

## **PRE FEASIBILITY REPORT**



**1600 MW (2x800 MW)  
KORBA WEST POWER PROJECT PHASE-II  
DIST. RAIGARH, CHHATTISGARH**

**Developer:**

**KORBA WEST POWER COMPANY LIMITED**

**Pre-Feasibility Report  
2x800 MW Korba West Power Company Limited  
(Phase-II)**

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**SECTION: 1  
EXECUTIVE SUMMARY**

## **1. EXECUTIVE SUMMARY**

### **1.1 Introduction:**

Chhattisgarh is a state in central India. It is the 10th largest state in India, with an area of 135,190 km<sup>2</sup> (52,200 sq mi). With a population of 25.5 million, Chhattisgarh is the 16th most-populated state of the nation. It is a source of electricity and steel for India. Chhattisgarh accounts for 15% of the total steel produced in the country. Chhattisgarh is one of the fastest-developing states in India.

The state was formed on 1 November 2000 by partitioning 16 Chhattisgarhi-speaking southeastern districts of Madhya Pradesh. Raipur was made its capital city. Chhattisgarh borders the states of Madhya Pradesh in the northwest, Maharashtra in the southwest, Telangana and Andhra Pradesh in the south, Odisha in the east, Jharkhand in the northeast and Uttar Pradesh in the north. Currently the state comprises 27 districts.

Chhattisgarh is one of the few states of India where the power sector is effectively developed. The Chhattisgarh State Electricity Board (CSEB) is in a strong position to meet the electricity requirement of the new state and is in good financial health. Chhattisgarh provides electricity to several other states. In Chhattisgarh, NTPC has thermal plant at Sipat, Bilaspur and Korba, while CSEB thermal and hydel units. Apart from NTPC and CSEB, there are a number of private generation units of large and small capacity. The state government has pursued a liberal policy with regard to captive generation which has resulted in a number of private players coming up.

The steel industry is one of the biggest heavy industries of Chhattisgarh. Bhilai Steel Plant, Bhilai operated by SAIL, with a capacity of 5.4 million tonnes per year, is regarded as a significant growth indicator of the state. More than 100 steel rolling mills, 90 sponge iron plants and ferro-alloy units are in Chhattisgarh. Along with Bhilai, today Raipur, Bilaspur, Korba and Raigarh have become the steel hub of Chhattisgarh. Today, Raipur has become the center of the steel sector, the biggest market for steel in India.

The Aluminium industry of Chhattisgarh was established by Bharat Aluminum Company Limited, which has a capacity of around one million tonnes each year.

Forests occupy 41.33% of the total area (as per the latest report by the Indian Forest Service) and the rich forest resources include wood, tendu leaves, honey and lac.

Chhattisgarh is rich in minerals. It produces 20% of the country's total cement produce. It ranks first in the nation for coal production and second in reserves, third in iron ore production and first in tin production. Limestone, dolomite and bauxite are abundant. It is the only tin-ore producing state in the country. Other minerals include corundum, garnet, quartz, marble, alexandrite and diamonds.

For the year 2014-15, Peak demand for Chhattisgarh state is 3817MW, however could manage to meet 3638MW i.e. deficit of 4.7%. Similarly, energy requirement for the same period is 21,499 MUs and could manage to meet 21,230 MUs i.e. deficit of 1.3%. Even though it is anticipated that Chhattisgarh will be power surplus by 2015-16, the state can supply electricity to several other states. The Government of Chhattisgarh is therefore, taking-up a number of strategic steps so that electricity requirement of the other states can be met.



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Electricity Act – 2003 has given highest priority to installation of Power Plants, encouraged Private participation in this sector and introduced open access of power transmission. With the above in view, Korba West Power Company Limited (KWPCCL) has planned to install 2x800MW at Chhote Bhandar, Bade Bhandar, Amlibhouna and Sarvani villages in continuation to existing 1x600MW.

Korba West Power Company Limited (KWPCCL) has set up a 600 MW (1x600MW) i.e. Phase-I of KWPCCL in Chhattisgarh State at Bade Bhandar Village (Dist. Raigarh). The unit is commissioned on 31-Mar-14 and have been supplying 5% net power generated to Chhattisgarh. KWPCCL is also selected for long term PPA with Andhra Pradesh for supply of 540MW.

Further, with the desire to contribute in development of other states and making them self-sufficient on the front of power generation, KWPCCL has proposed development of Phase II Expansion Project with additional capacity of 1600 MW (2x800 MW).

#### **1.1.1 Company Highlights:**

Korba West Power Company Limited has established 1x600 MW domestic coal based power project in Raigarh District of Chhattisgarh State, which is commissioned on 31-Mar-14.

KWPCCL has committed to contribute to reduction of the power shortage in the State of Chhattisgarh while protecting ecology environment of the region.

It is expected that KWPCCL will be able to ensure sale of power generated at the proposed expansion of Korba West Thermal Power Plant by operating the station at base load and thus ensuring adequate revenue generation. With the proposal taking shape, the commercial aspects viz. wheeling and banking, arrangement with the grid, possibility of supplying uninterrupted power to the identified consumers, Power Purchase Agreement (PPA) and other commercial and legal aspects with Power Grid Corporation of India Limited (PGCIL)/State Grid Authority shall be firmed up.

In the present study report, the plant location is studied with reference to availability of different inputs and other infrastructure for the station size under consideration. By evaluation of the data, a suitable configuration and layout for the station has been worked out. The study dwells upon other features viz. technical aspects, environmental issues, project implementation and finally the cost involved to implement this project.

#### **1.2 Executive Summary:**

##### **1.2.1 Demand Supply Scenario:**

For the purpose of power planning and grid management, Chhattisgarh is a part of Western Region. The State of Chhattisgarh is currently having substantial shortages in peaking capability. Even after taking into account the benefits expected to accrue from the ongoing state government projects, State share from the Central sector projects and Independent Power Producers (IPP) along with Captive Power Plants

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(CPP) being implemented by different industries in the state, the power shortage is not expected to be mitigated in the foreseeable future.

The state is trying to promote several projects to take care of the ever-increasing demand of power beyond 2014-15. Even if all the projects now on the drawing board fructify it does not cover the power deficit of the state. There shall, however, be no difficulty in selling the excess power if generated to the power starved states in the Southern and Northern regions.

### **1.2.2 Basic Requirements:**

Major considerations for selection of the site for establishing the proposed 2x800 MW Super Critical TPS :

- **Fuel Requirement @ 90% PLF:-**

- Coal : 7.66 MMT per annum (Considering 3540kCal/kg for design Coal)
- LDO : 13,000 KL per annum

- **Water Requirement:-**

- Water : 35 MCM per annum, including wet lime stone based FGD

- **Land Requirement:-**

- Presently 889.9 acres land is available within plant boundary. Expansion by further 2x800MW can be taken up within the same available land. However for expansion of ash dyke further 330 acres of additional land may be required.

Details	Area in Acre (1x600MW ) existing	Proposed Expansion 2x800MW Area in Acre (New)	Total (Acres)
Power Plant including auxiliaries	74.1	125	199.1
Ash Pond	185.25	330	515.25
Coal Storage and Handling	49.4	45	94.4
Raw Water Reservoir	41.99	-	41.99
Green Belt	197.6	100	297.6
Misc. Facilities	44.46	27.1	71.56
<b>TOTAL</b>	<b>592.8</b>	<b>627.1</b>	<b>1219.9</b>

- **Construction Facilities:-**

- Water required for drinking and construction purposes shall be sourced from existing system.
- The required construction power supply shall be drawn from existing unit.

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The plant layout for the proposed station has been developed keeping in view the optimum use of available land, direction of road and rail access, operational ease and financial requirements for the initial development of the Project. **The proposed plot plan is attached as Annexure -1.1.**

Technical features outlining the salient parameters of the main plant and equipment are discussed in the Section-5. The state-of-the-art technology will be deployed for auxiliaries and sub-systems to ensure safe and continuous operation of the units with minimum unscheduled outages.

It is proposed to use 100 % Domestic Coal with Ash Content of 45% and Sulphur Content of less than 0.55% for this Project. The coal handling system of the proposed power project will have the capacity of 2300/2530(Rated/ design) TPH with 100% redundancy and suitable crushing; stacking, reclaiming & feeding system will be provided. Coal storage of 10 days requirement shall be kept in plant

A dry extraction and disposal system is considered for the fly ash for the station. Efforts will be made to achieve 100% ash utilization within a period of 4 years. Unutilized ash, if any will be disposed in the ash dyke using HCSD system.

The condenser cooling shall be done by closed cycle cooling system.

The proposed electrical system will be provided with adequately sized equipment and with generous redundancy to ensure uninterrupted operation of the plant. Electrical equipment and systems are discussed and described in Section - 5.3 of the report. A 400 KV Switchyard will be provided for evacuation of power with required nos. of outgoing feeders. The exact configuration would be decided after tying up the power evacuation with the purchaser and the receiving substation voltage level.

The proposed station envisages the state-of-the-art Distributed Digital Control & Management Information System (DDCMIS) which will integrate various closed loop sub-systems, open loop sub-systems, monitoring and information sub-system covering the entire plant. The system will also integrate the various proprietary control packages supplied by the main equipment vendors for harmonious plant operation. The systems are described and discussed in adequate detail in Section – 5.4 of the Report.

Civil engineering aspects envisaged are detailed out in Section – 5.5.

To minimize emission of Suspended Particulate Matter (SPM) along with boiler flue gases, Electrostatic Precipitators of high efficiency and adequate size will be provided at exit end of each boiler to bring down SPM emission level fewer than **30 mg/Nm<sup>3</sup>**. One RCC stack of 275m with twin flues is envisaged for the proposed units. Liquid waste from the plant will be properly treated before re-use and/or disposal.

In Section – 8.3 of the report, O&M Philosophy for operation and maintenance is detailed out. The training requirement of O&M persons is also discussed in Section- 8.3.5.

The project will be financed in such a way that the capital structure is built up to equity capital 30% and loan capital 70%. The Project Cost with Interest during

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Construction (IDC) is estimated as Rs. 11,200 Crores. The considerations for Project cost and Tariff Calculation are discussed in brief in Section 9.

Adequate facilities will be developed for execution of the project. The project will be implemented on Engineering, Procurement and Construction (EPC) concept and may be awarded through International Competitive Bidding Process.

The schedule of commissioning of first unit is envisaged as 44 months from Zero Date and subsequent unit shall be commissioned within a gap of 6 months thereafter.

## **SECTION: 2**

### **PROJECT HIGHLIGHTS**

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## **2. PROJECT HIGHLIGHTS**

<b>Owner</b>	: Korba West Power Company Limited (KWPCCL)
<b>Plant Capacity</b>	: 600 MW (Existing) + 1600 MW (Proposed)
<b>Plant Configuration</b>	: 1x600MW (Existing) + 2x800 MW (Proposed)
<b>Location</b>	: Villages : Bade Bhandar, Chhote Bhandar, Amlibhouna & Sarvani : Nearest City : Raigarh, 25 Km : Nearest Railway Station : Kirodimal, 21 Km from Plant : Nearest Airport : Raipur (213 Km) : Nearest Sea Port : Dhamra Port, approx. (539 KM from Site) Paradip Port, approx. (485 KM from Site)
<b>Seismological Information</b>	: ZONE – II as per IS 1893 : 2002
<b>Land for the Project</b>	: Presently 889.9 acres land is available. Expansion by further 2x800MW can be taken up within the same available land. However for expansion of ash dyke further 200 acres of additional land may be required.
<b>Source of water</b>	: River Water nearly 5.5 kms from the Site.
<b>Water Requirement</b>	: 35 MCM per annum including wet lime stone based FGD
<b>Cooling System</b>	: Closed cycle cooling system.
<b>Primary Fuel</b>	: Domestic Coal
<b>Coal requirement</b>	: 7.66 million metric tonnes per annum @ 90% PLF (GCV - 3540Kcal/Kg, Ash – 45% (Max), Sulphur - (0.55% Max), SHR – 2150 Kcal / kwh)
<b>Support Fuel &amp; Source</b>	: LDO/HSD from nearest refinery/oil depots by Rail/Road.
<b>Support fuel (LDO/HSD)</b>	: 13,000 KL per annum @ 90% PLF (1 ml/kwh)
<b>Steam Turbine Generator</b>	: The Steam Turbine will be single shaft, multi-cylinders, tandem compound single reheat, regenerative, condensing unit directly coupled to AC Generator giving a continuous rated output of 800MW at generator terminals.

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- Steam Generator** : Steam Generator will be super critical pressure balanced draft furnace, single reheat, radiant, dry bottom type, sliding (variable) pressure operating, suitable for outdoor installation designed for firing pulverized coal as main fuel.
- Station Operation Philosophy** : Base Load
- Chimney** : 275 meter high RCC stack with Twin flues
- Power Evacuation** : By 400 KV system to Chhattisgarh and other utilities depending upon the requirement of the purchaser.
- Total Project Cost including IDC** : Rs 11,200 Crores (Approx.)
- Zero Date** : **Notice to Proceed to EPC Contractor**
- Project Completion Schedule from the Zero date** : Unit-1: 44 months  
Unit-2: 50 months.

## **SECTION: 3**

### **DEMAND ANALYSIS & JUSTIFICATION**



### **3.0 DEMAND ANALYSIS & JUSTIFICATION:**

#### **3.1 Introduction**

Power is among the key infrastructure that contributes towards the economic development of any nation. Since liberalization of the Indian economy in the early 1990s, the power sector in India has witnessed significant growth. Installed electricity generation capacity in India stood at about 281 GW in November '15, with a contribution of 69.5% from thermal. In transmission also, the country has made significant progress in the pursuit of making electricity available for all. Considering the positive change in policy matters, the country's growth is expected to follow an upward trend.

However, the peak electricity demand in the country is growing at a rate of 6.7% per annum whereas the average growth in the capacity addition during the last decade has been around 6.0%. Considering GDP growth rates of 8% per annum, the rate of growth of power needs to be more than 10% annually.

Further, the average per capita electricity consumption in India stands at 1010 kWh as compared to the global worldwide per capita consumption of more than 3000 kWh.

Keeping in view the growth of demand and the gap between demand and supply, the government has set a target of power generation capacity of around 2,98,067 MW by the end of 12th plan i.e. by 2017. Capacity addition during 12th plan is estimated at 98,190 MW, out of which the share of coal based power plants will be of the order of 66,600 MW.

With a reheat and regenerative machine of 800MW set size and assured availability of sufficient fuel at a competitive price, KWPCCL expects to generate power at an attractive price. The profitability can be assured if there is adequate demand for the next 25/30 years and if power can be transmitted to potential buyers or consumers at a reasonable cost. Energy from the proposed station may be evacuated to the state/national (PGCIL) grid through 400kV substations within a reasonable distance from the site.

#### **3.2 The Electricity Act 2003**

The Electricity Act - 2003 passed by the Parliament has ushered in sweeping changes in the Power Sector and provides a legal framework for enabling reforms and restructuring of the Power Sector. It has simplified administrative procedure by integrating the Indian Electricity Act, 1950, the Electricity (Supply) Act, 1948 and the Electricity Regulatory Commissions Act, 1998 into a single Act.

The Electricity Act, 2003 is based on the principle of promoting competition, protecting consumers' interests and providing power to all. The salient features of the Act are:-

- Unbundling of Generation & Transmission segments of the Power Sector

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- De-licensing of thermal power generation
- Liberalization in captive power policy
- Open access to transmission and distribution network
- Stringent penalties for power thefts
- Transparent subsidy management
- Constitution of Appellate Tribunal
- Thrust on rural electrification

The Act consolidates the laws relating to generation, transmission, distribution, trading and use of electricity; takes measures that are conducive for the development of the sector including rationalization of electricity tariff, ensuring transparent policies regarding subsidies and addresses environmental concerns, among others.

The Act has ushered a paradigm shift in the power sector. Competition is now possible not just in generation, but also in every facet of the sector including transmission and distribution and private sector investment is now facilitated by greater transparency brought in by the Act.

The Act permits free entry into generation, unless there are overriding safety and environmental concerns. The Act also promises non-discriminatory open access to the transmission system. To this end the Central Electricity Regulatory Commission (CERC) had framed the regulation for the "Open Access in Inter-State Transmission" in January, 2004, which facilitates the bulk sale of energy from generators to the customers. This has introduced the idea of trading in wholesale electricity.

### **3.2.1 Concept of Independent Power Producers:**

The Union Power Ministry is encouraging Independent Power Producers (IPPs) across the country as a means to create additional generating capacity at a faster rate through private sector participation.

Power plants usually sign long-term Power Purchase Agreements (PPAs) with State governments under which they agree to sell power to state-owned distribution utilities at agreed rate for a specified period.

Independent power producers may sign PPA with the state electricity utilities for supply of electricity regularly to the grid or to meet peak loads. IPPs may also sign long-term power purchase agreements with bulk power buyers, committing a certain percentage of their capacity to such agreements. IPPs can also sell the surplus power generated in the open market to licensed power traders who needs the power at that particular time.

The Electricity Act, 2003 recognized the concept of trading as a distinct licensed activity and CERC was identified as the regulator. CERC have issued guidelines for trade licensing, power trading and for setting up power exchanges. CERC have issued power trading licenses to many trading companies and power exchanges have come into being.

To facilitate sale of power to power traders and third parties, the government has established an open access policy in power transmission. Introduced in the Electricity

Act, 2003, open access basically refers to the right to transmit power over a system belonging to a third party. CERC have laid down procedures for open access in distribution. SERC of many states have followed up by laying down of provisions for open access.

With such concerted efforts in all areas, IPP's are considered a favorable option to meet the power demand.

### **3.3 National Electricity Policy**

The Central government has prepared the National Electricity Policy for development of the power system based on optimal utilization of resources. It is one of the key instruments for providing policy guideline to the Electricity Regulatory Commission (ERC) and to the Central Electricity Authority (CEA) for preparation of the National Electricity Plan. The Policy aims at accelerated development of the power sector, providing supply of electricity to all areas and protecting interests of consumers and other stakeholders keeping in view availability of energy resources, technology available to exploit these resources, economics of generation using different resources and energy security issues. The Policy also aims at overcoming the energy and peaking shortages and ensuring the commercial viability of the Electricity Sector, inter alia.

