliary buildings include compressor house, Diesel Generator Set building, ESP control room building,Air washer room, AHP Compressor building, Ash silo utility building, Fuel oil pump house etc.

- Compressor House, ESP Control room building, Air washer room, AHP Compressor Building, & Ash silo utility building shall be of steel-framed structures with concrete block wall up to roof. Floor / Roof slab shall also be provided with cast-in-situ RCC on permanent color coated galvanized MS troughed metal deck sheet supported on structural steel beams.
- DG set is rested on raft foundation which is housed in an enclosure which comes along with the DG Set. The Control room associated with the DG Set is a reinforced concrete building with concrete block wall.
- Fuel oil pump house – Pump house shall be of steel-framed structures with concrete block wall up to 3.0 m high from FFL and permanent color coated metal sheeting from 3.0 m to roof. Roof shall be provided with color coated metal sheet supported on purlins and steel beams; the switch gear building associated with the pump house is a reinforced concrete building with concrete block.

Any other plant building not mentioned above but required as per system / Technical specifications shall be provided with similar specification.

8.9.2 LOGISTIC BUILDINGS

Ancillary buildings such as technical building, electrical switchgear room building, operation & maintenance laboratories, permanent stores shall be of steel-framed structures with concrete block wall up to 3.0 m high from FFL and permanent color coated metal sheeting from 3.0m to roof, Roof slab shall be provided with cast-in-situ RCC on permanent color coated galvanized MS troughed metal deck sheet supported on structural steel beams. The non-plant buildings like fire station, canteen, administration, and dispensary and gate complex shall be RCC buildings with concrete block wall.

8.9.3 PAVING / PLINTH PROTECTION

Plinth protection around building and paving in main plant area shall be provided. Paving/hard surface shall be provided for vehicle parking and covered vehicle parking for cycles, scooters and cars/jeeps near Power house building and administrative buildings. Entire area behind the power house building towards the chimney shall be paved for the full length of the building.

8.10 FOUNDATION SYSTEM

All foundations shall be designed in accordance with provisions of the relevant Indian Standards. The provision of DIN 4024 shall also be followed for machine foundations where applicable.

For the foundations of Steam Turbo-generator, Fans (ID,FD,PA & SA), Diesel Generators etc detailed static and dynamic analysis shall be done.

Boiler feed pumps located at elevated floor and Crushers may be supported on vibration isolation system. The vibration isolation system shall consist of helical spring units and viscous dampers supporting an RCC deck which would support the machine. The vibration springs rest on a foundation system

The special requirements for concreting including grade, type of aggregate, use of admixture, temperature control, ultrasonic testing, etc, shall confirm to the requirements of the Technical Specification / requirements.

Suitable foundation system for all major and important equipment , heavily & lightly loaded structures (plant & Non-plant Area), shall be provided based on the outcome of detailed soil investigation prior to the start of engineering activities of the power plant structures / utilities.

8.11 TRANSFORMER AREAS

All transformers shall be supported on suitable foundation together with fire wall, drainage, containment arrangements for spillage of oil etc. Transformer foundation shall be provided

with necessary rail tracks for handling and removal of transformer from the foundation without disturbing the other transformers. Gravel filling shall be provided in the Transformer area for proper drainage. Fencing shall also be provided around transformer area as per Indian Electricity Norms.

8.11.1 SWITCH YARD

400kV Switchyard will be gas insulated switchgear (GIS) located inside the building while 132 kV switchyard will be outdoor type air insulated. Open foundations shall be provided for gantries / towers and equipment's in the switchyard area. The control building housing equipment's shall be RCC framed structure with concrete block wall.

8.12 CHIMNEY

The Chimney shall be a common multi-flue reinforced concrete chimney for the four units. The flue gas emission point shall be 275 meters above the plant grade level to comply with environmental regulations .

Internal platforms will be structural steel construction and will be supported from the RCC wind shield. The top 15 m of flues will be of stainless steel construction. The flues will be provided with thermal insulation. The floors/walkways will be of steel grating. The grade level slab will be of reinforced concrete with a metallic hardener floor finish.

The other components of the chimney include a large roll up door and a personnel access door at grade level, doors at all platform levels, a personnel access hatch in the roof slab, liner hatches, liner test ports for sulphur, oxygen, etc., rain water drainage system, flue liner drainage system, louvers with bird screens for ventilation openings, electrical power supply, distribution boards, socket outlets, power and control cabling, raceway system, stair and platform lighting, lightning protection and grounding system and suitable aviation lamp for external lighting and communication system will be provided. Rack and pinion elevator capable of carrying 1000 kg load will be provided in the Chimney.

Two coats of acid and heat resisting paint conforming to IS: 158 over a coat of compatible primer shall be given to the following surfaces :

- Internally for full height of the chimney shell including top of wind shield.
- Externally, from the top to a distance of 1.5 times the diameter of the chimney shell.

Painting the external surfaces of the chimney shell shall be with alternate bands of Orange or Red and White shade, each band with a band width H/9 or 30m whichever is smaller (H = Height of chimney in meters) and bands at the extremities being of Orange or Red shade. This shall be done after removing all loose and foreign matter to give a smooth and uniform finish.2 coats of approved synthetic enamel paint exterior type compatible with concrete

surface over 2 coats of compatible primer over the external surfaces. External surface of flue cans shall be painted with two coats of primer.

8.13 CW SYSTEMS

C.W. pump house shall house the cooling water pumps. Sub-structure of pump house shall be in appropriate grade of concrete. Necessary fore-bay and sump accommodating the Trash racks stop-logs including the handling arrangements shall also be provided in the C.W. Pump house. Super structure of pump house shall be open steel frame with Gantry-crane & the switch gear and control room shall be reinforced concrete building with concrete block wall.

Induced Draft Cooling Tower with back to back arrangement shall be provided for Unit-I & II, & a similar arrangement shall be envisaged for the other two units in this Power Plant. Induced draft cooling towers will be constructed with RCC structures and suitable grade of concrete shall be used. Arrangement shall be made for disposal of the blow down of cooling tower in to the plant water system.

RCC cold water channel shall be provided to convey cold water from cooling tower basins to CW Pump house.

CW ducts/pipes from CW pump house up to condenser and from condenser up to cooling tower shall be routed in a manner that there is minimum number of cross over.