### **3.4 Perspective of Power Development**

#### **3.4.1 Power Development Scenario of 12<sup>th</sup> Plan (2012-2017):**

As per the 5th National Power Plan (2002-2012) prepared by CEA a need based installed capacity of the order of 2,98,067 MW is required by the end of 12th Plan based on demand projections of 17<sup>th</sup> Electric Power Survey and a system reliability level of Loss of Load Probability (LOLP) less than 1% for the country.

The primary resources for Electric Power Generation are water, fossil fuel (coal, lignite, oil & natural gas) and nuclear energy. They would continue to serve as major resources for electric power generation in the long run, though various forms of renewable source, such as wind, solar, bio-mass, tides etc., will also contribute.

Based on the report of the working group on Power constituted by Planning Commission, a capacity addition of 78,700 MW was targeted in 11th Plan ending in March 2012, comprising 15,627 MW Hydro, 59,693 MW thermal and 3380 MW Nuclear. Out of the total thermal capacity of 59,693 MW, coal/lignite based capacity was expected to be 40,901 MW.

For 12th Plan ending in March 2017, CEA has identified a capacity addition of 98,190 MW comprising of 9,204 MW Hydro, 67,686 MW thermal, 2,800 MW of Nuclear and 18,500 MW of renewable sources. The 12th Plan program is comparatively large so as to provide not only for normal growth during the 12th Plan period, but also to compensate for any short fall in the capacity addition during 11th Plan period.

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### **3.4.2 Present Status of Demand & Availability:**

A review of the statistics reveals that during the year 2014-15, the country witnessed an energy shortage to the tune of 3.6 % and peak demand shortage of 4.7%. Notably there is an acute shortage in the certain areas of the country.

The peak demand shortage on all-India basis for this period was nearly 7006 MW. It may be noted that the peak demand is actually restricted demand and is likely to be much higher.

Keeping the present scenario of shortages in energy and peak demand in view and to maintain a GDP (Gross Domestic Product) growth of 8% to 10%, the Government of India has very prudently set a target of about 2,98,067 MW of power generation capacity by March 2017.

The capacity addition required in next five (5) years will be 98,190 MW. The thermal power generation addition, during this period is estimated to the tune of 67,686 MW. It is estimated that the total funds requirement in the next five (5) years will be approximately Rs. 6,43,831 Crs. This includes the expenditure on infrastructure development in coal mining and coal transportation to the power plant sites, as well as the funds required for setting up plants with transmission and distribution system.

### **3.5 The Power Scenario in Chhattisgarh**

The State of Chhattisgarh falls within Western region as per Central Electricity Authority (CEA). The total Installed capacity of Power Utilities as on 30.11.2015 with break-up in Western region and in Chhattisgarh in particular is as follows:

**Table 3.1**

	Thermal				Nuclear	Hydro	RES (MNRE)	Grand Total
	Coal	Gas	Diesel	TOTAL				
<b>WESTERN REGION</b>	68139	10815	0	78954	1840	7448	13373	101615
<b>CHHATTISGARH STATE</b>	13594	0	0	13594	47.5	120	390	14151

Source: CEA; All figures in MW  
RES: Renewable Energy Sources

As per 17<sup>th</sup> Electric Power Survey of CEA the electric energy requirement in the State of Chhattisgarh during the end year of 11<sup>th</sup> & 12<sup>th</sup> Plan periods have been projected as follows:

**Table 3.2**

<b>Plan Period</b>	<b>Energy Requirement (MU)</b>	<b>Peak Demand (MW)</b>
11 <sup>th</sup> Plan ended year 2011-12	21,785	3,565
12 <sup>th</sup> Plan year ending 2016-17	33,076	5,375

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From above, it is apparent that there is substantial requirement of capacity addition to bridge the gap of electricity demand & supply and also to meet the objective of National Electricity Policy of Govt. of India.

Considering the load growth and the schemes for capacity addition taken-up, the gap between the peak demand and availability is not likely to close in the near future.

### **3.6 Choice of Fuel**

It is proposed to use Domestic coal with Ash Content of 45% and Sulphur Content of less than 0.55% for this Project. The coal shall be transported through railway to the project site.

### **3.7 Station Configuration**

The proposed station is planned for total capacity of 2x800 MW. While selecting the unit sizes for large utility stations, the major criteria are:

- Plant availability
- Cooling Water availability
- Compatibility of grid to withstand sudden outage of unit
- Operating experience of the set size
- Thermodynamic cycle efficiency and specific input consumption viz. fuel, water etc.
- Specific investment requirement & cost of generation.

Station comprising 800MW is recommended in order to take advantage of economy of scale in specific cost, construction and operation of the units, manpower involved, the heat rate achievable and lower specific auxiliary power consumption. With higher set sizes, the capital outlay as well as cost of generation is comparatively less.

For the proposed station, installation of two (2) units of 800MW is considered preferable. These units 800MW set size have favourable heat rate at high plant load factor and reasonably low operating cost. Several power projects are in service or under implementation with 800MW units. As such, availability of skilled operating personnel from other thermal power stations in the country render definite advantage in favour of 800MW sets. Further these set sizes are considered appropriate in the light of expansion of both PGCIL and the State Grid to handle the generated power.

In the light of the above, configuration of 2x800 MW is considered appropriate for the proposed expansion of the station.

### **3.8 Justification of Project:**

The state of Chhattisgarh has been on the path of growth in all sectors of the economy. The state government is committed to ensure "Power to All" on round-the clock basis. Due to consistent support and growth strategy adopted by the State

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Government, the large, medium and small scale units are being set up every year. This process of industrialization further boosts the demand for power in the state. Moreover, open access provision of transmission system provided in the Electricity Act, 2003 enables a Power generating station to wheel the generated power to any parts of India.

Before undertaking a large Power Project, the criteria given importance are as follows:

- Unit size and station configuration
- Cost of Energy generated from the station.
- Load demand of the State, region and of the Country.
- Thermodynamic Cycle efficiency and reduced emission.
- Operating experience of similar plants.
- Station availability and Plant Load Factor attainable.
- Project Time frame

The Project proponents have carefully considered all above and decided to expand the existing Korba West Power Company Limited.

The basic requirements for setting up a Coal based Thermal Power Plant are Land, Fuel, Water and Power evacuation facility. The Project Authorities have already taken pre-emptive actions in these areas and their status is as follows:

**Land:**

Presently 889.9 acres land is available. Expansion by further 2x800MW can be taken up within the same available land. However for expansion of ash dyke further 200 acres of additional land may be required.

**Water:**

The Water requirement for the Project will be met from Mahanadi River which is at a distance of 5.5Km from the Power Plant site. Approval of 35 MCM is available from WRD, Govt of Chhattisgarh. The present 600MW utilizes about 13 MCM of water per year. The company has balance 22 MCM available for expansion. Further application is being made for additional allotment of 13MCM per year.

**Coal:**

It is proposed to use Domestic coal with Ash Content of 45% and Sulphur Content of less than 0.55% for this Project. The coal shall be transported through railway to the project site.

**Power Evacuation:**

Delivery point will be STU (State Transmission utility) interface which is the bus bar of the generating station from which the power shall be supplied at 400kV voltage level as specified by the STU.

The "low cost of power" would prove to be the strong point of this project in the merit order rating when compared to other power stations.

**SECTION: 4**

**PROJECT DETAILS**

## 4.0 PROJECT DETAILS

### 4.1 Accessibility:

The Project site is located near Bade Bhandar, Chhote Bhandar, Amlibhouna & Sarvani villages in Raigarh District of Chhattisgarh.

The Project site is located adjacent to NH-216 Raigarh – Saraipali section.

The nearest railhead Kirodimalnagar is 21 Km from Plant site. For the present project dedicated railway infrastructure is under development for transportation of coal from Bhupdeopur Station (29KM). For the proposed expansion project the railway infrastructure will be adequate.

### 4.2 Land for the Project:

Presently 889.9 acres land is available. Expansion by further 2x800MW can be taken up within the same available land. However for expansion of ash dyke further 330 acres of additional land may be required.

Details	Area in Acre (1x600MW) existing	Proposed Expansion 2x800MW Area in Acre (New)	Total (Acres)
Power Plant including auxiliaries	74.1	125	199.1
Ash Pond	185.25	330	515.25
Coal Storage and Handling	49.4	45	94.4
Raw Water Reservoir	41.99	-	41.99
Green Belt	197.6	100	297.6
Misc. Facilities	44.46	27.1	71.56
<b>TOTAL</b>	<b>592.8</b>	<b>627.1</b>	<b>1219.9</b>

### 4.3 Fuel Source and Availability:

#### 4.3.1 Source & Type of Fuel:

##### a) Main Fuel - Coal

The main fuel considered for the project is Domestic coal, the project being located within 150Km of major coal reserves of SECL and MCL, Coal storage of 10 days requirement is proposed at the power plant.

The annual requirement of coal is estimated at about 7.66 MMTPA for the two (2) units of 800MW, considering a gross calorific value of 3540kcal/kg at 90% plant load factor and station heat rate of 2150 Kcal/Kwh. The coal shall have Ash Content of 45% (Max.) and Sulphur content below 0.55%.



**b) Start-Up Fuel**

The boiler will be designed for cold start-up and initial warm-up using Light Diesel Oil (LDO/HSD). LDO/HSD will be received to the proposed plant by means of the rail/road tankers.

The annual requirement of secondary fuel-Light Diesel Oil (LDO/HSD) for cold start up for load stabilization is estimated to be around 13,000 KL per annum.

**4.3.2 Infrastructure & Mode of Transportation:**

The Domestic coal from SECL/MCL mines shall be transported through railway to the proposed site. Coal will be transported through rail wagons and will be unloaded in Wagon Tippler/Track Hopper at site.

**4.4 Makeup water Availability & Transportation:**

**4.4.1 River Water**

The additional water requirement for the proposed project will be met from Mahanadi River from located at a distance of approx. 5.5 km from the proposed project site. Water will be supplied through pipelines. Water received from the source shall be further treated in Pre-treatment plant and then used for power plant purposes. Water requirement for the proposed 2x800 MW power plant will be in the order of about 35 MCM per annum considering wet lime stone based FGD.

Indicative water balance is attached as **Annexure-1.2**.

**4.5 Power Evacuation Plan:**

It is proposed to sell power generated from the station at 400 KV level to Chhattisgarh state utilities through State Grid/ Power Grid Corporation of India Limited (PGCIL) system. Study for grant of open access to the project through PGCIL shall also be initiated.

**4.6 Environmental Aspects:**

In the proposed project, river water will be used in closed circuit for circulating water system. 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, contamination of soil water and air. A detailed EIA study shall be conducted to assess the impacts and the recommendations will be followed while establishing the project.

Electrostatic precipitators of high efficiency and stack height as per CPCB norms etc. will limit the emission levels. As such, no undue problem is envisaged from installation of the power plant at said location from environmental aspect.

Detailed environmental aspects have been given in Section – 7.0:

**4.7 Site Features:**

The selected site near Chhote Bhandar, Bade Bhandar, Amlibouna & Sarvani villages has the following inherent advantages:-

- Shared Infrastructure with Phase-I.
- Availability of land for Power Plant within the existing premises. Additional land required for Ash Dyke only.
- Assured uninterrupted water supply directly from river.
- The site is not located in any Eco Sensitive area.
- Power can be easily evacuated at 400kV level to State owned sub-stations in the region.
- The site is well connected by rail and road for transport of Fuel & Heavy equipment.
- Strategic location with respect to Pooling stations.

## **SECTION: 5**

### **TECHNICAL FEATURES**

## **5.0 TECHNICAL FEATURES**

### **5.0 TECHNICAL FEATURES:**

The power generating Units will be of Supercritical steam parameters utilizing domestic coal.

It is proposed to use clarified water as cooling water for condenser. The condenser cooling circuit shall operate on 'closed cycle system'.

The bottom ash will be collected in wet form and fly ash in dry form. Fly Ash shall be extracted in dry form and stored in storage silos for the purpose of utilization. Efforts shall be made for 100% fly ash utilization from 4<sup>th</sup> year onwards as per Fly Ash notification. Unutilized Fly Ash, if any, shall be disposed to ash dyke through High Concentration Slurry Disposal (HCSD) System along with Bottom Ash. From 4th year onwards Bottom ash shall be disposed to ash dyke through the trucks in semi-wet form.

Switchyard will be located near the power block. The power generated at the plant will be evacuated at 400 kV level to Chhattisgarh state utilities or bulk purchasers through existing and additional 400 KV lines proposed from Phase-2 Switchyard to Substations of Chhattisgarh & PGCIL system depending upon the requirement of the Purchaser.

Design requirements envisaged in "Central Electricity Authority" (Construction of electrical Plant & electrical lines) Regulations: 2007 shall be complied with.

The plant will be designed in compliance with applicable National and International Codes and Standards such as ASME, AWWA, ASTM, DIN, BS, IEC, IEEE, IS, etc. The plant will comply with all local statutory regulations and requirements, such as Indian Boiler Regulations (IBR), CCOE, Indian Factories Act, Indian Electricity Act, Environmental Regulations, etc.

### **5.1 PLANT PERFORMANCE:**

The general technical description is detailed in Section 5.2 for the steam turbine of 800MW from each Unit. For tariff calculation, the plant gross heat rate with performance coal, design ambient conditions and cooling water temperature, is considered to be 2150 kcal/kWh on GCV basis and the auxiliary consumption is considered as **7.5% (considering FGD & SCR)** of the gross power generated. Availability of the plant of similar size and type is above 90%.

The steam parameters will be selected considering the parameters offered by different manufacturers for equipment of similar type and rating, to get the advantage of standard proven design at competitive cost.

## **5.2 MECHANICAL EQUIPMENT AND SYSTEM:**

### **5.2.1 STEAM GENERATOR AND ACCESSORIES:**

#### **Steam Generator**

The steam generator units proposed for the station will be super critical, once through, outdoor, pulverized coal fired, balanced draft, single reheat, dry bottom type with two pass or tower type arrangement as per manufacturer's standard. For improved efficiency at part loads and flexible operability, boiler capable of sliding pressure operation is favoured. An added advantage in these type of boilers is feature of Boiler circulation pumps which shorten the start-up time and heat loss during start-up period.

The combustion system will be provided for pulverised coal firing with Low NOx type coal burners. The steam generators will be designed for continuous satisfactory operation with the range of coal. The furnace would be conservatively designed for fuel to burn completely and to avoid any slagging in the furnace and excessive fouling in the super heater sections of the boiler. 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.

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 for soot blowing operation, and also for start-up of the adjacent unit, and de-aerating of the steam generating units after prolonged use. 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. 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 at outlet over the range of 60% to 100% MCR load. Main steam de-superheating stations with provision for spraying water tapped off from feed water piping would be provided. Air preheaters, preferably of 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.

Draft system of each boiler would be provided with Forced Draft and 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 airflow to boiler and the induced draft fans will control furnace draft of the boiler through automatic control loops. The coal will be received to the coal bunkers of about 12 hours storage capacity and the same will be fed to the coal pulverisers utilising gravimetric feeders. The pulverised and conditioned coal will be then distributed to the Low NOx coal burners from each mill for combustion in the furnace of the boiler thro' coal conveying pipes.

LDO/HSD will be required for start-up, load carrying and flame stabilization at low load. LDO/HSD will be used for cold start-up and low load operation and flame stabilization.

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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.

**Electrostatic Precipitator**

Each steam-generating unit would be provided with electro-static precipitators. Each precipitator will have two parallel gas paths, any of which can be isolated for maintenance when required, keeping the other path in operation. Each path will have fields in series for collection of fly ash. The ESP will be designed for outlet dust burden not exceeding 30 mg/Nm<sup>3</sup> at 100% MCR and one field in stand by condition.

**5.2.2 Steam Turbine**

The steam turbine would be 3000 rpm, tandem compound, single reheat, regenerative, condensing, horizontally split, three-cylinder machine with extractions for regenerative feed heating. The turbine would be designed for main steam parameters of corresponding to the boiler output of pressure and temperature, before emergency stop valves of HP turbine and reheat steam parameters to IP turbine. The LP turbine will exhaust to condenser. 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.

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.

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 turning gear. The unit will also be provided with self-contained lubricating oil system for supplying oil to turbine and generator bearings and also to hydrogen seal oil system of the generator. The lubricating oil will be cooled by Closed Circuit Cooling Water System

Generator will be connected to its unit step up transformer. The auxiliary power requirement of the unit will be drawn from its unit auxiliary transformer tapped off from the generator bus duct. 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 unit will be guaranteed to generate required output at generator terminals continuously. The turbine will be suitable for wet steam washing for which set of auxiliary equipment necessary for the units will be provided.

### **5.2.3 Condensing Equipment**

Double pass surface condenser capable of maintaining the required vacuum while condensing steam at the maximum rating of the turbine will be provided. The condenser will be of divided water box design with rolled steel construction of body and water chamber. Condenser with Stainless Steel heat exchanger tubes, with steel tube sheet, baffles plates, etc. is envisaged for clarified water application. The condenser will be designed as per HEI code or equivalent. The condensers will have integrated air cooling zone and it should be designed so as to accept full quantity of steam during turbine HP and LP bypass operation without any undue vibration, thermal stress etc. The condenser axis will be at right angle to the turbo-generator axis.

Necessary controls for Oxygen content of condensate leaving the condenser hot well will be provided. The condensate temperature will not be less than the saturation temperature corresponding to condenser back pressure. The water boxes will be protected by a suitable protection system. The maximum heat load of the condenser will correspond to turbine operating with valves wide open condition at 105% TMCR steam flow.

Vacuum pumps will be provided to maintain the vacuum in the condenser by expelling the non-condensable gases. 1W+1S vacuum pumps per condenser shell (i.e., total 4 vacuum pumps for 2 shells) or 2W+1S vacuum pumps for the two shells will be provided.

### **5.2.4 Coal Unloading, Transportation and Feeding System:**

The coal handling system for 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 12 hrs Storage capacity in the bunkers.

Domestic coal will be used for the plant. The coal to the power plant shall be supplied through rail wagons and will be unloaded using track hoppers and wagon tipplers in the plant.

Coal in BOX-N/BOBRN wagons will be unloaded by wagon tipplers or in track hoppers and will be conveyed to the boiler bunker through crusher house and a number of coal transfer houses. Provision shall be kept for stacking crushed coal in existing stockyard and in new stock yards from where coal will be reclaimed as and when required in coal bunkers.

The sub systems of the Coal Handling Plant are:

- Coal unloading system (Track hopper (existing) & Wagon Tipplers)
- Crushing & Screening System
- Coal stacking & Reclaiming
- Reclaim hoppers
- Belt Conveyors

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- Metal Detectors
- Magnetic Separators
- Belt Scale
- Coal Sampler Stations
- Conveyor Supports, Galleries and Platforms
- Bunker Feeding System (V-Plough Tripper)
- Dust Extraction / Dust Suppression/ Ventilation System/Air conditioning system.

The coal of size (-) 300mm shall be made available at plant. The combination of conveyors shall feed uncrushed coal to screen. The higher size coal particle (more than 25mm) will be fed to crusher and smaller particle (less than 25mm) will be fed to belt feeder for feeding to conveyor. The bigger coal particle will be crushed to -25mm by the ring granulator type crusher.

Existing facility of phase-I is already having one number track hopper under operation. For Phase-II, 2x800 MW existing track hopper and new wagon tipplers will be used.

Conveyor of 2300T/hr (Rated) capacity will feed crushed coal to bunker through V-plough tripper. Auxiliary system like magnetic separator, metal detector, coal sampling unit, ventilation & air conditioning system and electronic belt weighing scale shall be provided at strategic locations. Dust suppression system shall be provided at the discharge end of all conveyors excepting crusher house at bunker bay while dust extraction system shall be provided at vibrating screen and bunker bay. Manual/ Electric hoist at various buildings shall be provided for maintenance purpose. All belt conveyors shall be provided with fire resistance and its speed shall be limited to 3m/sec.

2x100% coal crushing and conveying streams from track hoppers / wagon tipplers shall be provided up to bunker feeding system.

#### **5.2.5 Fuel Oil Handling System:**

The existing fuel oil handling system with addition of one LDO/HSD tank, LDO/HSD forwarding pumps, shall be used. Fuel oil dyke has provision of accommodating additional LDO/HSD tanks. One fuel oil pump house will also be constructed for accommodation of additional fuel oil pumps.

#### **5.2.6 Ash Handling System:**

Ash formed due to combustion of coal in the pulverised coal steam generator will be collected partly as bottom ash in bottom ash hopper and partly as fly ash in the fly ash hoppers. The major sub systems are as under:



#### **5.2.6.1 System Description & Capacity**

##### **Bottom Ash Handling System**

The bottom ash shall be collected from the boiler in a water impounded bottom ash hopper placed below the furnace of each boiler. Bottom ash from the bottom ash hopper of each unit shall be removed in 2.5 hours per shift of 8 hours. Bottom ash shall be conveyed through jet pumps in wet slurry form from water impounded hoppers to the bottom ash slurry sump. Further, bottom ash slurry pumps shall convey the bottom ash slurry from slurry pump house to dewatering hydrobins. Decanted water from hydrobins shall be fed to settling tank & surge tank; clear water from surge tank shall be circulated back to ash handling system for re-use. Semi wet bottom ash from hydrobins shall be conveyed through the belt conveyors to mixing tank for ultimate disposal to ash dyke in high concentration slurry mode along with fly ash. Further, provision shall be provided for unloading of semi-wet bottom ash from hydrobins to open trucks for disposal to ash dyke. Bottom ash size shall be reduced to (-) 5mm, by means of suitable bottom ash second stage crushers, before feeding in to mixing tank. Ash from economizer hoppers shall be conveyed in to bottom ash hopper in slurry form by means of flushing apparatus.

##### **Fly Ash Handling System:**

The fly ash handling system will extract fly ash pneumatically under vacuum from electro static precipitator (ESP) and Air Preheater hoppers, store fly ash in intermediate surge hoppers. From surge hoppers fly ash will be conveyed pneumatically under pressure to ash storage silos. Two ash silos of 16 hour storage of fly ash shall be provided. One boiler unit will be provided with one pneumatic conveying system for handling of fly ash collected in the fly ash hoppers. Fly ash from the ESP and APH hoppers of each unit shall be removed in 5.5 hours per shift of 8 hours.

The fly ash handling system will include vacuum pumps, aeration blowers and heaters, intermediate surge hopper, air compressors and dryers, fly ash transmitter, all valves, piping, supports, platforms, access stairs and ladders, all control & instrumentation, electrical equipment, power and control cable and cabling etc. The bends with wear resistant linings will be provided for fly ash conveying pipelines.

##### **Design criteria and System Capacity:**

The ash handling system shall be provided according to the following technical parameters: (Worst coal : Coal GCV 3015 kCal/kg)

a) Ash content in coal	: 45%
b) Coal consumption per boiler at BMCR condition	: 610 TPH/unit
c) Capacity of fly ash handling system	: 390 TPH/Unit
d) Capacity of bottom ash handling system	: 225 TPH/Unit
e) Capacity of HCSD system for bottom ash and fly ash	: 275 TPH/Unit
f) Bulk density of bottom ash (for volume calculation)	: 0.65 T/M3
g) Bulk density of Fly ash (for volume calculation)	: 0.75 T/M3
h) Storage capacity of RCC silos for fly ash	: 16 hours (minimum)

#### **5.2.6.2 Ash Disposal**

The fly ash generated from these units will be used in cement industries around the plant area. Fly ash will be collected in RCC silos and from the silos fly ash shall be loaded in to closed trucks and sent to cement industries. Fly ash can also be utilised

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in Brick industries, in construction of roads, in making fly-ash bricks and mine back filling. In case of exigencies, fly ash from the silos shall be disposed to ash dyke through high concentration slurry disposal (HCSD) system. Fly ash from the silos shall be fed in to mixing tanks where bottom ash and fly ash will be mixed with water in a controlled manner so that homogeneous high concentrated ash slurry shall be prepared. The so formed high concentrated slurry shall be disposed to ash dyke through HCSD pumps and seamless pipes lines. HCSD system shall be designed for disposal of bottom ash and fly ash on a continuous basis. Provision for loading of fly ash, in conditioned form, in to open trucks shall also be provided below the silo. Considering the quantum of ash generation from 2x800MW Units and fly ash utilization as per MoEF norms, approximately 200 acres land is required for ash dyke.

### **5.2.7 Plant Water System**

#### **5.2.7.1 Water drawl**

For drawl of water for the proposed project, it needs to lay another pipe from the existing water intake point up to plant site. The scheme of raw water withdrawal from intake to plant will be separately studied and designed along with the requirement of other facilities within the complex.

#### **5.2.7.2 Makeup Water System**

River water is considered as the source of water for the station. The consumptive water requirement of the proposed 2x800 MW station is estimated at around 4000 m<sup>3</sup>/hr ( 35 MCM per annum). The requirement of plant water will be met by drawl of water through an intake structure with pump house

Re-circulating cooling water system using wet evaporative Natural Draft cooling towers will be deployed for the proposed station. It will be used for the condenser and auxiliary equipment cooling in a semi-open cooling water circuit.

The total raw water requirement of 4000 m<sup>3</sup>/hr (actual 3919 m<sup>3</sup>/hr) considers high concentration slurry disposal (HCSD), heat cycle make-up, make-up to cooling towers, FGD and other consumptive requirements like potable water, different varieties of process and service water etc. It is proposed to utilise blow down from the cooling tower in coal handling, ash handling and intermittent quenching of water drained from boiler. The break down is furnished in the Water Balance Diagram. .

The existing intake water pumping arrangement with addition of one pump and enhancing the capacity of the existing pumps as required shall be used for pump water at river water intake pump house. Raw water from this pump house will be pumped through underground steel pipes.

Raw river water at the plant end will be received in water reservoir, which will have an overall storage capacity of about seven days' water requirement of the Plant. River water will thereafter, be pumped to the Raw water pre-treatment plant and Ash handling plant by 3x50% capacity Raw water pumps.

For the proposed units, two (02) clariflocculator units each having rated capacity of about 2400 m<sup>3</sup>/hr is considered for pre-treatment (PT) plant for CW system. Further

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two (2) nos. clariflocculators / tube settlers each having rated capacity of about 150 m<sup>3</sup>/hr is considered for PT plant of /DM system/ Plant cycle make up. Normally both the clariflocculator will be running at full load condition. However, when one clariflocculator is under maintenance, the second clariflocculator will run on overload condition to meet the desired clarified water requirement. Lime, alum, ferric chloride and other coagulant will be dosed in the clariflocculator to accelerate the coagulation.

Clarified water from PTCW will be used as make-up for the Circulating water system directly and some of the water will be used for service water system. From PTDM plant (2X150 m<sup>3</sup>/hr) water will be stored in a twin chamber RCC reservoir having a storage capacity of about 4-hours of clarified water requirement. From the Clarified water reservoir water will be pumped to DM plant.

Service water will meet the requirement of Potable water of Air Conditioning and ventilation plant, service water for washing, cleaning and other housekeeping needs, Cooling and sealing water of AHP, CHP service water etc. Service water will be met by three (3) nos. of Service water pumps (2W +1S) each having 50% capacity to meet the requirement of both units.

Feed water to meet the requirement of DM plant will be met by 3x50% feed water pumps.

2x100% potable feed water pumps shall be provided to meet potable water requirement.

Cooling water in circulation is estimated at 94200 m<sup>3</sup>/hr per unit, including the requirement of auxiliary cooling circuit (secondary circuit) and considering temperature rise across cooling tower as 9.3 °C.

The makeup water requirement for cooling circuit at full load is estimated at 3448m<sup>3</sup>/hr for two units. The cooling tower blow down is expected to be about 572 m<sup>3</sup>/hr. Part of CT Blow down water qty will be recycled back with Blow down recycle plant and reject water will sent to CHP dust suppression and Ash handling system .

The system design will take into consideration recycling of waste water and aim at minimum liquid effluent discharge. Sludge water from the clariflocculator will be recovered in a thickener and reused in the Plant. Regeneration effluent from DM plant will be neutralised before discharge to Central Monitoring Basin (CMB). The water from CMB after suitable treatment will be sent to horticulture

**5.2.7.3 Demineralisation Plant & Heat Cycle Make-up System:**

Assuming average 3% make-up for the heat cycle and accounting for three hours regeneration time, demineralising chains, of 2x90m<sup>3</sup>/hr capacity addition to existing DM plant have been envisaged for the proposed units. DM plant will supply heat cycle make-up, the make-up requirement for primary water circuit in heat exchangers for the auxiliary cooling system of boiler, turbine generator and other common auxiliaries.

In the DM plant, the water will be first filtered through dual media filters installed within the DM plant building. Filtered water will subsequently be passed through Ultrafiltration, Reverse Osmosis units, degassifier towers and mixed bed exchangers

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and the demineralised water will be stored in DM water storage tanks. Acid and alkali unloading, storage and feeding system will be installed for the DM plant resin regeneration. DM water will be stored in DM water storage tanks (2 X 3000 m<sup>3</sup>)

DM water from the storage tanks will be transferred to unit condensate storage tanks by three (3) nos. DM transfer pumps (2W +1S) each having 100% capacity to meet the requirement of one unit.

There will be one common DMCCW circuit for each unit - for both TG auxiliaries and SG auxiliaries. DMCCW system will have 2x100% capacity DMCCW pumps, 2x100% capacity Plate type Heat Exchangers, 2x100% Filters and one expansion tank.

#### **5.2.7.4 Circulating and Auxiliary Cooling Water System**

The plant CW system will include the CW and auxiliary CW pumping system, Natural draft cooling towers (NDCT).

It is proposed to provide single circulating water pump house in the plant for two (2) units with four (04) numbers of pumps in pump house, two (2) for each unit. CW shall be supplied to each condenser through CW piping which shall have concrete encasement from outside

All valves / butterfly valves, RE joints and other fittings shall be suitable for clarified river water application.

There are certain station auxiliaries which may have to be cooled by clarified water. In such case, however, it will be ensured that the clarified water is cooled and recycled through close cycle cooling using NDCT of CW system

The cold water after cooling tower will be led to the CW pump house through the cold-water channel by gravity. CW system blow-down would be drawn from the discharge of the main & auxiliary CW pumps and suitably treated prior to discharge.

#### **5.2.7.5 Closed Cycle Cooling Water System**

Closed circuit cooling water system would be adopted for steam generator and turbine generator and common auxiliaries like air compressors, ash handling plant equipment etc. DM water would be used in the primary circuit, which in turn will be cooled by circulating water in plate type heat exchangers. Make up to the primary side closed loop would be from unit DM makeup system. For the secondary side, cooling water would be tapped from CW inlet to condenser and discharged into the discharge duct downstream of the condenser.

For each unit, 3 (1 working for each Unit + 1 common standby for two Units) auxiliary cooling water pumps and 3x50% CCCW pumps for each Unit will be provided for supply of auxiliary cooling water to 3x50% Plate Heat Exchangers (PHE) provided per Unit. DM water which will be used for cooling the equipment in closed cycle shall be cooled in PHE's. The auxiliary cooling water pumps will be located within the CW pump house near the respective units. These pumps will take suction from the CW sump and return back to the CW outlet line from the condenser for rejecting heat to

main NDCT. However, alternative arrangement of booster pumps with suction from CW pump discharge shall also be acceptable.

#### **5.2.7.6 Condensate Polishing Unit (CPU)**

For maintaining the feed water purity condensate polishing plant will be provided in the feed water cycle at the downstream of condensate extraction pumps. The function of the CPU will be to purify the condensate from the condenser by removing solids and dissolved salts with the intent of reducing corrosion and depositions in the steam-water cycle.

The condensate polishing plant will be 4X33.3% capacity mixed bed trains, consisting of service vessels for each unit. The resins to be used would be strong acid cation and strong base anion type appropriate for the influent condensate quality. The resins will be separated and regenerated externally by transferring to a dedicated regeneration station. A common external regeneration facility will be provided for both units.

The CPU will be provided with associated chemical feed system for preparing, measuring and dosing the required chemicals.

#### **5.2.7.7 Service Water & Potable Water System**

Drinking water requirement for the plant will be met from the output of desalination plant receiving stock from fresh water system after proper filtration and treatment. Potable water thus generated shall be stored in a potable water tank of capacity 100 M<sup>3</sup>. There will be 2x100% drinking water pumps, which will supply drinking water to various facility area overhead tanks. Plant service water requirement will be met from the Overhead Service water tank and 3x50% Service water pumps, which will supply service water to various facility areas.

#### **5.2.8 Waste water Treatment Plant:**

The liquid waste shall be collected and treated/recycled generally as per the following way:

The waste water from neutralization pits of condensate-polishing plant, DM plant shall be collected in the respective neutralization pits and neutralized before pumping to the central monitoring basin.

The oily waste from main plant area shall be treated using oil water separator and the treated water shall be led to the tube settler provided for service water waste for further treatment. From CMB water will be pumped to horticulture.

Rain Water Harvesting.

Rainfall runoff from the coal pile will contain mainly suspended solids. This runoff will be routed to the settling basin for retention and settling of suspended solids, and the clear water from there may be used for dust suppression system.

The rain water is collected in the storm water drain running all around the project. Rain water harvesting pit is connected to the storm water drain.

Excess rain water will flow to common collection pit from where water can be pumped for use in the ash handling system.

The plant sanitary waste will be treated in the sewage treatment plant.

#### **5.2.9 Fire Detection and Protection System:**

A comprehensive fire detection and protection system is envisaged for the complete power station. This system will generally conform to the recommendations of TAC guidelines and NFPA – 850.

The following fire detection and protection systems are envisaged.

Hydrant system for complete power plant covering the entire power station including all the auxiliaries, buildings in the plant area and DM plant. The system will be complete with piping, hydrants, valves, instrumentation, hoses, nozzles, hose boxes/stations etc.

Automatic high velocity water spray system for all transformers located in transformer yard and those of rating 10 MVA and above located within the boundary limits of plant, main and unit turbine oil tanks and purifier, lube oil piping (zoned) in turbine area, generator seal oil system, lube oil system for SG feed pumps, consisting of detectors, deluge valves, projectors, valves, piping, instrumentation etc.

Automatic medium velocity water spray system for cable vaults and cable galleries of the main plant, switchyard control room, CHP control room & ESP control room consisting of smoke detectors, linear heat sensing cable detectors, deluge valves, isolation valves, piping, instrumentation, etc.

Automatic medium velocity water spray system for conveyors, galleries, transfer points and crusher house consisting of QB detectors, linear heat sensing cables, deluge valves, nozzles, piping, instrumentation, etc.

Automatic medium velocity water spray system for un-insulated fuel oil tanks storing fuel oil having flash point 66 deg C and below consisting of QB detectors, deluge valves, nozzles, piping, instrumentation, etc.

Automatic sprinkler or water spray system shall be provided for Auxiliary boiler, store and hydrogen generation plant.

Foam injection system for fuel oil storage tanks consisting of foam concentrate tanks, foam pumps, in-line inductors, valves, piping & instrumentation etc.

For protection of control room, equipment room, computer room and other electrical and electronic equipment rooms, suitable "Halon substitutes" such as "INERGEN" or "AGRONITE" system would be provided.

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Fire detection and Alarm system – A computerized analogue, addressable type early warning system will be provided to cover the complete power plant with compatible detection systems.

Portable and mobile extinguishers, such as pressurized water type, carbon-dioxide type, foam type, dry chemical powder type, will be located at strategic locations throughout the plant.

Existing above fire water pump house & storage tank will meet the requirement for additional 2x800 MW units. Following equipment will be additional required for phase II fire protection & detection system.

Additional Hydrant booster pumps, Addition Spray booster pumps required. All piping & detection system are designed for Phase II.

All necessary instrumentation & controls for the entire fire detection, alarm and protection system will be provided for safe operation of the system.

#### **5.2.10 Plant Air & Instrument Air System:**

For instrument/service air requirement of main plant and auxiliaries, air compressors having a required capacity and a discharge pressure of 8 bar (g) with Air Drying Plants of same capacity will be provided. For the complete plant, Four (04) numbers (2W+1 Hot Standby + 1 maintenance Standby) of Instrument air compressors will be provided. These compressors will be oil-free screw / centrifugal type provided with all accessories such as suction filters, inter-coolers, after coolers etc.

The air-drying plants will be capable of achieving a dew point of (-) 40 deg. C at atmospheric pressure. Individual air receiver will be provided near each air compressor and further unit air receivers will be provided near main plant of each unit.

#### **5.2.11 Air Conditioning System:**

Inside design conditions of 22 +/-1degree C dry bulb temperature and relative humidity not exceeding 50 +/-5% is proposed to be maintained in all air-conditioned areas for 24 hrs operation.