For Chlorinating requirements a separate Chlorine tonner Storage and Chlorination Plant Equipment shall be located in a RCC framed structure building.

8.14 RW SYSTEMS

The raw water reservoir of adequate capacity is located in power plant area is of earthen bund construction type on the northern side while the western, eastern & southern side has a R.C.C retaining wall. The combination of earthen bund as well as RCC wall construction is envisaged due to terrace grading proposed for the plant. Raw Water Pumps housed inside a pump house located north of the reservoir inside the plant area, shall feed water from the reservoir to raw water Clarifier. Sub-structure of pump house shall be in appropriate grade of concrete .Super structure of the pump house shall be of steel-framed structures with concrete block wall up to 3.0 m high from FFL and permanent color coated metal sheeting from 3.0 m to roof. Roof shall be provided with permanent color coated metal sheet supported on purlins and steel beams.

8.15 FIRE WATER STORAGE / PUMP HOUSE

RCC fire water reservoir of adequate capacity shall be provided in plant area for fire water storage. Pump house shall be provided adjacent to the reservoir which shall house fire water pumps. Sub-structure and superstructure of the pump house shall be similar to that of the raw

water pump house. Miscellaneous foundations for fire hydrant pipes and fire main pipes are envisaged.

8.16 PRE-TREATMENT PLANT

Clari-flocculators, Chemical house, sludge draw out chambers stilling chambers shall be provided to meet the treated water requirements of the power plant.

8.17 CLARIFIED WATER STORAGE TANK

Clarified water storage tank of adequate capacity shall be provided for storing treated water. Sub-structure of the water pump house shall be of RCC while superstructure shall be steel-framed structures with concrete block wall up to 3.0m high from FFL and permanent color coated metal sheeting from 3.0m to roof.

8.18 D.M. PLANT

Demineralization Plant building shall be a steel-framed structures with concrete block wall up to 3.0m high from FFL and permanent color coated sandwich insulated metal cladding from 3.0m to roof. Roof slab shall also be provided with cast-in-situ RCC on permanent color coated galvanized MS troughed metal deck sheet supported on structural steel beams

Underground RCC neutralization pit shall be constructed in two compartments with concrete of suitable grade. The inside face of pit shall be provided with acid/ alkali resistant lining.

Degasser and acid storage tanks being outdoor type installations, R.C.C. foundation along with dyke wall is envisaged. This shall be of RCC pedestals in suitable grade of concrete. The foundation for the DM tanks shall be of RCC ring walls.

8.19 WASHERY REJECT HANDLING SYSTEM

The fuel for the proposed project is washery rejects from Parsa East & Kente Basen Coal Blocks. It is proposed to utilize washery rejects from the washery plant as fuel for the power plant. The washery rejects from the washing plant is transported through belt conveyors and stored in storage Bins located adjacent to the power plant boundary on the western side of the project site. Washery reject conveyors will be provided for transporting the washery reject to power plant with intermediate storage within the power plant boundary.

This system consists of the following:-

1. Conveyors from Storage bins outside the plant to Power plant
2. Reject stock Area
3. Conveyor system from stock area to Crusher house
4. Crusher house building
5. Transfer points / Towers

6. Control & MCC Room
7. Conveyors from Crusher house to Boiler Area up to Bunker
8. Washery reject Settling Pond

8.19.1 CONVEYOR GALLERIES

Overhead conveyor galleries shall be of structural steel frame with metal sheet roofing and cladding. Walkways are to be provided at the sides of and between conveyors. The galleries shall be supported on steel trestles which shall have RCC foundations. Trestle supports for cables and pipelines shall be fabricated from structural steel sections and shall be supported on suitable foundations.

8.19.2 REJECT STOCK AREA

The entire area shall be paved with reinforced concrete for stacking of reject. Adequate slope shall be maintained over the entire area for drainage purpose. RCC drains shall be provided by the side of the Washery reject stock area. The drain shall have pre-cast RCC covers. The discharge from the Washery reject stockyard shall be collected in the settling pond for separation of Washery reject dust.

8.19.3 CRUSHER HOUSE

A separate building shall be provided for housing the crushers. This building shall be of structural steel framework with metal cladding, Roof & Floor shall be RCC slab on permanent color coated galvanized MS troughed metal deck sheet supported on steel beams. The crushers shall have a vibration isolation system with spring assembly and viscous dampers.

8.19.4 CONTROL AND MCC ROOM BUILDING

The control and MCC Room buildings shall be steel structures with concrete block wall. Roofs shall be RCC slab on permanent color coated galvanized MS troughed metal deck sheet supported on steel beams. Adequate doors and windows shall be provided as per requirements.

8.19.5 TRANSFER POINTS

Transfer points shall be provided at every change of direction of the conveyors. Transfer points shall have structural steel frameworks with RCC floor & roof on metal decking. Cladding shall be of un- insulated metal panel.

8.19.6 BULL DOZER SHED

A separate building will be provided for housing the Bull Dozers. This building will be of structural steel framework with metal cladding up to 1m from top & RCC grade slab.

8.20 FUEL OIL HANDLING

Fuel Oil for the plant is envisaged for transportation through road route, through road tankers.

The following Civil works are to be provided for the Fuel Oil Handling System.

Fuel oil pump house – Pump house shall be of steel-framed structures with concrete block wall up to 3.0 m high from FFL and un-insulated single skin metal sheeting from 3.0m to roof. Roof shall be provided with permanent color coated metal sheet supported on purlins and steel beams; the switch gear building associated with the pump house is a reinforced concrete building with concrete block wall.

An open unloading paved area shall be constructed for unloading the fuel oil from road tankers.

RCC ring wall / Flexible Foundations shall be as per IS 803 for Storage tanks.

RCC dyke wall with suitable paving around the tank area along with Oil separator pit and peripheral drains.

Miscellaneous foundations for pumps, pipe racks, pipelines trenches fencing etc. shall be provided as per requirements.

8.21 ASH HANDLING SYSTEM

This system consists of the following:-

1. Ash Compressor House with Control Room
2. Pipe Rack from BTG Area to Silo's
3. Ash Silo's
4. Ash handling system Utility Building

8.21.1 ASH COMPRESSOR HOUSE

This building houses the compressors & its control room. This building shall be of structural steel framework with metal cladding, Roof & Floor shall be RCC slab on permanent color coated galvanized MS troughed metal deck supported on steel beams.

8.21.2 PIPE RACKS

Pipe Racks structural steel frame structures for holding the pipes and cables. Walkways are to be provided in the racks for access. The Pipe racks shall be supported on suitable RCC foundations.

8.21.3 ASH SILOS

RCC ash silos are provided for collection of the fly ash. The Silos are supported on RCC Framed structure which sits on a suitable RCC foundation. The fly ash from the silos will be unloaded in trucks and will be discharged outside the plant to facilitate coal mine back filling.

8.21.4 ASH HANDLING SYSTEM UTILITY BUILDING

The utility buildings shall be steel structures with concrete block wall. Roofs shall be RCC slab on permanent color coated galvanized MS troughed metal deck sheet supported on steel beams. Adequate doors and windows shall be provided as per requirements.

8.22 EFFLUENT TREATMENT AND FINAL DISPOSAL

All treated liquid effluents shall be channelized to the Neutralizing pit or guard pond. After monitoring the quality after treatment, the same will be used for horticulture.

8.23 BOUNDARY WALL & WATCH TOWERS

A permanent pre-cast RC wall is constructed all around the power plant periphery towards security of the power plant. Steel Watch towers along the Boundary of the Plant shall be provided to maintain Security.

Any other civil, structural and architectural work not specified but necessary for interplant cables/LP piping trenches/ducts including water proofing and/or overground cable/LP pipe supporting steel structures with their foundations complete for entire area shall be provided. In general, LP pipes and cables shall be laid either on the ground or overground.

Any other civil, structural and architectural work not specified but necessary to render the Project complete shall be carried out.

8.24 LANDSCAPING

Landscape of the entire Power plant area including supply of plants maintenance and sprinkling of water through distribution pipe network shall be provided. Landscaped areas shall be irrigated by sprinklers with the treated water from the sewage treatment units.

9.0 ENVIRONMENTAL PROTECTION

9.1 INTRODUCTION

The environmental impact of the proposed power station covering the following aspects and the measures for controlling the pollution within the values specified by Central / State Pollution Control Board is briefly discussed in this chapter:

- Air pollution
- Water pollution
- Sewage disposal
- Thermal Discharge
- Noise pollution
- Particulate matter
- Pollution monitoring and surveillance systems

9.2 AIR POLLUTION

The Air pollutants from the proposed units are:

- Sulphur dioxide in flue gas
- Nitrogen oxides in flue gas
- Carbon monoxide in flue gas.
- Suspended Particulate Matter (SPM) in flue gas
- Washery reject dust particles during storage/handling

Mitigation measures to limit the above air pollutions are investigated in detail through an Environmental Impact Assessment Study to satisfy ambient air quality standards.

9.2.1 SO_2 Emissions

Presently provision of lime stone storage, handling & dosing system is being envisaged to meet the Sulphur dioxide level as per norms.

The minimum stack height to be maintained to keep the sulphur dioxide level in the ambient within the air quality standards, as furnished below:

The stack height for the 4 X 150 MW units under consideration will be 275 metres with four steel flues one for each Unit satisfying Environmental norms. The predicted Ground Level Concentration (GLC) for SO_2 is within the National Ambient Air Quality Standard as explained in EIA Report

9.2.2 NO_x Emissions

Use of CFBC technology of power generation will help to reduce the NOx generation in the boiler due to the lower combustion temperature in furnace. Low furnace temperatures of 815°C to 925°C plus staging of air feed to the furnace produces very low NOx emissions.

However, the impact of this project over the present Ground level concentration has been reviewed and verified in EIA study.

9.2.3 CO Emissions

Carbon monoxide (CO) another kind of pollutant hardly exists in the modern power stations as design of combustion control equipment and the furnace eliminates, almost completely the possibility of incomplete combustion. The ground level concentration is expected to be within the limit prescribed by ministry of environment and forest.

9.2.4 Particulate Matter (SPM)

The particulate matter emission from the plant is controlled by installing the electrostatic precipitators which remove most of the fly ash from the flue gas, thereby limiting the quantity of fly ash emitted to atmosphere. The ESPs will have a dust collection efficiency of not less than 99.91%, while firing washery reject with the highest ash content of specified range of washery rejects.

9.2.5 Washery reject Dust Particles during Storage/Handling of washery reject

Dust generated in the washery reject handling area will be minimised by providing suitable dust suppression/extraction systems. Bunker ventilation system would be provided to evacuate dust and hazardous gases from the bunkers. Collected dust would be returned to either the associated belt conveyor or to bunkers.

During the construction stage, water spray shall be arranged to minimize dust emissions. For the roads use by construction vehicles, water spray shall be arranged at all the places prone to dust emission.

9.3 WATER POLLUTION

The wastewater treatment systems will be designed to collect and treat the various effluents from the site, which are as follows:

Effluents	Sources	Method of treatment	Disposal / Reuse
Oily wastes	Transformer yard, TG hall floor wash Fuel oil handling area.	Tilted Plate interceptor, oil skimmer to bring down the treated water oil level to less than 10 ppm.	Treated effluents are reused for horticulture and removed oil is taken offsite for disposal.
Industrial waste with high suspended solid levels	♠ Steam generator area Floor wash ♠ Service water wastes	Treatment through Tilted Plate Interceptors to reduce suspended solid levels to within PCB norms.	Treated effluents are reused for horticulture and ETP sludge will be disposed appropriately.
Chemical contaminated waste	DM Regeneration waste	Neutralization in a neutralizing pit to bring the pH to acceptable levels.	The acid and alkali effluents generated during the regeneration process of the ion exchangers will be drained into an underground neutralizing

Effluents	Sources	Method of treatment	Disposal / Reuse
			pit. The effluent will be neutralized by the addition of either acid or alkali to achieve the required pH. The effluent will then be pumped for utilisation such as ash handling plant by effluent discharge pumps and the excess will be utilised for horticulture and gardening purposes.
Sewage	♠ Canteen ♠ Toilets	Sewage Treatment Plant where that sewage is large and localized anaerobic treatment where generation of sewage is limited.	Treated sewage is reused for horticulture.

Note: The Plant is designed for zero liquid effluent discharge. No liquid effluent will be sent out of the plant.