Air Conditioning system will be provided for all those areas, which require close control of environment conditions and will cover the following areas:

Central Control Room consisting of Control Rooms, Control Equipment rooms, Telecommunication Rooms, Microprocessor, Computer and Programmers Rooms, Data Storage Rooms, UPS Rooms, and Steam & Water Analysis Rooms, Conference Room, Shift Charge Engineer's Room (if applicable), Relay Rooms and ESP Control room. A centralised chilled water system is envisaged for air-conditioning the above areas. This system will consist of three (3) nos. (2 nos. two working + 1 no. one standby) screw chilling units using R134a refrigerant. This system also consists of 3 x 50% (2W+1S) capacity chilled water pumps, 3 x 50% (2W+1S) capacity condenser cooling water pumps, 3x 50% (2W+1S) capacity induced draft FRP cooling towers, adequate number of air-handling units for circulating the conditioned air through air-distribution system.

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Coal Handling Plant Control Room

Switchyard Control Room including Computer Rooms, Telemetry Room, PLCC & Telex Room

Required areas in Service/Facilities Building/Administration Building

Plant/Demineralization plant Control Rooms, Water and Fuel Analysis Room, Instruments Room.

Any other area, which contains control and instrumentation equipment requiring Space Conditioning or otherwise required to be air conditioned.

A central water cooled chilled water type air conditioning plant will be provided for air conditioning of central Control Room and its associated area.

For other areas, either package type air-conditioning unit or D-X type air conditioning unit will be provided as per requirement.

**5.2.12 Ventilation system:**

Evaporative Cooling System will be provided in the following locations within the Power House Building by Air Washer Units. Coursing of air in desired direction / areas shall be made by using roof extractors and wall mounted supply/ exhaust fans.

- a) TG bay (ground, mezzanine and operating floor), HP/LP heater area, condenser area, boiler feed pump area, CPU dosing skid, Lube oil system and Oil cooler area located within A-B-C bays.
- b) De-aerator Floor in B-C bay
- c) 220V DC / UPS Battery & Charger areas
- d) LT Switchgear Rooms located within Bays A-B
- e) Cable Spreader Rooms located within Bays A-B
- f) Wet SWAS Panel Room
- g) Boiler MCC area located at
- h) Cable Vault for Boiler MCC area located at EL
- i) AC Plant Room

Air Washer Units will also serve the electrical areas except Battery room, of the Power House Building. Around 70 % of the total washed air supplied to these electrical areas shall be exhausted outside through gravity dampers to maintain a little over pressure inside the electrical rooms. Motorized Fire dampers are provided in the supply air ducting leading to all electrical rooms. Such Fire Dampers will operate with the sense from the fire detection system to be provided for the electrical rooms.

Dry ventilation system with Fan-Filter unit and Back draft dampers shall be provided for the elevator machine rooms of the Power House Building.

Exhaust ventilation system shall be provided for the Toilets of the Power House Building by installing wall mounted Axial flow fans.



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Electrical rooms of various auxiliary buildings are provided with Dry ventilation by supply fan filter units. The air shall be exhausted through back draft dampers maintaining a little overpressure of 2 to 3 mmWG with respect to the outside atmosphere.

In the switchgear room of ESP Control Room cum Fly Ash Equipment Building washed and filtered air supply is provided by Unitary Air Filter unit due to the reasons that the ESP Control Room cum Fly Ash Equipment Building is located in a very dusty zone & heat load of the said Building is exorbitantly high. Hot air will be exhausted through Back draft dampers.

Any other areas where equipment heat load is high Exhaust (pull type) ventilation is adopted for the 220V DC / UPS Battery & Charger areas by providing three nos. (Each of 50% capacity) Bifurcated type axial flow exhaust fans of spark proof construction and with flame proof motors. In the event of failure of any of the battery room exhaust fans, the third fan will be put into operation to take care of the ventilation need of this Battery Room. All the parts of this system coming in contact with acid fumes shall be epoxy painted.

#### **5.2.13 Piping System:**

Piping, valves, fittings, supports, for steam, condensate, water, oil, air and others etc. will be provided as per the requirement of the systems. Pipelines running outside the powerhouse will be routed on pipe trestles to the extent possible. However large diameter raw water and cooling water pipes will be buried. Proper protection by wrapping coating and/ or other necessary corrosion protection devices will be taken. For high temperature steam line ASTM A -106 Gr. B, ASTM A-336, P22, P91, P92 shall be used.

#### **5.2.14 Chemical Feed System:**

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

Normally All Volatile Treatment (AVT) chemistry is adopted for Once through supercritical boiler. AVT is the traditional water treatment method where Hydrazine and ammonia or amine is injected upstream of Low Pressure heaters of the condensate system or down stream of condensate Polishing plant. As high purity of feed water is required and no additional conditioning chemicals can be fed to the boiler, the use of condensate polishing is required with once through units.

Now another system which is known as Oxygenated water treatment (OWT) has been applied by few manufacturer to overcome the problem faced in AVT.

In OWT system, ammonia and oxygen will be injected upstream of Low Pressure heaters of the condensate system. Also oxygen can be injected in the Boiler Feed pump suction.

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The Chemical Feed System shall consist of two independent systems of Low Pressure (LP) Dosing Systems for AVT system. The LP dosing system shall be designed on unit system i.e. each power generation unit shall have its own chemical dosing system and thus shall be independent of other units in the station. The chemical feed systems shall be self-contained and complete.

**5.2.15 Condenser On-load Tube Cleaning System:**

Two (2) nos. 2x100% Condenser On Load Tube Cleaning System complete with ball recirculation units, pumps, drive motors, ball collectors, debris filter etc. and appurtenances matching the requirements of the Condenser.

**5.2.16 Hydrogen Generation Plant:**

Hydrogen cylinders will be procured or hydrogen generation plant shall be installed based on requirement at later stage.

**5.2.17 Thermal Insulation:**

All equipment / pipes / ducts whose surface temperature is higher than 60°C, will be provided with thermal insulation for personnel protection and heat conservation. The insulation material will be chemically inert, non-combustible and will be harmless. Outer surface of the insulation will be covered with aluminium cladding of 22 BWG. Materials and thickness of insulation will be selected so as to limit the surface temperature to 60°C with an ambient temperature of 47°C and wind velocity of 3.4 m/s.

Steam turbine and also, BFP drive turbine shall have spray insulation to maintain differential expansion of turbine within permissible limits apart from conserving heat.

**5.2.18 Cranes & Hoists:**

Two (2) no. of EOT cranes of adequate capacities will be provided in the turbine hall for erection and maintenance of turbo-generators and their auxiliaries except generator stator. The main hook capacity of each crane will be 20% over and above the heaviest component / equipment (including slings etc.) to be handled in TG hall.

CW pump house, ACW pumps, Air Compressors, Workshop and other Facility requiring frequent handling of heavy loads will also be provided with EOT cranes of suitable capacity. For handling other heavy equipment weighing 600 kg and above, electrical / manual cranes and hoists of appropriate type and rating will be provided.

**5.2.19 Chimney:**

One (1) no chimney with 2 flues, of 275 m with RCC construction is envisaged for 2x800 MW Units to comply with environmental regulations. The chimney will be concrete shell type, MS flues with top one third SS liner to cater to two (2) units of 800MW. The chimney will be provided with lightning arrestors and aviation warning lights. System design will include on-line Opacity meter & gas analysers for SO<sub>2</sub> and

NO<sub>x</sub> monitoring, CO monitoring and Flue Gas Oxygen analysers etc. The Chimney will be provided with rack & pinion type elevator to facilitate maintenance.

#### **5.2.20 Elevators:**

One (1) goods-cum-passenger elevator of about 3000 kg carrying capacity will be provided for each of the steam generating units. One (1) number passenger elevator will be provided at the entrance of the power house building for movement of personnel.

#### **5.2.21 Painting & Corrosion Protection:**

All mechanical and electrical equipment including piping system and structures will be painted with international standards / IS standard colour code for ease of identification. All steel structures will be painted with epoxy resin based paints. Galvanised structures will have minimum 610 mg/m<sup>2</sup> zinc coating. Suitable allowance on thickness will be provided for the surfaces, which can not be protected by application of painting. All buried piping will be provided with bitumen paint based coating and wrapping. Cathodic protection system shall be provided for all underground structures wherever it will be felt necessary.

All equipment, buildings, structures etc exposed to atmosphere shall be painted to suit atmospheric climate.

#### **5.2.22 Workshop & Laboratory:**

The power plant is already equipped with a work shop capable of catering to the routine maintenance requirements of the plant.

A central chemical laboratory adjacent to the DM plant buildings is already established for the station. This has necessary equipment and facilities to test and analyse steam, water, oil, coal etc. required to ensure satisfactory operation and maintenance of the station.

### **5.3 ELECTRICAL SYSTEMS & EQUIPMENT:**

#### **5.3.1 General Description**

The generation voltage shall be above 27 kV or as per Manufacturer's standard. The generator would be connected to the switchyard through a step-up Generator Transformer. The power can be evacuated through the lines already existing in Phase-1 Switchyard and proposed to be added in the Phase-2 switchyard.

The scheme would be with GCB. Station transformer shall be connected to Gen IPBD tap off. A Station Maintenance transformer shall be connected to 400KV system which shall provide backup to all UTs & STs. 11KV board of Station maintenance transformer shall charge 11KV ST and UT boards for commissioning power.

#### **General Principles of 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

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interconnected electrical system with provision for easy maintenance and overhauling.

The design principles and standards delineated herein are generally in compliance with latest IEC/IS Standards and the Code of Practice already established in the country.

Indian Electricity Rules wherever applicable have also been complied with Design ambient temperature for Electrical Equipment is considered as 50°C.

### **Auxiliary Power System**

Auxiliaries of the Power plant range from large capacity motors to small fractional horsepower motors. The motors shall be connected to power supply as per following design criteria:

Below 0.2 kW	240V, 1 Phase, 50 Hz.
From 0.2 kW to 200 kW:	415V, 3 Phase, 50 Hz solidly grounded system
Above 200 Kw to 2000 KW	6.6kV, 3 Phase, 50 Hz resistance grounded system
Above 2000 KW	11 KV, 3 Phase, 50 Hz resistance grounded system

Continuous duty 415 V motors rated 110 KW and above will be controlled by breakers. 415 V Motors rated less than 110 KW will be controlled by fuse and contactors. HT Motors will be controlled by either Vacuum Circuit Breakers or Vacuum Contactors. HT motors of Coal handling system will be controlled by fuse and vacuum contractors considering frequent starting.

### **System Neutral Grounding**

Generator Neutral Grounding: Through Neutral Grounding Transformer.

400 KV System Grounding: Effective/ solid grounding.

11 KV & 6.6 KV System Grounding: Resistance grounding

415 V System Grounding: Effective/ solid grounding

### **5.3.2 Rating of Major Equipment Generator**

The generator coupled with steam turbine will have the following salient technical features:

Type	:	Synchronous generator
Rated capacity	:	941 MVA, 800MW
Stator cooling	:	By Hydrogen / water
Rotor cooling	:	By Hydrogen
Rated power factor	:	0.85 lag
Rated Terminal Voltage:		27 kV or manufacturer's standard
Insulation class	:	F (Temperature rise limited to class 'B')
Rated Frequency	:	50 Hz
Frequency variation range:		-5% to +3%
No. of phase	:	3

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Rated Speed : 3000 rpm

Generator shall conform to IEC-34.

Short circuit ratio shall not be less than 0.48. .

Generator shall be capable of operating continuously on an unbalanced system in such a way that, with none of the phase currents exceeding the rated current, the ratio of the negative-sequence component of current ( $I_2$ ) to the rated current ( $I_n$ ) does not exceed the values specified in IEC 60034-1 and under fault conditions shall be capable of operation with the product  $(I_2/I_n)^2$  and time (t) not exceeding the values in IEC 60034-1.

The withstand capability of generator for 3 phase short circuit at the generator terminals when operating at rated MVA and p.f. with 5% over voltage will be for a period of not less than 3 seconds.

The generator shall be capable of delivering at least two thirds of the rated output with one gas cooler out of service.

Line charging capability (MVAR) of generator will be not be less than 30% rated MVA at zero PF leading.

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 neutral of the generator will be earthed through distribution transformer and secondary resistor to limit the ground fault current to 15 amps.

Surge diverters and protective capacitors will be provided near Generator to protect the insulation of the generators from surges, both from steepness of wave front and magnitude of surge level.

The generator will be provided with static excitation system consisting of Dual channel Digital AVR with Auto as well as Manual control.

The excitation system will have fast response time to meet the system requirement. The AVR (Automatic Voltage Regulator) shall maintain steady generator terminal voltage under variable load conditions and for parallel operation with the grid. Ceiling voltage for exciter will be > 150%.

AVR response time will be short so that it can control generator during system disturbances requiring rapid changes in excitation to maintain the system dynamic stability margins. The excitation response time shall be < 0.5 sec and response ratio shall be >2.

Excitation system will be provided with power system stabiliser for achieving dynamic stability under varying operating conditions.

The excitation system will have in-built protective as well as limiting devices so as to safeguard the generator and excitation system against all possible faults, troubles and mal-operation, if any.

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The static thyristor excitation system will be equipped with features such as cross current compensation, volt/frequency ratio controller, slip stabilisation, rotor angle limiter, stator and rotor current limiter, follow-up circuits, field suppression gear.

The generator will be provided with seal oil system, Hydrogen cooling system, stator water cooling system (if applicable) and CO2 system for purging of hydrogen and fire protection system.

### **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
Voltage ratio	:	400 kV /27 kV (Generator Voltage)
Frequency	:	50 Hz
Vector group	:	YNd11
Percentage impedance:	:	14.5% approx.
Capacity	:	3 X 330 MVA
Cooling	:	ONAN/ONAF/OFAF (60/80/100 % capacity)
Taps type	:	Off circuit tap changer
Taps range	:	+5% to -5% in steps of 2.5%

HV side shall be solidly grounded.

### **Other Transformers, Bus duct and switchgear:**

- Unit Transformer and Unit Auxiliary Transformer: 50 MVA, 27/11.5 KV and 25 MVA, 11/6.9 KV respectively.
- Station Transformer- Two winding 100/50/50 MVA, 400/11.5/ 11.5 KV
- Station Maintenance Transformer.
- Auxiliary Transformers-11 or 6.6 KV/ 0.433 KV Dry type
- Bus ducts:
  - Generator Bus duct- Isolated Phase Busduct (IPBD)
  - 11KV & 6.6 kV Bus duct- Segregated Phase Busduct (SPBD)
  - LT Bus duct- Non Segregated Phase Busduct (NSPBD)
- 11 KV and 6.6 kV Vacuum Switchgear
- Motor Control Centre and Power Control Centre

### **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.

### **5.3.3 Protective System**

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

A group of such protective devices may be necessary to protect the equipment under different abnormal conditions arising in the system. Each equipment shall be provided with a unit as well as backup protection.

Besides this, protection against lightning surges will be provided with lightning arresters at suitable locations for outdoor equipment over and above the shielding wires and lightning masts.

In any case, proper discrimination and selectivity shall be provided so as to isolate only the faulty elements, keeping the healthy part of the system in service. The protective relays shall be of numerical type.

The major electrical equipment will be provided as a minimum with the protections as listed below:

#### **400kV Switchyard Protection**

- Line Protection- Duplicate Distance Protection, non-switched schemeAuto reclose relay
- Fault Locator
- Backup over current and earth fault protection
- Redundant Bus bar Differential Protection

In addition to above, Lockout relays, trip circuit supervision relays, Local breaker backup Protection will be provided.

#### **Generator Protection**

- Differential protection - generator winding
- Over voltage protection
- Stator earth fault protection
- Reverse power protection
- Negative phase sequence current protection
- Field failure protection
- Rotor earth fault protection
- Generator overload protection

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- Overall differential protection for generator and generator transformer
- Generator under frequency protection
- Local breaker back-up protection
- Diode failure relay.
- Backup Impedance Protection
- Low forward Power protection
- Pole slipping protection
- Winding temperature protection
- Standby stator earth fault protection
- Loss of field protection
- VT fuse failure protection
- Inter turn fault protection

**Generator Transformer**

- Transformer Differential protection
- HV restricted earth fault protection
- HV backup overcurrent protection
- HV backup earth fault protection
- Buchholz protection
- Oil/winding temperature protection
- Over fluxing protection
- Pressure Relief Valve
- LBB protection
- Oil surge protection

**LT transformers**

- Over current protection (IDMTL & instantaneous)
- Earth fault Protection
- LV side Backup Earth fault protection
- Buchholtz protection



- Oil/winding temperature protection

#### **Unit Transformers**

- Differential protection
- Restricted Earth Fault protection for LV winding
- Over current protection on HV side & LV side
- Backup Earth fault protection
- Buchholtz protection
- Oil/winding temperature protection
- Pressure Relief valve
- OLTC surge relay protection.

#### **Station Transformers**

- Differential protection
- Restricted Earth Fault protection for HV & LV winding
- Over current and earth fault protection
- Backup Earth fault protection for HV & LV side
- Buchholtz protection
- Oil/winding temperature protection
- Pressure Relief valve
- OLTC surge relay protection.

#### **11KV & 6.6 kV Motors**

- Multifunction Numerical motor protection relay having flexibility to accommodate following protections:
- Differential protection (for motors rated 1500 kW and above)
- Thermal overload protection
- Instantaneous overcurrent and definite time - overcurrent protection
- Earth fault protection
- Single phase and phase unbalance protection

- R.T.Ds. for winding/bearing temperature protection (for motors rated 1000 kW and above)
- Locked rotor Protection

#### **5.3.4 Grounding and Lightning Protection**

The plant grounding system will be designed as per the requirements of IEEE-80/IEEE 665/IS-3043. The earth mat of the station will be designed such that the total ground impedance does not exceed 1.0 ohm. The plant grounding will utilise Mild Steel Rods. Equipment grounding conductor will be of galvanised steel flats/GI wire.

Each large structure and building complex will have a ground loop around its perimeter. The ground loops around each structure will be connected to the ground grid.

The fence within the ground grid will be bonded to the plant ground system. The power plant ground grid shall be tied together with the switchyard ground grid.

The grounding system will be connected to all metallic equipment, electrical as well as non-electrical (except underground pipelines), located at the plant site. All these shall be connected at two distinct points. This shall include all structures, buildings, towers, etc.

The chimney and powerhouse building will be equipped with lightning protection. Lightning protection conductors located on the top of the structures will be connected to the ground loop surrounding the structures with down comers as per the provisions contained in the latest issues of Indian Electricity Rules and IS 2309.

#### **5.3.5 400 kV Switchyard**

Power evacuation shall be through 400 KV Switchyard. All the Generators shall be connected to 400 kV Switchyard through Generator Transformer. . The switchyard will be provided with the feeders as described earlier. The switchyard will be of outdoor air insulated or indoor Gas Insulated type.

The switchyard will be provided with necessary current transformer, capacitor voltage transformers, surge arrestors, protective relays etc.

The control, monitoring and operation of the switchyard will be through SAS (Substation Automation System) in the Switchyard Control Room. Sequential Event Recorder (SER), which is a part of SAS will be provided with analog and digital signals. These signals as a minimum will contain status of all protective relays, lock out relay and breaker auxiliary contacts. These signals will be hardwired to SER cabinet.

The salient technical features of the switchyard are as follows:

The switchyard shall be designed considering the following parameters.

Nominal System Voltage	:	400KV
Highest System Voltage	:	420KV

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Rated frequency	: 50Hz
No. of Pole	: 03
Design ambient temperature	: 50° C
Lightning impulse withstand voltage	: 1550KVp
Switching impulse withstand voltage	: 1050KVp
Power frequency withstand voltage	: 630KV
Short time current and duration	: 50KA for 1 sec.
Dynamic rating	: 125KVp
Corona extinction voltage	: 320KV
Phase to phase clearances	: 4000mm (min.)
Phase to earth clearances	: 3500mm (min.)
Live part to Ground	: 8000mm (min.)
Section clearance	: 6500mm (min.)
Creepage distance	: 31mm/KV
System neutral earthing	: Effectively earthed

The salient technical features of major switchyard equipment are as follows:

**Circuit Breaker**

Type / Application	: SF6 Gas Puffer type, electrically trip free, outdoor type
Number of pole	: 3 nos., single pole
Nominal / highest system voltage	: 400KV / 420KV
Rated Current	: Corresponding to rated Voltage
Operation duty	: O-0.3 Sec-CO-3 min-CO
First pole to clear factor	: 1.3
Total break time (Max.)	: 45 msec.
Max. allowable switching overvoltage under any switching conditioning	: Not more than 2.3 p.u.
Type of operating mechanism	: Spring Operated
No. of trip coils per pole	: 2 nos.

**Disconnecter**

Type / Application	: Double break, outdoor type
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Mounting	: Horizontal, Upright
No. of phases	: 3
Nominal / highest system voltage	: 400KV / 420KV
Rated Current	: Corresponding to rated Voltage
Type of operating mechanism	: Motor operated
Operating mechanism voltage	: 3 Phase 415V / 1 Phase 240V
Control Supply	: 220V DC

**Current Transformer**

Type / Application	: Oil filled, outdoor type, hermitically sealed
Nominal / highest system voltage	: 400KV / 420KV
Type of insulation	: Oil immersed Class A
Accuracy Class for tariff metering	: 0.2S
Accuracy Class for other metering	: 0.5
Accuracy class for protection	: 5P20/PS

**Voltage Transformer**

Type / Application	: Oil filled, outdoor type, hermitically sealed
Nominal / highest system voltage	: 400KV / 420KV
Type of insulation	: Oil immersed Class A
Capacitance	: 8800 / 4400 pf
Accuracy Class for tariff metering	: 0.2
Accuracy Class for other metering	: 0.5
Accuracy class for protection	: 3P

**Lightning Arrestor**

Type	: Outdoor type
Nominal / highest system voltage	: 400KV / 420KV
Rated arrester voltage	: 390KV
Nominal discharge current	: 20 kA of 8/20 microsecond wave
Minimum discharge capability	: 8KJ/KV

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Long duration discharge : 3 & 4  
Pressure relief class : A

**Sub Station Automation (SAS) System**

The SAS shall comprise full station and bay Control, monitoring and communication functions and shall provide all functions required for the safe and reliable operation of the Substation. SAS shall be based on a decentralized architecture and on a concept of bay-oriented, distributed intelligence. The SAS shall conform to IEC 61850 standards. The SAS layout shall be structured in station level and bay level.

All the systems comprising the SAS shall be state-of-the-art, based on latest industry standards, suitable for operation under electrical conditions present in the EHV substations, follow the latest engineering practice, ensure long term compatibility requirements and continuity of equipment supply and safety of the operating staff.

The guaranteed annual system availability shall be not less than 99.9 percent. To ensure availability, adequate redundancy in system design shall be provided at hardware and software level. Required redundancy shall also be provided at CPU, Power supplies, communication channels, network and nodes

**Control aspects**

- a) The entire station shall be controlled and supervised from HMI. Clear control priorities shall prevent the operation of a single equipment which can be initiated at the same time from more than one of the various control levels. The priority shall always be on the lowest enabled control level.
- b) Generator transformer breaker will be synchronized from Generator control/relay panel located in the Main plant control room. Further for emergency tripping of these breakers, hard wired facilities shall be provided in Main plant control room.
- c) Tie circuit breaker in Generator transformer diameter shall be controlled from both Generator control panel and SAS / BCU for same diameter. Selection for Tie circuit breaker control shall be provided in the Relay panel of the feeder.
- d) For Circuit breakers, Local operation shall be carried out from CB operating box, for which Local/remote selector switch located in the CB operating box shall be selected in local. This operation is envisaged only for maintenance and testing of circuit breaker.
- e) For Isolators, Local operation shall be carried out from Isolator operating box, for which Local/remote selector switch located in the Isolator operating box shall be selected in local. This operation is envisaged only for maintenance and testing of Isolator.

### **5.3.6 Balance electrical systems**

These shall cover:

- Power and Control Cables
- Illumination System
- Normal A.C. Lighting of the Plant
- Emergency AC Lighting
- Emergency DC Lighting
- Plant Communication
- Station DC System
- Uninterruptible Power Supply System
- Emergency DG Set
- Cable Installation System
- Miscellaneous Motors

## **5.4 CONTROL & INSTRUMENTATION SYSTEMS**

### **5.4.1 Design Philosophy:**

#### **Objective**

The control and instrumentation system for each unit of the plant will be designed to ensure safe, efficient and reliable operation of the plant under all regimes of operation, namely start up, shutdown, normal operation, part load operation and under emergency conditions resulting in cost effective power generation with optimum fuel consumption and reduced emission levels.

#### **Design Philosophy**

The operation, control and monitoring system envisaged for each unit of the plant would be based on a state of the art microprocessor based Distributed Digital Control Monitoring and Information System (DDCMIS) also referred as Distributed Control System (DCS) of internationally launched latest proven technology.

The state of the art control and instrumentation system will relieve the operator from continuous surveillance, minimize operator interventions and will take pre planned actions required in case of process drift or if unsafe trends or conditions develop in any regime of operation. The system will alert the operators as to any abnormal conditions or situations requiring manual intervention in a timely manner.

The design of the control and instrumentation system would be such as to permit on line localization, isolation and rectification of fault in the minimum possible time. Ease of maintenance would be given due importance at system design stage.

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The DDCMIS will provide a comprehensive integrated control and monitoring system to operate, control and monitor the Steam Generator & auxiliaries, Steam Turbine-Generator & auxiliaries and power cycle equipment and auxiliaries including DCS based Balance Of Plant (BOP) systems with a hierarchically and functionally distributed structure.

Monitoring and control, Data acquisition, alarm annunciation, fast response time, fail safe design, sequence of events recording, online diagnostic and online maintenance are some of the inherent features of the DDCMIS to be designed for the proposed Power Plant.

Plant operation and control will be through the Operator Interface Units (OIU) located on the Unit Control Desk (UCD) in the Central Control Room which will consist of colour graphic LED monitor, keyboard/Mouse and also through Large Video Screen (LVS).

The main plant including Steam Generator and its auxiliaries, Steam Turbine Generator and its auxiliaries and power cycle equipment's and auxiliaries etc. will be controlled and monitored through DDCMIS.

DDCMIS will include the modulating controls of the plant including Co-ordinated Master control, Steam Generator modulating controls, Turbine governing and other Turbine modulating controls, and modulating controls for power cycle equipment's.

All open loop control functions for the main plant including Steam Generator and the Steam Turbine Generator and their auxiliaries along with power cycle equipment and systems will be implemented in the DDCMIS so that centralized drive operation for the main plant and auxiliaries is possible. DDCMIS will also include sequential start up, shutdown of the plant including Steam Generator, Turbine Generator and power cycle Equipment and Systems.

The control functions will be backed up by protection, interlocks and safety functions. This would cause pre-planned actions in cases where unsafe conditions develop faster than the control capability of modulating controls or before the operator can be expected to respond to the plant upset conditions in any regime of plant operation.

The Balance of Plant (BOP) off-site systems like Coal handling, Ash handling, DM Plant, Fuel oil unloading and transfer, Condensate polishing unit ( shall be part of DCS), Flue Gas Desulphurisation ( Shall have Separate DCS), etc. will be monitored through the PLC Based operator interface units in the central control room. These packages will have independent and stand-alone PLCs in hot redundant configuration. All the PLC based packages will be integrated by Ethernet/OFC at CCR. Additionally, all the BOP package systems will be provided with 24" LED HMI Operator Interface Units (OIU) with printer in the Local control room. & also connected with dedicated Operator Interface Units (OIU) placed in Main Control Room for monitoring of BOP packages.

Operation and Monitoring of Plant Electrical and downstream System will be performed through DDCMIS. Additionally, DDCMIS will have a redundant Software link with SCADA System for monitoring of switchyard system.

Plant abnormal conditions will be alarmed through the Operator Interface Units. Alarm printer will be provided to print out all alarms with time tagging and in the chronological order.

Sequence of Event Recording function will be provided for recording and printing occurrence of events in a chronological order for quick diagnostic of fault and remedial action.

DDCMIS will perform online performance calculations to determine plant/equipment efficiency and to detect and alarm unit/equipment malfunctions.

#### **5.4.2 Major Control & Instrumentation System**

The major components of Control and Instrumentation system of the unit will comprise of the following:

- Distributed Digital Control Monitoring and Information System (DDCMIS) with plant wide data High way.
- Steam Generator Control and Protection System configured within the DDCMIS or as per Manufacturer's standard design interfacing with the DDCMIS.
- Steam Turbine Generator Control and Protection System configured within the DDCMIS or as per STG Manufacturer's standard design interfacing with the DDCMIS.
- Turbine Supervisory Instrumentation system for STG.
- Vibration monitoring predictive Analysis system for major plant auxiliaries.
- Operation, monitoring and control of electrical systems.
- Master and Slave Clock System.
- Central Control Room, Unit Control Desk and unit Control panel.
- Measuring Instruments & flow elements.
- Steam and Water Analysis System (SWAS) and chemical dosing system.
- BOP PLC based control system..
- Continuous Emission monitoring instruments and all flue gas analyzers.
- Uninterruptible Power Supply and Distribution.
- Final Control Elements.
- Instrumentation & special cables.
- Maintenance and Calibration Instruments.
- Plant Performance Calculations System.
- Instruments Air Supply
- Erection Hardware and Special tools and tackles.
- Plant Closed Circuit Television System (CCTV).
- Performance Analysis Diagnosis & Optimization System (PADOS)

#### **5.4.3 Distributed Digital Control Monitoring & Information System (DDCMIS)**



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An integrated functionally Distributed Digital Control, Monitoring & Information System (DDCMIS), synthesized from one general family of interchangeable multifunction hardware has been envisaged for the Plant.

The DDCMIS will be of proven and latest configuration and will be provided with suitable Open Protocol Connectivity (OPC) like Ethernet TCP/IP communication for high speed LAN so that it can be connected seamlessly with other OPC compliant system. Data transmission speed will be sufficient to meet the response of the Distributed Control System

An Open Architecture based DDCMIS with Global Database and intelligent distributed configuration has been envisaged for the plant. Necessary interfaces between DDCMIS of all the units of the plant will be provided. It will be capable of handshaking with any third party system with standard protocol. The primary objective will be centralized monitoring, presentation & report of data for information and analysis of the entire plant. The main Data Highway will be high-speed dual redundant type with a bus speed of minimum 100 MB/Sec or higher. Not required as we have considered the EWS/OWS of the uniform make BOP PLC in the CCR. [ALL the offsite packages will have uniform make stand alone PLCs and this will be connected to the CCR where the EWS/OWS of that make PLC will available.](#)

#### **5.4.4 Steam Generator (SG) Control System:**

The Steam Generator control system will include the following functional blocks:

- Furnace Safeguard and Supervisory with Flame Monitoring System (FSSS).
- Secondary Air damper Control (SADC).
- Steam Temperature
- Auxiliary pressure reducing and de-superheating station (APRDS) Control System.
- Mill / Pulveriser Control System
- Coal Feeder Control System
- Steam Generator Auxiliaries Controls
- Soot blower Control System
- Electromatic Relief Valve control, Furnace Temperature Probe control and other miscellaneous control.
- Air Heater Leakage Control System and Fire Detection System.
- Acoustic steam leak detection system

The Steam Generator protection system is integrated with the unit control and automation system and software communication (signal exchange) from and to it will be redundant. In the event of this interface not being able to handle time critical signals, they and other critical parameters will be hardwired.

The boiler protection system will be a fully electronic, fail safe multi-channel system. The protection system, implemented through TMR/Redundant controllers will accept plant protection input signals in a 2-o-o-3 (Two Out of Three), 1-o-o-2 (One Out of Two) or 1-o-o-1 (One out of One) selection configuration, depending on the measurement loop installation constraints and criticality requirements.

The boiler protection philosophy to be implemented is based on the respective required regulations.

Alternatively, if proprietary Steam Generator control system by manufacturer is provided, it will be complete with all the functional blocks described above with operating interface arrangement. The control system will have redundant software link with the Plant DDCMIS and some of the critical signals for protection of the boiler will be hardwired to the plant DDCMIS.

#### **5.4.5 Steam Turbine Generator (STG) Control System:**

The STG control and governing system is configured as a TMR/Redundant Control system, which allows for bump less control transfer from the one to the other channels in the event of a channel failure.

A turbine stress limiter/controller is also included, to control stress in the turbine via measurements at predetermined locations in the turbine. This function will be continuously active under all operating conditions, but particularly during start-up. The STG control system will typically include the following functional groups:

- Digital Electro hydraulic Governing Control System (DEHC)
- Automatic Turbine Run-Up System (ATRS)
- Automatic Turbine Testing System (ATT)
- Turbine Stress Evaluator (TSE)
- Turbine Protection System (TPS)
- Turbo-supervisory Instrumentation (TSI)
- HP, LP Bypass Control System
- Generator Auxiliaries Control System

The turbine protection system is integrated with the unit control and automation system and software communication (signal exchange) from and to it will be redundant. In the event of this interface not being able to handle time critical signals, they and other critical parameters shall be hardwired.

The system will be a fully electronic, fail safe multi channel system. The protection system, implemented through redundant controllers will accept plant protection input signals in a 2-out-of-3, 1-out-of-2 selection configuration, depending on the measurement loop installation constraints and criticality requirements.

The turbine over speed protection is an independent SIL 3 /TUV certified system in accordance with IEC 61508 and IEC 61511, integrated in the protection system. As a minimum four speed measurement probes and measuring wheel are provided, of which three probes are operational and one standby. The speed trip signal is based on a 2-out-of-3 voting signal which trips the turbine directly.

The turbine protection philosophy to be implemented is based on the respective required regulations.

Alternatively, if proprietary STG control system by manufacturer is provided, it will be complete with all the functional blocks described above with operating interface arrangement. The control system will have redundant software link with the Plant DDCMIS and some of the critical signals for protection of the STG will be hardwired to the plant DDCMIS.

#### **5.4.6 BOP Package Control System:**

##### **Balance of Plant (BOP) control system:**

Balance of plant packages shall be PLC based and these shall be integrated by Ethernet at the Central control room for centralised monitoring. Additional operator interface unit with printer shall also be provided in the local control room for each of these plant packages. These packages include:

- Coal handling plant
- Ash handling plant
- Water treatment including DM plant
- Fuel oil unloading and transfer
- Air Compressors
- HVAC
- Fire detection and protection systems.
- Condenser on line tube cleaning system. ( Shall be Part of DCS)Vibration monitoring system.
- Condensate polishing system. ( Shall be Part of DCS)
- Waste water treatment plant (ETP,STP)

Information from other stand-alone systems shall be made available to DDCMIS of each unit through hardwired signal exchange, if required.

The control, interlock, protection and start / stop operation for the Off Site package like DM Water Plant, Coal Handling Plant, Ash Handling Plant, , Fuel oil unloading and storage will have dual redundant PLC based control system. For noncritical BOP packages dedicated control system is envisaged. PLC based package systems will be

integrated by Ethernet at the central control room. Dedicated BOP OIUs in the CCR will be provided for monitoring of these packages.

For redundant PLC based BOP packages, redundant CPU, memory, power supply and communication modules will be provided. For all the BOP packages OIU at the local control room will be provided along with printer for alarm monitoring.

#### **5.4.7 Turbine Supervisory Instrumentation System & Vibration Monitoring System:**

Turbine Supervisory Instrumentation will be complete with Sensors, Amplifiers, Special Cables and monitors with all necessary equipment and accessories. Radial, Axial and thrust Bearing Vibrations, Axial Shift, Eccentricity, differential expansion etc., will be some of the important measurement for the Steam Turbines and its driven equipment like Generator.

PC based vibration monitoring system will be provided, which will be knowledge based with the capability of dynamic data analysis and provides complete information about machines. This will also include latest Machinery Management Software including analysis of the Generator Overhang for data acquisition and predictive maintenance of machinery /equipment. The vibration monitoring system will be provided with necessary interfaces with DDCMIS for centralized monitoring purpose.

#### **5.4.8 Vibration Monitoring & Predictive Analysis System for Major Plant Auxiliaries:**

The Vibration Monitoring & Predictive Analysis System will be provided for all critical equipment including ID Fans, FD Fans, PA Fans, CEP, Boiler Feed Pumps, CW Pumps etc for condition monitoring and analysis of critical Mechanical equipment. The System will be complete with Proximity Type Vibration Sensors, Amplifiers, Special Cables and monitors with all necessary equipment and accessories.