9.4 THERMAL DISCHARGE

According to the Central Pollution Control Board stipulation, the thermal power plants using river water should adopt open recirculating cooling with cooling towers. For the proposed plant no hot water discharge to ambient is envisaged.

9.5 NOISE POLLUTION

Several noise suppression and attenuation features shall be designed into the plant for the protection of personnel at all normally accessible locations within the plant boundary, both inside and outside the different buildings, and for the protection of the inhabitants living in the vicinity of the power plant.

9.6 EQUIPMENT NOISE

To achieve the noise limitations around the equipment as stipulated in the Environmental clearance for this project, the main measures taken shall be as follows:

- Small units like condensate and vacuum pumps, shall be designed so as to limit noise emission,
- Bypass valve, the desuperheater and the relevant piping shall be covered with acoustic insulation.
- To achieve the noise limitations in the control room, the control equipment such as computers and its accessories (printers, etc) and the air conditioning system shall be designed so as to limit noise emission.
- During maintenance/inspection works, the personnel will wear ear protections.

9.7 POLLUTION MONITORING AND SURVEILLANCE SYSTEMS

For thermal power stations, the Indian Emission Regulations stipulate the limits for particulate matter emission and minimum stack heights to be maintained for keeping the sulphur dioxide levels in the ambient within the air quality standards.

The characteristics of the effluent from the plant would be maintained so as to meet the requirements of the State Pollution Control Board and the Minimum National Standards for Thermal Power Plants stipulated by the Central Pollution Control Board for Prevention and Control of Water Pollution.

9.8 AIR QUALITY MONITORING PROGRAMME

The purpose of air quality monitoring is acquisition of data for comparison against prescribed standards, thereby ensuring that the quality of air is maintained within the permissible levels.

It is proposed to monitor the following from the stack emission:

- Particulate matter
- Sulphur dioxide
- Nitrogen oxides
- Mercury

It is proposed to monitor particulate emission, SO2, NOx and Hg quantitatively on the stack and with the aid of a continuous emission stack monitoring system. The stack monitoring data would be utilised to monitor compliance with respect to statutory standards.

Further it is proposed to monitor and record the weather parameters such as temperature (Maximum. & Minimum), humidity, wind direction, wind speed, rainfall etc. on daily basis, for this purpose, it is proposed to install Weather Monitoring Station with necessary gadgets. Also, adequate number of air quality monitoring stations will be installed around the plant location. The exact location where such stations are required will be firmed up in consultation with Chhattisgarh Environment Conservation Board.

9.9 ASH GENERATION, UTILISATION AND DISPOSAL

9.9.1 ASH UTILISATION AND DISPOSAL

Ministry of Environment & Forest's Notification on Ash Utilization dated 14-09-1999 and its amendment in 2009 stipulates that new power stations shall have to achieve 100% fly ash utilization by 4th year of commissioning.

Adani Group as a socially conscious company considers utilization of ash produced at its coal based power station as a thrust area of its activities. The proposed thermal power project (4X150 MW) in Distt. Surguja shall produce about 2.5 Million tonne of ash annually. In order

to gainfully utilize the ash in various application areas and to meet the requirement of gazette notification for ash utilization following actions are proposed.

1. The company shall provide system for 100% extraction of dry fly ash along with suitable storage facilities. Provision shall also be kept for segregation of coarse and fine ash, loading this ash in to closed / open trucks. This will ensure availability of dry fly ash required for manufacture of Fly Ash based Portland Pozzolana Cement (FAPPC), asbestos cement products, use in cement concrete works, ash based building products and other uses of ash.
2. The company shall make efforts to motivate and encourage entrepreneurs to set up ash based building products such as fly ash bricks etc.
3. Pilot cum demonstration fly ash brick manufacturing plant shall be set up at this thermal power project and bricks produced shall be utilized in the construction activities and also for demonstration to the local entrepreneurs to encourage them for manufacturing ash bricks in the area.
4. To promote use of ash in agriculture / wasteland development - show case project shall be taken up in the vicinity of power stations.
5. All government/ private agencies responsible for construction/ design of buildings, development of low lying areas, and construction of road embankments etc. within 100 kms of the plant area shall be persuaded to use ash and ash based products in compliance of MoEF's gazette notification.
6. Any, balance fly ash and bottom ash would be disposed off safely by mine backfilling.

With all the efforts mentioned above - it is expected that fly ash generated at the thermal power stations shall be utilized in the areas of cement, concrete and asbestos cement products manufacturing, brick manufacturing, road construction etc. However, in order to prepare realistic road map for 100% Ash Utilization, detailed market study shall be carried out. Based on the recommendation of study, detailed Road Map for 100% Ash Utilization in line with MOEF gazette notification shall be prepared and submitted to the regulatory authorities.

9.10 GREEN BELT

The landscaping and ground cover system meant to enhance the appearance of selected areas, enhance soil and slope stabilization of the land of the power plant, and assist in reducing the noise level and fugitive dust generated by the plant.

As per the stipulations of MoEF, green belt will be provided all around the power plant boundary by planting trees. The selection of plant species for the project area will made to suit to the existing soil conditions.

9.11 ENVIRONMENT MANAGEMENT

SPPL had engaged M/s. Greencindia Consulting Private Limited as the Environment Consultant and the agency carried out Environmental Impact Assessment studies for the project with the following scope of work:

- Undertake EIA study as per MoEF guidelines and approved TOR for the project
- Baseline data collection
- Environmental Impact Assessment Statement
- Environmental Management Plan
- Risk Assessment and Disaster Management Plan

There is no National Park and Wildlife Sanctuaries within 10 km radius of the proposed site. The proposed project would be equipped with state of the art pollution control devices to bring down the emission/ discharge of pollutants within the acceptable norms.

The company is in the process of obtaining Environmental Clearance from Ministry of Environment & forest (MoEF), New Delhi for setting up 4 x 150 MW power plant.

10.0 PROJECT IMPLEMENTATION

10.1 METHOD OF IMPLEMENTING THE PROJECT

The Project shall be executed under the Split package concept by placing orders on different contractors for different activities under Turnkey Supply, Erection testing and commissioning. BTG package will be as single package or may be split to two packages with an Engineering consultant for interfacing Boiler and STG package.

Project Company shall be assisted in formulating the concepts, systems, basic and detailed engineering, procurement, field engineering services. The other services such as Construction Management Services, Erection, Commissioning and Testing services, Inspection and Quality control, Expediting and Project management will be from the project company professionals.

10.2 CONSTRUCTION

10.2.1 Owner's Responsibility

The proposed project being a green field project, construction facilities will have to be developed, keeping in view the available infrastructure and the requirement to implement the project within scheduled time frame.

The Owner will have to carry out preparatory works such as construction of boundary wall, approach roads, arranging for construction power, construction water, etc. This preparatory work would be followed by site leveling and grading, construction of in-plant road network for ease of movement of plant and equipment and developing drainage facility to divert catchment and ensuring other facilities viz, construction gate, watch tower, greenery, identifying area for labour hutment etc.

10.2.2 Project Infrastructure Development

Transportation Links

Approach Road:

The 4x150 MW units will involve transportation of heavy consignments for the boiler and TG packages and the road from Bisrampur or Pradeep port including the approach road from NH 111 will be strengthened if required.

Construction Space & Buildings:

About 1500 m^2 of construction office space and 2500 m^2 of covered storage will be required to be provided in plot area for construction of offices, stores etc. Space shall be earmarked for batching plant and storage yard during plant construction. A construction space is also required for locating fabrication and pre-assembly yard.

Construction Water:

Construction water supply will be provided at a single point to the concerned contractor for drawing necessary distribution system.

Construction Power:

The peak demand of construction power is tentatively around 2000kVA, assuming certain quantity of site fabrication of steel. The requirement of construction power for the proposed project shall be tapped from nearest 33 kV sub-station. The contractors will be provided power connection at 415 V level at single location which shall be further distributed by them. .

Construction Equipment:

The Contractors and his subcontractors would bring their own construction equipment.

A few transport vehicles like car, jeep, truck, etc. are, however, are required to be procured by the Owner for his staff.

Temporary Construction & Enabling Works

Space for Construction office and covered storage are to be provided at site area for construction of offices, stores etc. Space shall be earmarked for batching plant and storage yard during plant construction. A construction space is also to be provided for locating fabrication and Pre-assembly yard.

10.2.3 Organizational Set-up for Plant Construction

Skilled and unskilled workers would have to be brought by the Contractors from outside as required. Proper manpower planning both by Contractors and Owner needs attention well in advance to ensure smooth and timely execution of the project.

In view of implementation of the project, it is envisaged that the project group of Owner be headed by an executive in the level of Chief Manager, who will look after the overall activities in compliance with the project schedule. He would be assisted by a team of Senior Managers / Engineers experienced in various disciplines including technical, administration, staff and legal affairs. Other staff will be recruited progressively as the project activity progresses.

10.2.4 Safety & Health Hazard Monitoring

The Owner is primarily responsible for safety and health hazard aspects during project construction. In view of this, Owner jointly with contractors shall constantly monitor safety and health aspects on periodic basis. The responsible personnel identified for this task would be empowered to identify unsafe construction practices, non-use of safety gears, source of potential health and safety hazards viz, gas leakage, faulty electrical connections, unsafe

excavations, unsanitary conditions, fire hazards etc. in the work sites. They would suggest ways and means to prevent occurrence of accidents arising out of the aforesaid situations as well as bringing to task the erring personnel.

Apart from prevention measures, as detailed above, there should be an infrastructure to deal with potential accident situations. The infrastructure shall consist of, but not limited to, first-aid centre, ambulance, fire-fighting system etc. and trained personnel to take care of these emergency services.

10.2.5 Security

An elaborate security system to be arranged by the Owner to secure the proposed project site from theft, pilferage, obstruction to work etc. The security shall be established for the whole perimeter, in general, and storage spaces, in particular, by installation of fencing/boundary walls and security gates manned by trained security personnel.

10.2.6 Labour Welfare & Statutory Regulations

Owner, being the principal employer for the project construction, shall have the primary responsibility in this regard. A dedicated group would be formed to take care of these functions. The licenses required for project construction are, but not limited to, license /clearance to engage labour under Contract Labour Regulation and Abolition Act, Workmen's Compensation Act, clearance from State Electricity Inspectorate for construction power installations, license for use of explosives under Indian Explosives Act clearance, from State Boiler Inspectorate, Factory Directorate, etc. The group shall also monitor the compliance of all the statutory regulations by the Contractors and their sub-contractors.

10.3 PROJECT IMPLEMENTATION SCHEDULE

SPPL management team shall have the overall responsibility for timely implementation of the project. The overall responsibilities include co-ordination between the various project execution agencies, monitoring of project schedules, appropriate mobilization of manpower and other resources so that effective cost control and timely completion of the project can be ensured.

The company shall invite offers from reputed companies for supply of BTG and BOP packages. Based on cost effectiveness / economics, the tenders shall be finalized. The packages shall be ensured with guaranteed performance parameters and timely deliveries.

The project is expected to achieve commercial operations (COD) for the first unit within 27 months from the date of Start of construction at site (Zero date). . The first unit of 4x150 MW shall be commissioned within 27 months from the start of the construction at site and subsequent units at an interval of 6 months each.

An experienced and well-organized Project Execution Group would be engaged to overview and steer the project from inception to commissioning stage.

Construction Phase and Commissioning Phase:

Construction Planning, Monitoring and Control:

Site activities start progressively with the award of Contracts based on the Master Network schedule (Level-3 network), during the award, Level-4 networks are finalized, keeping in view the interface events needed to be realized. Execution group & Contract Admin group starts interaction with the contractors soon after the receipt of the Letter of Award to establish the site office. Based on the L-3 & L-4 networks, site Field Engineering Group also starts interaction with Central Engineering Group to get the required drawings in the sequence in which they are needed for continuous work for the next six months.

Project Review Meeting:

A Project Review Team headed by the Project Head with members from various functions at the head office and site is constituted for every project to review the progress of project on a monthly basis. The meeting of the team is conducted every month. This is chaired by the Project Head and attended by different departments of Head Office and Site. The meeting reviews both pre-award and post-award progress of EPC contract.

Interface problems among Engineering, Contracts and Site affecting project execution are also reviewed and appropriate decisions taken to expedite the release of drawings, materials and such other requirements.