The vibration monitoring & Predictive Analysis system will be provided with necessary interfaces with DDCMIS for centralized monitoring purpose.

#### **5.4.9 Central Control Room:**

Existing central control room will be utilised for control & monitoring of upcoming phase-2 units. Some modifications will have to be done for installing the control desk of the phase 2 units. All the three units of the plant will be monitored and controlled from the existing central control room.

#### **5.4.10 Central Control Room Equipment:**

The Central Control room will accommodate the following equipment.

- a. Unit Control Panel (UCP), Unit Control Desk (UCD) and printers in the central control room.
- b. DDCMIS system cabinets and electrical relay cabinets and other systems panels (as required) in the Control Equipment room.
- c. Shift charge Engineer's monitor with key board and printers in Shift Charge Engineer's room.

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- d. System Maintenance Engineer's monitor with key board along with the printer in System Maintenance engineer's equipment room.
- e. Uninterrupted Power Supply System (UPS) in UPS room.
- f. Public Address System panels, Fire alarm system panels etc will be suitably housed in main control room.
- g. Large Video Screens for respective units .
- h. Furnace Flame T.V
- i. Alarm Annunciator
- j. Station LAN

**5.4.11 Unit Control Desks/**

**Unit Control Desk:**

The unit control desk (UCD) will house OIUs, including Monitor, Keyboard, and Mouse. The UCD will also house Telephone Hand set for communications. The unit, functional group or drive level control and operation of all main plant equipment including non-synchronising breakers of 415V, 6.6 KV and 11 KV system will be done from the Operator interface units (OIUs).

**5.4.12 Master & Slave Clock System:**

Master and Slave Clock System in redundant configuration would be provided in order to maintain uniform timing throughout for the various plant facilities and also for time synchronization between various digital systems including DDCMIS, and other DCS Based Systems for all units of the plant.

The system will include two master clocks in 100% redundant configuration (one working and the other stand by) and slave clock display units. Master clocks will have own synchronizing pulse generation facility as well as the facility to receive synchronizing Pulses from the Global Positioning Satellite (GPS) system. The GPS receiving System will be complete with Antenna and other electronic devices.

In the event of non-availability of GPS Pulses, the time synchronizing pulse from the Master Clock itself will be utilized for time synchronization of the Plant DDCMIS with other Systems.

**5.4.13 Plant Closed Circuit TV:**

Closed circuit TV and plant cameras along with redundant switching system, keyboards, monitors, interconnecting cables and interface to LVS has been envisaged for surveillance, safety and security of various plant areas.

#### **5.4.14 Steam Water Analysis System (SWAS):**

A centralized comprehensive Steam and Water Analysis System (SWAS) for each unit will be provided for continuous on line monitoring of water and steam purity in the plant cycle. Measurements of Specific Conductivity, Cation Conductivity, pH, Hydrazine, Dissolved Oxygen, Silica, Sodium and Phosphate will be provided.

SWAS will consist of Sample Conditioning Panel (Wet Panel) and Analyzers Panel (Dry Panel) located in air-conditioned SWAS room.

Various steam samples with primary coolers and water samples would be routed to a centralised place and cooled to the required temperature before entering analysers / cells. Sample Conditioning Panel will contain sample filtering, secondary sample cooling and temperature control, pressure reduction and control, flow rate control, necessary instruments required for sample conditioning and monitoring. Primary sample coolers and high-pressure reduction units will be located in field. Provision of grab samples will be provided in Sample Conditioning Panel.

The analysers shall be located in a separate Dry panel near the sampling rack in an air-conditioned environment. The Analyzer Panel will consist of process analyzers, monitors and annunciators. Analyzer panel will have alarms for local annunciation with provision for repeat alarms in Central Control Room. The signal from the analysers will be hooked up with Plant main DDCMIS.

Both the sample rack and analysers are located in a central place with the analyser panel section partitioned for air-conditioning. The SWAS room will be suitably located in the Main Plant Building.

#### **5.4.15 Continuous Emission Monitoring System:**

Continuous Emissions Monitoring System (CEMS) for monitoring of Flue gas Emissions from the Stacks of the Plant will be provided, which will consist of the following analyser Instruments:

- a) Oxides of Nitrogen NO<sub>x</sub>
- b) Sulphur Dioxide SO<sub>2</sub>,
- c) Carbon Monoxide CO
- d) Stack Opacity Monitor.
- e) H<sub>2</sub>O

CEMS will be complete with flue gas sample extraction and conditioning and analysing system. will be provided to hook up the Emission Monitoring System to the Plant DDCMIS.

#### **5.4.16 Ambient Air Quality Monitoring System:**

Analytical Instruments for Ambient Air Quality Monitoring will also be provided to check upon the ambient air quality around the Power Plant.

#### **5.4.17 Field Measuring Instruments:**

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All field transmitters are envisaged to be smart type having 4-20 mA DC signal output with 100:1 turndown ratio and with superimposed digital signal conforming to HART. Portable digital calibrator/HART communicator is envisaged for on line calibration of the transmitters. Accuracy of process transmitters is envisaged as 0.35%.

All temperature elements (RTD/Thermocouple) will be duplex type. Thermocouple will be mineral insulated type.

Measurement of steam flow, feed water flow condensate flow, SH & RH attemperation flow and BFP recirculation flow is proposed with the help of flow nozzles. In light oil & heavy oil flow service Coriolis type mass flow meters have been envisaged. Orifice plates will be used in other water services. Aerofoil / Ventury type sensors will be used for Combustion Air flow measurements. Orifice Plate will be used for all other flow measurements.

Field instruments would be suitably grouped and clustered area wise and would be terminated in local junction boxes for onward connection to the DDCMIS marshalling cabinets.

#### **5.4.18 Smart Transmitter Maintenance Station:**

Dedicated standalone PC based Smart Transmitter Maintenance Station (STMS) also called HART maintenance station, will be provided for centralized configuration, maintenance, diagnostic and record keeping of all electronic smart transmitters. Transmitter signals will be wired parallel to DDCMIS control system and HART modules of STMS, which will be connected to PC through suitable communication modules. Complete diagnostic, record keeping, calibration and configuration, event and log reports, historical database records of all transmitters will be possible from the STMS.

#### **5.4.19 Uninterrupted Power Supply (UPS) & Distribution:**

An uninterrupted power supply (UPS) system would be provided to cater to single phase, 50 Hz, 2 wire power supply requirements of instrumentation and control systems viz. man-machine interface equipment, analysers, instruments mounted on the unit control panel and other independent systems. For all system cabinets and operation hardware 24 V DC battery systems shall be envisaged. Any other voltages required shall be derived from the UPS source.

UPS system in redundant configuration will comprise of 2x100% redundant inverters of IGBT based, 2x100% redundant chargers, one battery set, static switches, bypass transformer and voltage stabiliser, manual bypass switches and AC distribution board etc.

One maintenance free Lead-Acid / Nickel Cadmium type battery set will be provided. The battery will be rated for a minimum period of one hour considering design margin of 15% and aging factor of 1.25. Each battery charger will be completely automatic and self-regulating type with quick boost and trickle charging capability. Boost charging unit will be rated such that the completely discharged battery can be fully charged in 10 hours.

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A stand by AC Power Source with bypass transformer and static voltage stabiliser unit with manual bypass switch will be provided as a back up to the inverters. Status monitoring facility of the UPS will be provided in the DDCMIS by hardwire connectivity.

**5.4.20 Final Control Elements:**

In general, control valves, dampers and other final control elements would be of pneumatically operated type except for HP / LP bypass and other critical valves, which will be of hydraulic operated type and Fan/Pump flow/speed control devices will be operated by electric/hydraulic actuating mechanisms. Control valves will have wide range of controllability, less noise and have adequate fail-safe feature.

Smart Positioners will be provided for pneumatically operated final control elements to interface with the DDCMIS. Each final control element will be provided with Smart positioners, electronic position transmitter of 4-20 mA output, air lock relay, air filter regulator, hand wheel, limit switches, solenoid valves and other accessories in accordance with the system requirements. In case of control signal or pneumatic supply failure, the final control element should go to fail safe position.

**5.4.21 Instrument & Special Cables:**

Individual / pair shielded and overall shielded twisted pair colour coded copper cables would be used for analog signals and overall shielded cables would be used for digital signals. All these cables are armoured. All the insulation including overall sheath would be FRLS quality. 1.5 sq. mm copper control cables shall be used for binary signals, and 2.5 sq. mm copper control cable would be used for cabling for services like field solenoid valve to the control system. 1.0 sq. mm instrument cables shall be used for analogue signals. Compensating cables will be provided for connecting the thermocouple inputs to the measurement system of DDCMIS. The interconnecting cables between any two cabinets and between cabinets and panels would be of prefabricated type. The communication bus of the DDCMIS would be coaxial / twisted pair cable.

Cable interconnection philosophy is to be adopted such that extensive grouping of signals at field will be done by use of junction boxes so that multi pair cables can be used from junction boxes to system cabinets.

Prefabricated cables would also be used for interconnection between DDCMIS Cabinets, CRTs, LVS, printers and operator stations and other related equipment.

**5.4.22 Maintenance & Calibration Instrument and (Instrument Laboratory):**

One set of Maintenance and Calibration Equipment for instrumentation and control systems, common for all Units of the plant will be provided. This would consist of calibration equipment such as electronic test bench, pneumatic test benches, dead weight tester, manometers, air sets, RCL Bridge, digital channel simulator, logic probe, testing meters / devices / calibrators for at site testing and calibration, etc.



#### **5.4.23 Instruments Air Supply**

I&C Systems will be supplied with adequate Instrument air supply from compressor, Air dryer Assembly. Moisture and oil free Instrument air at 6 Kg/cm<sup>2</sup> and minus (-) 40°C dew point will be used.

#### **5.4.24 Erection Hardware:**

All required installation hardware including impulse pipes, tubes, valves, manifolds, fittings, cable trays, holders, angles and conduits etc. required for proper installation and interconnection of instrumentation and control system shall be provided. All materials and installation thereof shall confirm to latest editions of American National Standard Code for pressure piping, ANSI B 31.1, ANSI B 16.11, ASME Boiler and Pressure Vessel codes, IBR and other applicable ASME, ANSI and local Standards.

### **5.5 CIVIL WORKS:**

#### **5.5.1 Soil Properties and Load Bearing Capabilities:**

Detailed Soil Investigation studies would be conducted at site and kind of foundation would be decided in the due course based on local soil strata.

#### **Seismic Considerations**

The power station is located under Zone- II as per IS: 1893 (part-I):2002 Analysis and design of structures to resist the seismic forces will be carried out as per the provisions of IS: 1893. The applicable importance factor of 1.50 will be considered during detailed engineering.

#### **Wind Loading**

The applicable design wind pressure will be computed during design of buildings and structures as per IS:875-18:802 for the zone in which the proposed power station is located. Design wind speed to be considered as 39 Km/hr. The applicable design wind pressure, appropriate coefficients for variation with heights and shape of structures will be considered.

#### **5.5.2 Power House Building Superstructure:**

The main power plant building comprising TG bay (A-B bay) and the adjacent electrical & deaerator bay (B-C bay) will be of steel framed construction up to the roof level. The floor slabs at intermediate levels will be of RCC and supported on steel beams & columns. The TG bay roof (A-B bay) and side cladding will be provided with 0.5 mm pre-colour coated PVF-2 galvalum high strength single skin metallic cladding. The deaerator bay (B-C bay) will have side cladding of brickwork (cement plastered with architectural finishes); B-row and C-row duly painted. Floor slabs and roof covering of B-C bay will be of cast in situ RCC construction. A-B bay will be equipped with EOT cranes. B, C, D row wall will be of bricks.

Roof will be provided with suitable drainage arrangement through rainwater down corners. doors, windows and rolling shutters will be provided.

All structural components will be shop welded while the field connections will be made with high-tensile bolts or welding as determined in design stage. The transverse frames will be of framed type. In the longitudinal direction, these transverse frames will be braced to resist horizontal forces.

#### **5.5.3 Special Foundation Requirements for Rotating Equipment:**

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

All rotating equipment will be provided with foundation isolated with adjacent foundations. The vibration isolation foundation system will be provided for, Turbine driven Boiler feed pumps, and Coal crushers.

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

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

Civil foundations will be designed to take into consideration soil bearing capacity and ground water table. Generally raft/spread foundations will be considered.

The minimum grades of concrete will be in accordance with appropriate class of exposure as per IS - 456 - 2000. Concrete grade for various works will be –

- M35 for decks of spring supported machine foundations and substructure.
- M30 Mechanical Foundation chimney shell and substructure of spring supported machine foundation.
- M25 structural RCC work in foundations and superstructures, water retaining structures and chimney raft foundation.
- M20 Grade slab & other miscellaneous items

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

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

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

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All building will be provided with 1500 mm wide and 150 mm thick plain cement concrete paving around on the outside. The plinth protection will be laid over prepared sub-base and base.

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

#### **5.5.4 Structural Steel Works:**

Structural works will be designed for dead-load plus adequate live-load plus worse of wind load and earthquake load with importance factor of 1.5 and seismic load as per IS 1893:2005 as applicable for zone-II.

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

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

RCC foundations for Turbo-generators, Boiler feed pumps, (as required) ID/FD/PA fans, coal mills and coal crushers will be provided with vibration isolation systems supporting the top RCC deck to support the machine/equipment.

#### **5.5.5 Water Retaining Structures:**

RCC Water retaining structures will be leak proof and designed as un-cracked section. The design will conform to IS:3370. In all liquid retaining structures, PVC water bar will be provided at each construction/expansion joint.

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

#### **5.5.6 Civil Works for Plant Water System:**

##### **1. Cooling Tower**

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Natural draft cooling tower for each unit to handle 90700 cu.m/hr water with leak proof underground basin and separation of whole basin in two parts by means of partition wall, internal platform arrangement, hot water duct system and CW channel etc. Suitable draining and pumping arrangement from the drain box outside is provided for sludge disposal. Cooling Tower will be RCC framed structure as per the requirement of BS:4485-1996 Part I to IV.

**2. Pre-treatment plant & overhead tanks for potable water/ service water**

Pre-treatment plant consists of required capacity clariflocculator along with Aerator, Filtered water reservoir, firewater sump, and pump houses, sludge deposition tanks etc. The design and construction of all these structure shall be based on IS:3370 part I to IV along with the provision of specified leak proof arrangement of structures.

**5.5.7 Civil Works for Coal Handling Area:**

Additional one Wagon Tippler, Crusher House and Stacker Reclaimer will be constructed. Conveyors galleries, supporting trestles and transfer houses will be of fabricated structural steel work. All components will be of welded fabrication with bolted/welded joints for erection and assembly in the field. Intermediate floors and roof in transfer houses will be of reinforced concrete supported on structural steel framing. Crusher foundation with vibration isolation spring system for isolating the crusher house building will be of RCC frame. Conveyor tunnels will be of concrete box section with provision of appropriate water proofing arrangement.

**5.5.8 Civil Works for Ash Handling Plant:**

The Ash collector & store system will be of RCC construction with RCC columns and beams. The ash hopper will be compartmentalized lined with abrasion resistant liners. Provision for suitable steel inserts will be made for installation of the pipes, valves etc. The facilities will have the provision for travelling crane of adequate capacity and lift. The blower/compressor room will be separate RCC construction in flat roof construction located close to ESPs to accommodate the blowers/ compressors with its auxiliaries.

Pipe rack for conveying the ash and water pipes to silos will be of structural steel framed construction having its columns mounted on the RCC foundations Foundation for collection tank, pipe rust structures and foundation for conveying system to silos and provision of installing composed air system will be provided.

**5.5.9 Civil works for Waste Water Management:**

As a part of waste water system management, adequately sized settling sump, oil water separator; settling pond; waste treatment plant sumps will be provided in RCC construction lined inside with suitable materials. Plant drainage system will be designed as per the area drainage pattern. The surface run off the power plant area and also the process water taken out buildings are taken to natural drainage system through a designed storm water drains through open drains, pipes.

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Plant rainwater drainage will be connected to the nearby existing natural drainage system.

For the main power plant building one no. with sufficient capacity of sewage treatment plant will be located in the vicinity and for other miscellaneous buildings indigenous septic tank and soak pit will be provided.

All the waste water from powerhouse building, boiler building chemical house etc. are taken to a common medium basin where water is separated from oil and other chemical in WWTP and necessary civil work like Lamellar clarifier, dry and wet sand pit etc. will be constructed as per IS:456 - 2002 and IS:3370 part I to IV.

**5.5.10 Civil works for Switchyard:**

Civil work for switchyard will consists of tower foundations, equipment foundations, foundations for lighting mass towers, control room building and cable trenches, roads drains and link fencing.

**5.5.11 Civil works for Chimney:**

One (1) no. Twin-flue RCC chimney having flues of steel with insulation (insulated outside the flue) will be provided. The height of the chimney as per CPCB will be 275 M. The chimney will be fitted with 500 kg capacity elevator, staircase inside the windshield of RCC slip form construction. Chimney will be fitted with pollution measuring apparatus & warning lights at top.

Chimney will be provided with lightning arrestor, aviation warning lights as per statutory requirement. The outside of the chimney shell will be painted with acid resistant cement paint. The top of the chimney shell will be painted with alternate red and white bands conforming to Aviation safety Standard requirement.

**5.5.12 Civil works for Township/Residential Colony:**

The township/residential colony is not a part of this proposal.

**SECTION: 6**  
**PROJECT IMPLEMENTATION**

## **6.0 PROJECT IMPLEMENTATION**

The Project Company will establish Project Management Systems for close monitoring of the Project for quality, schedule and environment. The project will cover activities on all fronts including conflict resolution, drawing necessary expertise and support from Implementation Consultants on regular basis.

The Project is proposed to be executed under Multiple EPC Contracts.

### **6.1 Project Implementation Schedule:**

The first Unit of 2x800 MW project is proposed to go in to commercial operation in 45 months from "Zero date" and for subsequent unit with a gap of 6 months. 'Zero date' is the date on which notice to proceed (NTP) will be issued to the EPC Contractors to commence construction of the project.

### **6.2 Project Management:**

The major phases of the project during its implementation are classified under the following heads:

- 1) Planning & Contract Packaging
- 2) Design, Engineering, Tendering & Contract award
- 3) Manufacturing, Inspection and Expediting Phase
- 4) Transportation/ Handling of Equipment
- 5) Construction/Erection and Testing/Commissioning
- 6) Operation & Maintenance and Manpower Training & Placement.