Budgetary review is also done during this meeting and shortfall, if any, identified and responsibility center fixed to get the commitment.

10.4 Quality Control

In order to ensure that the power plant is completed in time and performs at the expected level throughout its operating life, adherence to a high standard of quality will be ensured during all phases of project execution from the initial design stage till commissioning and take over. All necessary features required for trouble free operation and convenience of maintenance will be taken into account at the initial stages itself in the Contractor's basic engineering, detailed designs and drawings. Suitable quality assurance requirements are incorporated in the tender specifications in order to ensure that the equipment supplied conforms to the required quality standards. During the contract engineering stage, the Contractor's design and drawings will be checked by the Owner's Engineer (Consultant) in order to ensure compliance with the specified quality requirements and good engineering practice. The Contractor will also be required to submit an overall quality plan covering specified quality requirements, manufacturer's standard quality assurance procedures and

statutory requirements. Separate quality plans will be finalised with the Contractor for both shop manufacturing activities and site activities.

In order to physically ensure that the quality of equipment and systems supplied to the project are as per the approved quality plans, critical items of plant will be inspected by the Owner's Engineer and / or the Project Company at the manufacturing stage (stage inspection) and at the time of final shop performance tests, where applicable.

All site works will be subject to quality surveillance in order to ensure high standard of quality of the complete power plant. The quality control measures proposed to be adopted by the Project Company would include:

(i) Establishing procedures for quality control including non-destructive testing requirements at site, monitoring and ensuring quality assurance of site works.
(ii) Ensuring adherence to codes governing site work.
(iii) Ensuring that the materials used for site works comply with the required technical specifications and that they have undergone the requisite shop tests and have been found fit for use.
(iv) Over seeing the Contractor's work in ensuring that the plant is constructed/ erected design alignments and grades are in accordance with the drawings and specifications.
(v) Approving corrective actions taken by the Contractor in case any of the works are not in accordance with approved designs and specifications.
(vi) Ensuring that any modifications in design or construction/ erection procedures, required to be changed due to unforeseen conditions at site, are resolved expeditiously the Contractor by sound technical solutions.

.

11.0 OPERATION & MAINTENANCE PHILOSOPHY

GENERAL:

The purpose of this section is to broadly outline the operation and maintenance philosophy to be adopted for this project. This will act as a useful input for basic as well as Detailed Engineering of the Project so that all required provisions for optimum Operation and Maintenance of this plant are made during the Engineering stage itself.

11.1 OPERATION PHILOSOPHY:

OVERALL REQUIREMENT

1. **Base Load Station:**

   TPP at Surguja will be a pit head station and will be basically designed to work as base load station.

2. **Design:**

   The design of Surguja (4X150 MW) TPP will cover adequate provision for the following:

   - Capability of rapid unloading from full load to no load under controlled conditions in not more than 20 minutes to minimize turbine cooling.
   - Capability to achieve full load within 30 minutes after synchronizing subsequent to an 8 hour shutdown (overnight).

3. **House Load Operation:**

   The main plant, auxiliaries as well as all associated systems and controls will be designed to permit house load operation, without shutting down the unit in the event of sudden loss of load demand due to tripping of transmission lines or other grid disturbances. It should also be designed for part load operation on consistent basis.

4. **Participation in Load Frequency Control:**

   The design of main plant control systems will permit participation of variable pressure operation and two shift operation in load frequency control in the event of system disturbances.

DESIGN FOR HIGH UNIT AVAILABILITY:

1. **General:**

   High availability of the unit and all associated auxiliaries and sub-systems is one of the main O&M objectives for ensuring high PLF and low partial loading. This objective will be implemented by adopting the following principles: -

   a. Use of equipment and systems whose design performance and high availability has been fully established by a considerable record of successful operation for similar service conditions in coal fired utility power stations.

   b. Use of only field proven design concepts and conservative designs.

   c. Special consideration for proper approach for ease of operation and maintenance while selecting the equipment and while finalizing the location and layout plans.

   d. Strict implementation of quality assurance norms during design, manufacture as well as installation and commissioning stage.

e. Strict compliance with approved commissioning documentation, comprising of Standard Checklists, Testing Schedules and Commissioning Schedules etc., forming a part of commissioning documents for the project.

f. Easy accessibility and maintainability of the equipment shall be the prime consideration during selection of the same.

g. Approachability of equipment for easy operation shall be considered during detailed engineering stage.

2. Sizing of Critical Equipment-Margins & Standby:

Provision of adequate margins will be made while sizing all-important auxiliaries and sub-systems to ensure operation of the unit under the worst conditions and after normal wear. The following aspects will be kept in view:

a) The unit as a whole shall be suitable to generate at 105% of the name plate rating on a sustainable basis to meet the requirement of the grid.

b) Each major equipment (fans, BFP's, CEP's, CC pumps, ECW pumps, CW pumps etc) will be capable of meeting 60% of Boiler MCR requirements. However, while sizing adequate range-ability and turndown capability will also be provided for proper operation of related control systems.

c) The unit and equipment control system shall be designed in such a way that the unit will survive the loss of major equipment and continue to operate at a lower load.

d) The number and size of Feeders will be so selected that with worst coal at BMCR one Feeder will be spare. With worst coal at TMCR and also with design coal at BMCR two Feeders will be spare.

3. Washery Rejects Handling Plant:

The design and sizing of washery rejects handling plant has an important bearing on station plant load factor. Hence, the following steps will be taken while designing the plant so as to ensure high PLF for the stations:

a) Washery rejects handling plant shall be able to meet the daily coal requirement considering 100% PLF and design coal.

b) Adequate standby capacity will be provided in the plant and for crushers so that outage of a single crusher or other equipment will have no effect at full load operation of station with worst coal.

c) Adequate number of properly designed suspended magnets and online magnetic separators, Metal Detectors will be provided to segregate magnetic and non-magnetic materials respectively.

d) To minimize the dust nuisance in rejects handling area, effective dust suppression system shall be provided in wagon tippler, bunker floor, transfer points and stockyard. Dust extraction system shall be provided in the crusher house.

e) In order to take care of unforeseen disruption in fuel supplies, reject stockyard equal to 4 days full load requirement will be designed at station end.

f) In order to avoid flooding of underground portions, all conveyor galleries shall be over-ground.

4. Design for Efficient Operation:

The basic and Detailed Engineering of the project will be done so as to help in achieving high standard of Operational Performance especially with respect to efficiency & Heat Rate. This may include the following key indices.

- Low auxiliary power consumption
- Low make-up water consumption
- No oil support above 25%-30% MCR operation.
- Optimum efficiency and heat rates for the units and their sub system by achieving design parameters.

Provision will be made for accurate and reliable measurement of fuel receipt, & consumption per unit oil receipt and oil consumption per unit, total D.M. Water production and make-up water consumption per unit, generator output, auxiliary power consumption, flue gas oxygen content etc. These values will be fed to Information System (IS) and daily reports regarding receipt, consumption and stock position will be prepared.

Adequate provision of sequence controls, safety interlocks and protection, automatic modulating controls and operator guidance messages through CRT will be made to assist the operators in safe and efficient operation of these units.

Provision will be made for on-line performance calculations for the unit and major sub-systems in DAS. On line CRT display of heat rate penalties due to deviation of key parameters from the design values will be provided by HMI.

Provision shall be made to monitor power being exported from the station.

TO ACHIEVE OPTIMUM EFFICIENCY, FOLLOWING PROVISIONS SHALL BE MADE:

a. Spray water for reheater steam shall be tapped from feed water line after the high pressure heaters to take advantage of the gain due to feed water heating. However, to compensate for the passing of spray control valves due to excess spray water pressure, multistage or equivalent valve shall be used before spray control valves.

b. Condenser shall have an on line tube cleaning system. Provision shall also be made to supply condenser with clean & suitably chemically treated water to avoid fouling in condenser tubes and for proper functioning of the tube cleaning system.

c. High pressure feed water heaters shall be designed for optimum TTD to gain maximum heat from extraction steam.

d. Optimum heat transfer in boiler 'shall be monitored and effected by installing a boiler cleanliness monitoring system. Intelligent soot blowing using the above should be a part of the system.

e. Turbine shall be provided with high and sustained efficiency seals, with proven record of satisfactory performance.

f. Large equipment like ID fans shall be provided with variable frequency drive to reduce power consumption during part load operation.

g. Tubular Air Preheaters shall be provided to completely avoid the air leakage.

h. ESPs and associated Flue gas treatment equipment shall be designed to achieve parameters better than latest environmental norms for chimney gas without flue gas conditioning.

5. Instrumentation for Efficiency Monitoring:

a) Flue gas exit temp, measurement shall be done using multiple thermocouple sensing from different points of a grid in the cross section of duct

b) Pr. Helium Detector/Temp, measurement instruments at HP & IP turbine inlet and outlet, all extraction lines, drip lines and heater inlet/outlet feed water line are required to be of very high accuracy to provide accurate temp. Press measurement for correct cylinder efficiency & heater performance calculations condenser performance with on line instruments.

c) Flue gas sampling provision at Air Preheater inlet and outlet shall be of multiple probe type for collecting samples from different points in a grid across the cross section.

d) High temperature O_2 probes shall be provided at the furnace exit so as to monitor combustion efficiency.

Instrumentation for Reliability:

Main turbine/ Generator, shall be having on line performance & vibration based diagnostic system.

Accuracy of the on-line instruments used for absolute pressure/ differential pressure, temperature for determining cylinder efficiency, heater performance and condenser performance shall be of 0.2% class or equivalent.

6. Design for abt Requirement:

Under ABT regime, following further operating conditions are required to be taken care of:

a) There are 96 time blocks in a day of 15 mins. each and there may be a requirement of changing Unit load with change in frequency in each block.

b) Unit may have to be kept under reserve shut down and brought back fast as per grid demand,

c) Minimum Partial Loading.

To meet such extended requirements, following design considerations are to be met:

i) Unit should be designed for a faster ramp up/ Ramp down rate without effecting undue thermal stresses.

ii) Unit shall be capable of meeting the requirement of fast start up and quick loading till full load.

iii) Steam generator, Turbine generator and their auxiliaries shall be designed to run with satisfactory performance from one overhaul to another without requiring any major shutdown.

7. Operation Management System (OMS):

The operation of this project will be optimized by implementing Operation Management System. This system covers clear definition of responsibilities of all key executives including shift-in-charge, AGM/DGM (Operation), AGM (O&M)/GM etc. and lays down the procedure for detailed analysis of O&M problems. It also covers the system of daily reporting to Corporate Office and monthly operation review team (ORT) meetings.

8. Operation Review Team (ORT) Meetings:

The following important aspect will be covered during the monthly ORT meetings:

- Review of actual performance of the station and each unit vis-a-vis targets and norms for key operating parameters like generation, availability and deviations on heat rate, specific coal/oil consumption, make-up water consumption, auxiliary power consumption etc.
- Review of specific O&M problems of the project and progress of corrective actions.
- Review of external constraints like coal supply problems, power evacuation problems and other related difficulties.
- Review of commercial and financial performance.
- Review of house keeping standard.
- Proper implementation of OPMS and regular ORT meetings are expected to help in achievement of high standard of plant operation.

9. Training of O&M Personnel:

Since O&M cadre for this project is likely to be largely based on fresh engineering graduates, considerable importance has to be given to training of O&M personnel so that the required skills in various specialised disciplines could be created in the shortest possible time. It is therefore very important to ensure that all engineers meant for maintenance become fully familiar with their area of work (O & M Dept.). This will be achieved at least 24 months prior to synchronisation of unit by:

- Study of O&M Manuals and Drawings.
- Review / Preparation and finalization of commissioning documents.
- Supervision of pre-commissioning and commissioning activity.
- Preparation of documents for maintenance management system.
- Participation in actual maintenance work in similar project.
- Participation in annual overhauling work in one project.
- Training at manufacturer's works in specialized areas/ simulator/ other utilities.
- This on-the-job training activity will be co-ordinated by AGM (O&M) and Project Co-ordinator from Corporate Training in the areas of operation and maintenance of modern facilities shall also be organised

10. Training of Operation Engineers:

i) Simulator Training:

The operation engineers will undergo extensive training on replica simulator at Simulator Training Institute, Korba/Sipat. This training will be so designed as to fully equip the operators with the requisite know how and confidence to effectively handle all plant upsets and crisis situation which are likely to arise in a plant.

ii) Training at manufacturers Works and other Utilities:

The operation engineers will undergo extensive training at manufacturers work for familiarisation and for design/testing aspects. They will also be imparted training in the running units of other utilities also where new technologies have already been adopted by these utilities and our organisation is in the process of absorbing these technologies.