The Project will be managed by the Project Company under the overall direction and control of its Director. Full-time project management responsibility shall vest in the Vice President of the Project Company. The Project Company's site establishment shall be headed by a Construction Manager who shall be responsible for all site works.

### **6.3 Planning Phase:**

#### **6.3.1 Contract Packaging**

The Company intends to implement the project through a Multiple EPC (Engineering, Procurement & Construction) Contract. The EPC contract will cover complete mechanical, electrical, instrumentation and associated civil works including site development and approach roads but excluding colony.

KWPCL shall carry out pre-EPC preparatory works such as carrying out feasibility studies, construction power and arranging the same upto single point of plant boundary, carrying out soil investigation etc. KWPCL shall use existing site office & necessary facilities for proper monitoring & execution of project in scheduled time.

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Indicative scope of the packages envisaged is as below:

**EPC Package:**

EPC Package will include Steam Generator & Auxiliaries, Steam Turbine Generator & Auxiliaries, Power Cycle equipment including BFPs, CEPs, Regenerative system LP & HP Heaters, Deaerator, HP Piping, HP & LP Bypass Systems, Station C & I, plant electrical systems like Switchyard, HT & LT Transformers, HT/LT Switchgear also like Coal Handling System, Ash Handling System, DM Plant, CW/ACW System including Cooling Tower, Fire Protection System, Instrument & Process air system, Cranes & hoist, Plant Miscellaneous pumps, Piping and Systems; and Civil, structural and architectural work of the plant including Civil works for all equipment, all buildings in the plant, chimney, civil works etc.

EPC Contractor will establish a comprehensive reporting structure, which broadly includes:

- Management Reports – Progress Reports Daily and Monthly including Three month look ahead Planning, Exception Reports, etc.
- Quality Assurance and Control Programme – Shop and site
- Site Safety, Health and Environment
- Statutory Permits and Clearances

**Other Works:**

This will be carried out by KWPCCL through separate contractors / suppliers. This will include procurement of standard tools, mobile equipment, fire tender and construction of residential colony.

**6.3.2 Master Project Implementation Programme – Master Network:**

The Master Network identifies the key milestone dates for each package in the area of engineering, procurement, manufacturing, dispatch, construction, erection, testing & commissioning. The Master Network, which is the overall programme of the project implementation, will be finalized in consultation with the EPC Contractors and Implementation Consultant. The date of Notice-to-Proceed of the EPC contract will be the zero date of the Master Network.

**6.3.3 Engineering Consultant:**

The Engineering Consultant would undertake the various tasks related to the engineering, design. Apart from this, they would also provide necessary engineering back up support during construction, installation and commissioning at site.

The drawings and documents generated by the EPC Contractors would be reviewed and checked/ approved by the Consultant to ensure the following:



- Compliance to the contract requirements
- Compliance to the various local/ statutory authorities
- Correct design and technology
- Various interfaces amongst various systems / equipment / sub-contractors

#### **6.4 Tendering, Contracts & Engineering Phase:**

##### **6.4.1 Engineering, Planning, Monitoring & Control:**

The engineering services plan and the schedule of the project engineering activities, within the time frame specified for the engineering milestones is finalized in the Master Network. The engineering programme at Level-2 accordingly will show the dates for data availability, tender drawing release, specification release, bid evaluation and construction drawing release etc.

The schedule drawn up by each engineering discipline will also take into consideration the assistance from the Implementation Consultant.

Departmental reviews will be conducted by the Project Company Project Coordinators to evaluate the work actually performed vis-à-vis detailed schedules Milestones on a predefined frequency. Corrective action will be identified and the plans updated.

##### **6.4.2 Contracts Planning, Monitoring & Control:**

Based on the key event dates identified in the Master network, detailed plan for pre-award activities up to award of contract would be finalized and monitored vigorously.

When the EPC Contract is awarded, detailed programme in the form of networks is tied up with the EPC contractor to clearly indicate the owner's obligation and the EPC Contractor's responsibilities. The owner's inputs in terms of land availability, construction power/water availability, civil fronts etc. while that of the EPC contractor's in terms of drawing submission, manufacture, supply, transportation, erection and commissioning is clearly brought out in the program. Monthly progress reports including S curve are generated for monitoring & tracking purposes.

#### **6.5 Manufacturing, Inspection & Expediting Phase:**

##### **6.5.1 Inspection & Expediting:**

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

#### **6.5.2 Quality Assurance:**

An independent Quality Assurance Group for ensuring the quality during the project engineering, procurement and manufacturing, as well as during material storage is organized in the Corporate Office. Contractor would be asked to follow a comprehensive Quality Assurance and Control Programme developed by the Project Company/Consultant for the entire project. The quality control and assurance activities would be supervised by the Project Company/Implementation Consultant and / or through the appointed offsite approved agencies for shop as well as field activities.

Before the award of the contract the QA dept. shall discuss with the prospective EPC contractors and finalize mutually acceptable inspection programme and detailed quality plans. In the post-contract stage, the inspection reports generated by the inspectors are reviewed to evaluate the quality status with respect to the specified levels and necessary coordination of all actions necessary to ensure the achievement of the required quality levels.

The quality plans after discussions and finalization with the Contractor will form a part of the contract.

#### **6.6 Transportation / Handling of Equipment:**

The entrance of site is adjacent to National Highway 216. The nearest railway station (broad gauge) is located at Kirodimal at about 21 km away from the site. There are many heavy equipment to be transported to site, suitable road till site from National / State Highways as well as from nearest railway station, already developed.

The list of main equipment, which fall in the heavy category are Generator Stator, Generator Rotor and Generator Transformers, Deareator, HP Heater and Ceiling Girder.

Route survey already will be conducted by the EPC contractor for planning and implementation of transportation of all major equipment/materials.

#### **6.7 Construction & Commissioning Phase:**

##### **6.7.1 Construction Planning, Monitoring & Control:**

Site activities start progressively with the award of identified packages. Based on the Master Network Schedule (L1 network) prepared during the award of the EPC Contract, L-2 networks would be finalized, keeping in view the interface events required to be realized. Based on the L-2 network the Execution Group would initiate securing of required drawings in sequence for continuous progress of works at site.

##### **6.7.2 Project Review Team Meeting:**

A project review team headed by Director of the Project Company with members from the Head Office and site will be constituted to review the progress of project on a

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monthly basis or a predefined frequency. The meetings will review both pre-award and post-award progress of EPC contract in line to the project Milestone of their package.

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 will also be carried out during this meeting and shortfall, if any, will be identified and responsibility would be fixed to ensure correction.

**SECTION: 7**

**ENVIRONMENTAL ASPECTS**

## **7.0 ENVIRONMENTAL ASPECTS**

### **7.1 Environmental Aspects:**

In the proposed project, river water will be used in closed cycle circulating water system. Electrostatic precipitators of high efficiency and stack height as per CPCB norms etc. will limit the emission levels. As such, no undue problem is envisaged from installation of the power plant at said location from environmental aspect.

#### **7.1.1 Type & Source of Pollution:**

The various types of pollutions likely to be created by the proposed power plant, which has a socio economic impact, can be broadly classified into the following categories:

**Table – 8.1**

**Type & Source of Pollution**

<b>Sr. No.</b>	<b>Type of Pollution</b>	<b>Source of Pollution</b>
1.	Air Pollution	<ul style="list-style-type: none"><li>○ Dust particulates from fly ash in flue gas</li><li>○ Sulphur dioxide in flue gas</li><li>○ Nitrogen oxides in flue gas</li><li>○ Coal dust particles during storage/ handling of coal</li><li>○ Dust in the ash disposal area</li></ul>
2.	Water & Sewage Pollution	<ul style="list-style-type: none"><li>○ Waste water from water treatment (WT) plant</li><li>○ Steam generator blow down</li><li>○ Cooling tower blow down</li><li>○ Plant drains</li><li>○ Waste water from coal pile area run off</li></ul>
3.	Noise Pollution	<ul style="list-style-type: none"><li>○ Steam turbine generator</li><li>○ Other rotating equipment</li><li>○ Combustion induced noises</li><li>○ Flow induced noises</li><li>○ Steam valve</li></ul>

The proposed plant will be provided with necessary equipment and systems to meet all applicable environmental regulations. The plant has been envisaged to have the following features, which will help in reducing emissions and waste water:

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- Low NOx burners & SCR have been envisaged to reduce the NOx generation and consequent emission less 100 mg/Nm<sup>3</sup>.
- FGD has been envisaged to reduce the SOx generation and consequent emission less 100 mg/Nm<sup>3</sup>.
- High efficiency Electrostatic Precipitators has been envisaged to limit the particulate emissions to 30 mg/Nm<sup>3</sup>.
- One no. 275 mtr Height twin-flue chimney is envisaged for the plant, in line with the MoEF guidelines, which will help dispersion of air borne emissions over larger area and thus reducing the impact of the power plant on ground level concentrations.
- Closed cooling water system with cooling towers envisaged, thus reducing significantly the makeup water requirement for the plant.
- The Plant will be designed to treat all waste water that generated from plant. The waste water will be discharged as per the prevailing environment norms.
- Dust extraction and dust suppression systems have been envisaged in the coal handling plant.
- Adequate drift elimination system shall be provided on cooling towers to avoid the saline drift to the nearby areas.

**7.1.2 Pollution Monitoring and Control Measures:**

There are no ecologically sensitive or archaeologically important monuments in the area. Ministry of Environment and Forest (MoEF), have laid down procedures for environmental clearance for industrial projects including thermal power stations. The notification requires industry to carry out EIA study, in accordance with MoEF guidelines to determine the impact of new industry on the existing environment in respect of atmospheric and liquid pollutants and resultant air and water quality in the area to ensure their quality well within the prescribed limits. Separate EIA study would be carried out for the proposed project covering aforesaid issues.

Environmental Management Plan (EMP) is proposed to be established for the plant to detail out the environmental quality measures to be undertaken during the construction and operational phases. EMP will also discuss the post project monitoring measures to be adopted by the plant authorities in order to maintain the waste water qualities within the acceptable limits specified by the Chhattisgarh Environment Conservation Board and the Ministry of Environmental & Forests (MoEF).

The environmental monitoring programme will be provided with trained and qualified staff who will monitor the ambient air as well as stack flue gas quality to ensure that the quality of discharge gases are maintained within the permissible limit. The main stack will be provided with portable monitors to periodically monitor the PM, NOx and SO<sub>2</sub> constituents in the flue gas on continuous basis.

The plant waste water will be periodically analyzed on a weekly basis so that the waste water is maintained within the permissible levels of the pollution control board regulations.

The pollution control measures proposed to be adopted for the project are summarized as follows:

#### **7.1.2.1 Air Pollution:**

High efficiency Electrostatic Precipitators (ESP) will be installed to control the emission of ash particles. The precipitators would be designed to limit the particulate emission to less than 30 mg/Nm<sup>3</sup>.

In order to meet the guidelines of State Pollution Control Board for SO<sub>2</sub> emission, one (1) no. twin-flue chimney of 275 m height has been envisaged. The chimney would be provided with personal access for regular monitoring of stack emissions.

For the control of fugitive dust emission within and around the Coal handling plant, dust extraction and suppression systems will be provided. Dust suppression system will be installed at all the transfer points in Coal Handling Plant and at Coal stockyard. Dust extraction system would be provided in crusher house, and at Coal stockyard. Further in order to arrest the coal dust generation, all conveyers will be provided with enclosed galleries. The bottom portion of all the conveyors will be provided with seal plates within the power plant area and above roads.

During the construction phase, no significant impact on air quality is expected. However, fugitive dust emissions and NO<sub>x</sub> levels may temporarily increase in the immediate vicinity of construction site due to soil excavation and vehicular movement. Such impacts will be confined to the construction site. These will be minimized by sprinkling water and proper maintenance of vehicles. Green belt will be developed all around the plant periphery as per the norm laid down by MoEF to minimize dust nuisance outside the plant boundary.

Dust collection system with ventilation system having bag filters will be provided to evacuate dust and hazardous gases like Methane from the coalbunkers. Collected dust will be returned to coal bunker. The dust collector outlet emission will be restricted to 30 mg/Nm<sup>3</sup> to trap the dust in the bunkers.

Plant equipment and FGD design and operation will ensure SO<sub>2</sub> emissions are limited below 100mg/Nm<sup>3</sup>.

To control NO<sub>x</sub> emissions from the SG adequate technical measures will be adopted during the design & engineering stage. The latest available technology will be used to control these emissions. eg. Low NO<sub>x</sub> burners which generate NO<sub>x</sub> below 100mg/Nm<sup>3</sup> will be used in the Boiler.

#### **7.1.2.2 Ash Disposal:**

##### **Utilization**

Fly ash generated from the proposed power plant will be commercially utilized, to the extent possible, in one or more of the following industries: (i) cement, (ii) brick, (iii) fly

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ash, (iv) road making and paving, (v) agriculture, (vi) mine back filling and (vii) any other industry that is technically feasible. Apart from these uses, fly ash can be used for the construction of ash-pond dyke, reclamation of low-lying areas and such agricultural applications as soil conditioner and fertilizer.

The following strategies will be adopted to ensure full fly ash utilization in brick and cement block manufacturing:

- I. Fly ash will be supplied free of charge at the silos to brick and cement block factories.
- II. Basic technology, as well as initial expert advice for using fly ash in making bricks and cement blocks, will be provided to local brick and cement block makers free of charge.
- III. Seminars and workshops will be organized at the expense of KWPCCL to create market awareness for fly ash bricks and cement blocks in large cities.
- IV. The Chhattisgarh state government will be requested to provide certain financial incentives, in line with those provided by some other states, to brick and cement block makers, and to ensure the use of fly ash building materials in public works projects to the fullest possible extent.
- V. As the major constraint in spreading the adoption of fly ash building materials is the unreliability of fly ash supply to widely dispersed brick and cement block industries, the state government can be requested to provide valuable assistance by creating depots near large consumption centres under its auspices.

#### **Ash Disposal**

Additional 330 acres land for ash pond expansion is to be acquired near in contiguous to plant boundary.

Bottom ash, which normally contains more unburned carbon and clinkers, is not suitable for conversion into useful products and will be disposed to the ash disposal area.

#### **7.1.2.3 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.

The plant is expected to increase the noise level in the surrounding due to operation of plant and machinery. Necessary noise control and abatement measures will be adopted to minimize the noise level from the plant during construction and operation phase to a maximum of 85 dBA at a distance of 1 metre as per the requirement of OSHA (Occupational Safety and Health Administration) Standards.

The major sources of noise during the construction phase are vehicular traffic, construction equipment like dozers, scrapers, concrete mixers, cranes, generators, pumps, compressors, rock drills, pneumatic tools, saws, vibrators, etc. Also, all measures will be taken to limit the noise levels at the plant boundary within the stipulated limits.

To achieve the noise limitations around the equipment, the main measures taken shall be as follows:



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- Each feed water pump sets shall be covered by a separate enclosure,
- Each coal crusher shall be covered by a separate hood,
- Small units like condensate and vacuum pumps, shall be designed so as to limit noise emission,
- Bypass valve, the de-superheater 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 (such as printers) and the air conditioning system shall be designed so as to limit noise emission.
- During maintenance/inspection works, the personnel will wear ear protections.

To achieve the far field noise limitations, the following main measures shall be taken, as appropriate for that purpose:

- Steam vent pipes shall be fitted with silencers,
- The steam generator thermal insulation shall be designed to limit noise emission,
- The steam generator draught fans, the electrostatic precipitators and the air heaters shall be designed to limit noise emission,
- The main transformers shall be designed to limit noise emission.

An Environmental Impact Assessment Study shall be carried out to access the noise level limits to be kept at the proposed plant boundary considering the back ground noise level.

#### **7.1.2.4 Water Pollution:**

River water is required for makeup to the closed cycle re-circulation system of condenser cooling. It is proposed to utilise the power plant waste water for plant reuse to achieve minimum discharge concept. It is envisaged to install cooling tower blow down recycle plant to utilize part of cooling water blow down back to cooling tower and reject water for ash handling purposes and treated waste water from various sources for gardening. Rest of the waste water treated and the treated will be used for Plantation activities.

Streams of waste water emanating from the power station sources during operational phase will be treated individually based on the waste water quality. The treated waste water will be recycled for plant use and for green belt development. Therefore, there will be no impact on the ground water resources.

The major waste water generated from the plant like DM Plant discharge will be treated in a waste water treatment plant and recycled. No discharge of liquid waste to the other public boundaries is foreseen for the proposed power station. The coal pile area run off water during monsoon season will be led to a pond. Coal particles will

settle down in the pond and clear water will be allowed to overflow to the central monitoring basin for treatment.

In the power plant, some specific locations in TG / SG area require washing, to maintain good plant housekeeping and prevent build-up of dirt and waste material, which generates waste water. This waste water along with process drain will be led to an oil water separator for separation of oil. The clear water will be led to the central monitoring basin. The dirty oil will be recovered separately in a drum.

The rain (storm) water removed from the building roofs, non-process area and grade level surfaces will be directed through the open ditches and culverts to the storm drainage piping. The storm water from the storm water drainage piping shall be discharged outside the plant boundary. All ditches will be concrete lined and located along the roads. All drainage ditches will be located to provide the shortest practical drainage path while providing efficient drainage for the yard. Grade level will be contoured such that storm water run-off is directed on the ground by sheet flow, to well defined drainage paths leading to the ditches.

#### **7.1.2.5 Solid Waste Management:**

Sewage from various buildings in the power plant area will be conveyed through sewer lines to sewage treatment plant.

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

#### **7.1.2.6 Afforestation and Green Belt Development:**

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.

Extensive afforestation at plant area is planned along with a green belt development program in line with MoEF guideline which would not only act as lung space in the area but would also improve aesthetics and will be continued in all available space. As per the stipulations of MoEF, green belt will be provided all around the power plant boundary by planting trees and the total green area including landscaping area will be 1/3<sup>rd</sup> of the plant area.

#### **7.1.2.7 Storage of hazardous materials:**

Hazardous material anticipated to be stored at site during construction include petrol, diesel, welding gas, weld inspection material, radiographic material, paints, cleaning chemicals, DM plant chemicals etc. These materials will be stored in accordance with prescribed safety norms in ventilated enclosures. Safety instructions and signage will prominently be displayed at appropriate points/locations.