11. Training of Maintenance Engineers:

Maintenance engineers will be imparted training at manufacturers work for familiarization and for design/testing aspects.

11.2 MAINTENANCE PHILOSOPHY:

1. Maintenance Management System:

The maintenance of this project will be carried out as per the well-developed maintenance management system. This system aims at maximizing the availability of generating units while ensuring minimum maintenance cost and safety of plant and personnel. The maintenance management system shall aim to have no break down from overhaul to overhaul. The maintenance management system covers organizational structures, preventive maintenance schedules, predictive maintenance detailed work specification covering all maintenance jobs, permit to work system, long term maintenance planning, safety aspects etc. This system provides for daily maintenance planning meeting for about 30 minutes for finalizing maintenance schedule for next 24 hours and resolution of interface problems between departments. These meetings are supplemented by meeting of HODs for half an hour daily to accelerate the decision-making process and to lay down the priorities and guidelines for maintenance work during the next 72 hours.

2. Spare Parts Management System:

The primary objective of spare part management system will be to ensure timely availability of proper spare parts for efficient maintenance of the plant without excessive build-up on non-moving inventory. The spare parts management system will cover the following aspects:

- Proper codification of all spares and consumable.
- Spare parts indenting and procurement policy.
- Criteria for ordering of mandatory and recommended spares.
- Judicious fixation of inventory levels and ordering levels for spare parts based on experience in similar projects.
- Development of indigenous sources/in house capability for imported spare parts.
- Development of more than one source wherever practicable.

3. Availability of O&M Manuals:

- All plant equipment supply contracts will include provision for supply of sufficient copies of detailed O&M manuals for distribution to the different user departments of Project Company.
- O&M manuals will be made available to all concerned at least 12 months prior to the commissioning date of first Unit to avoid problems in preparation of commissioning documents as well as proper installation & commissioning of equipment.
- The draft O&M Manuals will be reviewed by project engineering group / corporate engineering and corporate knowledge team to ensure completeness and proper coverage. The final manuals will incorporate all the comments.
- Schematic diagrams, P&I diagrams, wiring diagrams, cable schedule, valve schedules, pipe schedule etc shall also be submitted by vendor.
- "FINAL" O&M Manuals, which will be distributed to all concerned as per the approved distribution policy of the company, will be available to all concerned before start of the commissioning

activities of unit to avoid problems in preparation of commissioning document as well as proper installation & commissioning of equipment.

4. Special Tools and Tackles:

The primary objective of the system will be to ensure timely availability of proper spare parts without excessive build-up of non-moving inventory. The system will cover the following aspects:

- Proper codification / identification & retrieval of all spares & consumables
- Proper storage & protection
- Spare parts indenting and procurement policy
- Judicious fixing of inventory levels and spare part ordering based on experience of similar Units or other benchmarks.
- Development of indigenous sources/in-house capability for imported spare parts.
- Development of more than one source wherever applicable.
- Suitable lifting tools and tackles shall be provided for carrying out maintenance with full safety.
- Quick erect scaffolding for boiler furnace and set of sky climber shall also be part of special tools and tackles.

12.0 PROJECT COST ESTIMATE

12.1: Cost Estimates:

The project is proposed to be set up at an aggregate cost of Rs. 4997.93crores comprising of expenditure towards land, EPC cost, water, Township, transmission line, preliminary and pre-operative expenditure, contingencies, Interest during Construction and Margin Money for working Capital.

12.2 Basis of Project Cost

The project cost estimate has been worked out on the following basis:

12.2.1 Assumptions for Hard Cost Input

The followings are key assumptions made while estimation of project cost.

- Total four (4) Units of 150 MW capacity with CFBC technology has been considered.
- The cost of main equipment package including BTG package with auxiliaries, and mandatory spares has been worked out from the cost of similar kind of projects
- The cost of balance of plant equipment, auxiliaries and services has been estimated from in-house data for similar items of other ongoing domestic projects.
- The cost of general civil and architectural works of the plant has been estimated based on similar works of other ongoing domestic projects.

12.2.2 Assumptions for Soft Cost Input

The major assumptions made to compute the soft cost are as follows:

- Financing - Debt: Equity - The project is considered to be financed by domestic equity and rupee term loan with 70:30 Debt Equity Ratio. The rate of interest of debt is considered as 11.00 %. No financing cost for Equity has been considered.
- Interest During Construction (IDC) - has been included in the Project Cost based on the phasing of the expenditure upto COD of 4th Unit.
- Working Capital - The rate of interest on working capital loan is assumed to be 11.00% p.a.
- Taxes and Duties - Taxes and Duties have been considered as per prevailing rates.
- Contingency @ 5.0.0% has been considered on the cost estimate for EPC and Non EPC works.

12.3 Project Cost

On the basis of assumptions discussed above, the estimated costs of the project amount to Rs. 4997.93 Crores. The summary of break-up of the project cost is indicated in below Table

Project Cost Break Up

Particular	Estimated Cost (Cr)
Land & Site Development	18.15
Engineering, Procurement & Construction Cost	3458.49
Water Arrangement	165.00
Transmission Line	335.00
Total Hard Cost	3976.64
Preliminary & Pre-operative Expenditure	214.96
Interest During Construction Period & Financial Charges	477.31
INSURANCE	26.52
Contingencies & Overheads	230.90
Margin Money for working capital	71.65
Total Cost	4997.93

(All figure in Rs. Crores)

The Project cost is estimated at Rs. 4997.93 Crore & is proposed to be finance with senior debt, sub debt & equity in ratio of 70:30. The proposed components of financing are:

12.4 Interest during Construction Period:

The interest during construction (IDC) period estimated at Rs. 442Crore has been calculated assuming an implementation period of 27 months for the first unit and thereafter each unit shall be commissioned within an interval of 6 months each for the fourth unit from the start of construction at site (Zero Date)

12.5 Working Capital:

The provision for margin money for working capital has been made at Rs. 72 Crore.