**7.1.2.8 Rehabilitation:**

The R&R of displaced families for additional 200 acres land required for Ash Dyke, shall be taken care by KWPCL.

**7.1.3 Rapid Environment Impact Assessment (REIA) Studies:**

Environment Impact Assessment (EIA) studies will be carried out and base line data will be collected. Rapid EIA Report will be prepared to identify the impact of the proposed power plant on the flora, fauna, human inhabitations, etc. in the surrounding area and prescribe mitigation measures.

Rapid Environmental Impact Assessment (EIA) report will elaborate the assessment of the impact on the environmental scenario around the proposed Power plant, with regard to the main environmental attributes viz., air, water, soil, noise, ground level concentration (GLC) and socio-economic conditions.

The success of any EIA study will primarily depend on the accuracy of assessing the baseline environmental situation prior to superimposing the predicted result on the ambient situation to arrive at the post project scenario.

The baseline environmental situation will be assessed with respect to land use, soil, demography and socio-economics, meteorology, hydrology, water quality, terrestrial ecology and aquatic ecology. Suitable remedial / mitigation measures will be incorporated in the plant, to comply with pollution control authorities norms.

**7.1.4 Post Project Environmental Management Plan:**

**Air Environment:**

The major source of air pollution is from combustion of coal, which results in release of SO<sub>2</sub>, NO<sub>x</sub> and PM.

Prediction for SPM is made taking into consideration the design efficiency of the ESP. It is observed that the emissions from the power plant, on implementation of the control measures, will be negligible. Increase in Ground Level Concentrations (GLC) of dust after installation of the power plant will be estimated by EIA Consultant to verify compliance with the GLCs within prescribed levels.

The predicted ground level concentrations of PM, SO<sub>2</sub>, NO<sub>x</sub> will also be verified within the limits of the National Ambient Air Quality standards prescribed for rural use.

Coal handling areas are potential sources of causing occupational health hazards such as asthma, tuberculosis and bronchitis. To control dust generation, dust suppression and dust extraction system will be provided at appropriate locations. In addition, frequent wash downs of these areas, with plant service water, will be undertaken.

SCR to be installed (if reqd.) for meeting the NO<sub>x</sub> emission norms & FGD to be installed to meet SO<sub>x</sub> emission norms.

**Noise Environment:**

The major sources identified as contributing towards noise pollution from the power plant are Compressors, Steam turbines, other rotating equipment, inlet & exhaust systems etc. However the impact of such noise on the neighbourhood is predicted to be negligible.

The turbine & generators will be provided with acoustic enclosures and housed in buildings that would considerably reduce the transmission of noise to the outside environment.

Noise levels will be periodically monitored and any corrective action taken.

#### **Water Environment:**

The common waste water treatment plant, which receives discharges from neutralization pit of DM Plant, clarified waste water from Oil Water Separator, etc will be designed to enable maximum re-use/recycling. The treated waste water will be utilised for plant consumptive requirements and for green belt development.

#### **7.1.5 Risk Assessment & Disaster Management Plan:**

##### **Risk Assessment:**

Environmental risks are inherent in design and operation of any power plant. Risk involves the occurrence or potential occurrence of an accident consisting of an event or sequence of events.

The main objectives of risk assessment are as follows:

- Identification of hazard prone area and estimation of damage distance for the maximum credible accident scenario visualized for storage.
- Computation of frequency of occurrence of hazards and evaluation of risks
- Recommendation of risk mitigation measures and arriving at a Disaster Management and Emergency Preparedness Plan.

Identification of hazards in a power plant is of primary significance in the analysis, quantification and cost effective control of accidents involving chemicals and process. Hence, all the components of a process/system/plant needs to be thoroughly examined to assess their potential for initiating or propagating an unplanned event/sequence of events, which can be termed as an accident.

As coal is subject to spontaneous combustion it may catch fire given the slightest opportunity. This fire hazard is greatly influenced by the amount of airflow through the mass of coal.

Thus, storage of coal would be designed in such a way that the air content in the coal pile is minimized. Dimension of the coal stack, particularly the height, is a very important parameter for making storage of coal safe and adequate care would be taken while designing the same.

Fuel oils LDO/HSD will be used in small quantity for initial start-up. Chlorine and other chemicals are used in the makeup water treatment & DM Plant. The hazards associated with the use of these materials would be taken careful consideration and due precaution would be taken for its safe handling at various stages of usage.

**Disaster Management Plan:**

A major emergency in a plant is one that has the potential to cause serious injury or loss of life. It may cause damage to property and serious disruption, both inside and outside of the plant. The disasters identified as most likely to occur in the power plant are:

- Fire at oil storage area
- Fire at coal storage area
- Toxic release of chemical

Hazard analysis has revealed that the damage distance is mainly confined to plant boundary only.

The main objective of the disaster management plan is to prevent or at least reduce the risk of accidents through design, operation, maintenance and inspection. An important element of accident mitigation is emergency planning, which would consist of:

- Recognising the possibilities and probabilities of each kind of accident
- Assessing the on-site and off-site implications of such incidents and deciding the emergency procedures that would need to be carried out.
- A number of elements makeup a good and workable disaster management plan. They are briefly discussed below:

**Identification and assessment of hazards:**

Experience has shown that for every occasion that the full potential of an accident is realized, there are many other occasions when some lesser event occurs or when a developing incident is made safe before reaching full damage potential.

**Procedure for personnel and equipment:**

This involves setting up of an emergency communication system, formation of an emergency response team and setting up of an emergency control centre.

It is essential that the emergency plans be regularly tested so that any defect may be corrected. The plan should be reviewed and updated and any changes made should be disseminated to all concerned.

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Emergency plan needs to consider emergency shutdown procedure so that phased and orderly shutdown of the plant & systems can take place when necessary.

Depending upon the methodology adopted for the co-ordination of various aspects of disaster management, specific responsibilities should be fixed for civil and government agencies. Outside agencies support is required for the emergency responses such as:

- Augmenting the firefighting service and firewater
- Emergency medical help for the injured personnel of the plant
- Evacuation of personnel
- Law enforcement, traffic control and crime prevention
- Co-ordination with other nearby industrial establishments
- Communication facilities
- Procuring fire-fighting consumables such as foam compound, fire hose, etc.

**Maintenance and Monitoring:**

The safety of a plant and function of safety related systems could only be as good as the maintenance and monitoring of these systems. It is of great importance to establish plant maintenance & monitoring schedule, which includes the following tasks;

- Checking of safety related operating conditions both in the control room and at site / on the field.
- Checking of safety related parts of the plant on site by visual inspection or by remote monitoring.
- Monitoring of safety related utilities such as electricity, steam, coolant and compressed air.
- Preparation of maintenance plan and documentation of maintenance work specifying the different interval and type of works to be performed.

In addition, the maintenance and monitoring schedule will specify the qualifications and experience required by the personnel to perform their tasks.

**Reporting to Authorities:**

In the management of a major hazard, in an installation, it is likely that the incident is to be reported to the concerned authorities. Reporting will be carried out in three steps.

- Identification/notification of a major hazard installation

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- Preparation of a safety report
- Immediate reporting of the accident

The safety report gives the authorities the following opportunities:

- To carry out specific inspection in order to learn about hazards arising from these installations.
- To establish contingency plans.

Emergency planning rehearsals and exercises will be monitored by senior officers from the emergency services. After each exercise, the plan will be thoroughly reviewed to take account of omissions or shortcomings.

Increase in concern of disaster management plans has prompted the Ministry of Environment and Forests, Govt. of India to make risk assessment and disaster management a mandatory requirement for the power industry.

**SECTION: 8**

**SYSTEM DESIGN AND O&M PHILOSOPHY**



## **8.0 SYSTEM DESIGN AND O&M PHILOSOPHY:**

### **8.1 Overall Requirement:**

The station will be designed to operate primarily as a base load station. Design of the plant will provide for the following;

- Capability of rapid unloading from full load to no-load conditions in the minimum possible time to minimize turbine cooling.
- Capability to achieve full load within the shortest possible time after synchronization, subsequent to an overnight shutdown (8 hours).
- The main plant, auxiliaries and associated systems & 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.
- The main plant control systems will be designed to permit participation in load frequency control in the event of system disturbances.

### **8.2 Design Philosophy:**

#### **8.2.1 System Design for high Unit availability**

The objective of high availability of the Unit and associated auxiliaries will be achieved by adopting the following principles for ensuring high PLF and low partial loading;

- Use of equipment and systems of design performance and high availability which has been fully established by a considerable record of successful operation for similar service conditions in coal fired utility stations.
- Use of only proven design concepts and conservative designs.
- Strict implementation of quality assurance norms during design, manufacture as well as installation and commissioning stage.
- Strict compliance with the project company approved pre-commissioning and commissioning procedures as well as standard checklists forming a part of commissioning documents for the project.

#### **8.2.2 Sizing of critical equipment- margins & redundancy/standby:**

Adequate margins will be provided while sizing all important auxiliaries and sub-systems to ensure operation of the Unit at full rated capacity under the worst conditions and taking into consideration normal wear & tear. In this regard, CEA regulations for construction of electrical plant & electrical lines shall be complied without any exception.

### **8.2.3 Design for efficient operation:**

The basic and detailed engineering will be carried out to ensure achievement of high standards of operational performance especially with respect to the following key indices:

- Low auxiliary power consumption.
- Low makeup water consumption.
- No oil support above 40% MCR operation with any combination of mills.
- Optimum efficiency and heat rates for the Units and sub-systems.

Provision would be made for accurate and reliable measurement of coal receipt, coal consumption per Unit, oil receipt & consumption per Unit, total DM makeup water production and makeup water consumption, flue gas oxygen content etc. Daily reports regarding receipt, consumption and stock position will be prepared. Also provision would be made for on-line calculations for the performance of the Units and their major-subsystems in the Data Acquisition System (DAS). The operation of the plant would be optimized and the performance of the plant would be reviewed on a regular basis.

### **8.2.4 Operation Performance Management System (OPMS):**

The operation of the plant will be optimised by implementation of OPMS. This system will clearly define the responsibilities of all key O&M personnel including the shift-in-charge. This will also cover the system of daily reporting to the Monitoring Group of Corporate Office and monthly O&M review meetings.

## **8.3 Operation & Maintenance Philosophy:**

In order to ensure a high level of performance of the power station, the operation and maintenance of the power station would be entrusted to experienced O&M Contractor.

In order to ensure that the design and construction of the power station incorporates all necessary features required for easy and efficient operation and maintenance of the proposed power plant, the proposed O&M Contractor would also be consulted during the review of package vendors, plant design features, operational and maintenance features of plant systems and equipment.

### **8.3.1 Maintenance Management System:**

The maintenance of the plant will be carried out as per the maintenance management system to be developed by the project company. This system would aim at maximising the availability of the generating Units while ensuring minimum maintenance cost and safety of plant & personnel. The system would cover organizational structures, preventive maintenance schedules, detailed work specifications covering all maintenance jobs, permit-to-work system, long term maintenance planning, safety aspects etc.

### **8.3.2 Spare Parts Management System:**

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.

### **8.3.3 Special Tools & Tackles:**

All equipment supply contracts will include the provision of supply of special tools & tackles, wherever required, for installation, commissioning, and maintenance of the plant & equipment. These will be handed over to the O&M department at the appropriate time after commissioning of the Unit.

### **8.3.4 O&M Training:**

An experienced O&M contractor will be placed at an early stage to introduce the best system and operational management and practices. O&M contractor will be assisted by a group of experienced technical personnel, to carry out the operation of the plant.

The O&M crew will be associated with the plant commissioning stage itself to get them fully familiar with plant. Suitable training schedule will be developed for this purpose.

### **8.3.5 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.

### **8.3.6 Coal Supply Management:**

The minimum requirement of coal will be based on operating norms. However, the monthly requirements will be finalized during the quarterly meetings with the concerned authorities or through the Coal Supply Agreements. The coal handling

plant of the Power Plant will be designed to meet the peak requirement on daily basis with adequate reserve capacity to take care of normal breakdowns and maintenance requirements.

#### **8.4 Employee Facilities:**

##### **8.4.1 General:**

Employees required for 2x800 MW Units in addition to existing O&M staff is estimated to be around 250 nos. excluding contract labour.

##### **8.4.2 In-Plant Facilities:**

The following facilities already exist in this station:

- i. Technical office
- ii. Construction offices and stores (at construction stage only)
- iii. Time and security offices
- iv. First Aid and fire fighting station
- v. Canteen and welfare centre
- vi. Toilets and change rooms
- vii. Car parks and cycle/ scooter stands
- viii. Training centre

Office space shall be provided as per good practice and canteens, toilets and restrooms according to norms laid down in relevant factories act. The above facilities shall also be adequately furnished and equipped.

##### **8.4.3 Colony:**

Township/Residential colony is not part of this proposal.

**SECTION: 9**

**PROJECT COST ESTIMATES AND FINANCIAL ANALYSIS**

## **9 PROJECT COST ESTIMATES AND FINANCIAL ANALYSIS:**

In this section project cost estimate has been worked out and fixed cost as well as variable cost of generation has been computed for the proposed project in order to assess overall financial viability of the project. For this purpose, a comprehensive financial model has been set up based on CERC guideline, representing a complete simulation of the Project with regard to technical and financial aspects.

### **9.1 Basis of Project Cost**

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

#### **9.1.1 Assumptions for Hard Cost Input**

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

- Total two (2) Units of 800MW capacity with super critical steam condition 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 with super critical steam conditions.
- 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.
- Contingency @ 5.0% has been considered on the cost estimate for EPC and Non EPC works.
- Cost of Transmission Project is not considered.

#### **9.1.2 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 2<sup>nd</sup> Unit.
- Working Capital - The rate of interest on working capital loan is assumed to be 11.00% p.a.

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- Taxes and Duties - Taxes and Duties have been considered as per prevailing rates.
- Exchange Rate - BTG components have been considered to be domestic.

## **9.2 Project Cost**

On the basis of assumptions discussed above, the estimated costs of the project amount to Rs. 11,200 Crores. The summary of break-up of the project cost is indicated in Table 9.1 below.

**Table – 9.1**  
**Project Cost Break Up**

<b>Particular</b>	<b>Estimated Cost</b>
<b>Land &amp; Site Development</b>	100.00
<b>Engineering, Procurement &amp; Construction Cost</b>	8000.00
<b>Water Arrangement</b>	50.00
<b>Coal Supply Arrangement</b>	50.00
<b>Total Hard Cost</b>	<b>8200.00</b>
<b>Preliminary &amp; Pre-operative Expenditure</b>	500.00
<b>Interest During Construction Period</b>	1500.00
<b>INSURANCE</b>	20.00
<b>Contingencies</b>	700.00
<b>Margin Money for working capital</b>	300.00
<b>Total Cost</b>	<b>11200.00</b>

(all figure in Rs. Crores )

The Project cost is estimated at Rs. 11,200 Crores & is proposed to be finance with senior debt, sub debt & equity in ratio of 70:30.

The proposed components of financing are:

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Particular	Rs Crores	%
Capital Contribution – Equity	3360	30
Debt Finance	7840	70
Total	11200	100

### 9.3 Phasing of Expenditure

Date of Execution work start at site has been considered as Zero Date. Financial Closure and BTG award shall be done prior to Zero Date. The quarterly expenditure for the Project cost including IDC has been spread for the Project Schedule of 50 months from Zero Date, considering the completion schedule of 44 months for the first Unit and within a gap of 6 months for subsequent units.

### 9.4 Cost of Generation & Tariff Calculation

The estimate for the cost of generation for the project has been arrived on the basis of following technical inputs and financial inputs.

#### 9.4.1 Technical Input Assumptions

Basic data for the purpose of estimation of operational expenses are as follows:

- Plant gross capacity has been considered as 2x800 MW.
- Plant load factor of 90 % has been considered
- Station heat rate of 2150 Kcal/kWh has been considered.
- Plant Auxiliary power consumption has been considered @ 7.5%.
- The gross calorific value (GCV) of coal has been considered as 3540 Kcal/Kg of design coal.

#### 9.4.2 Financial Input Assumptions

The following are the financial assumption in Tariff calculation:

##### Debt Structure

The repayment period of the proposed loan structure has been shown in the Table-9.2 below. No moratorium period has been considered.

**Table- 9.2  
Loan Structure**

Description	Unit	RTL
Interest Rate	%	12.50%
Repayment Period	Years	10
Repayment Mode	Instalments	Quarterly



### **Return on Equity**

ROE has been considered as 15.5% (as per CERC Norms).

### **Working Capital**

Working Capital covers the following:

- Coal costs for 2 months
- Secondary fuel cost for 2 months
- O&M expenses for 1 month
- Maintenance spares, 1% of Project Cost, annually escalated @ 6%

### **O&M Expenses**

Annual fixed operation and maintenance cost has been considered as Rs. 2.0 million per MW of generation as first year of operation and escalated at the rate of 6.27% per annum as per CERC norms.

### **Fuel Cost**

Domestic Coal is considered for the plant. Coal cost is considered as Rs. 2500 per Ton including the transportation cost. The escalation rate of 3 % per annum is considered on the coal cost. Secondary fuel cost is considered as Rs. 48000 per KL with an escalation of 3 % per annum.

### **Depreciation**

5.28 % of EPC cost for first 12 years after COD and 2.05% for balance 13 years using straight line method along with Advance against Depreciation (AAD) as per CERC norms. The economic plant life has been taken as 25 years for depreciation calculation as per CERC norms, with addition of 10 years by R&M between 20 to 25 Years.

### **Taxes & Duties**

The rates of corporate tax has been considered as 32.4450% as per the latest notifications. Corporate tax, though not included in the component of tariff as per CERC norms, has also been considered to arrive at the post tax tariff (net saleable tariff).

#### **9.4.3 Tariff Calculation**

In accordance with CERC guidelines

**SECTION: 10**

**PERMITS AND CLEARANCES**

## 10.0 PERMITS AND CLEARANCES

Certain permits and clearances are required to be obtained by KWPCCL from different Government and Statutory Agencies at various stages of development phase of the project. These are classified into two broad categories known as statutory and non-statutory clearances. The list of clearances/permits required for the project and their status is as under:

**Table 10.1  
Statutory Permits and Clearances**

Sr. No.	Description	Authority	Status
1	Registration of the Company	Not Required	Korba West Power Company Ltd (KWPCCL) is already registered
2	Water availability	WRD, GoCG	Additional water required for 2x800 MW will be 36 MCM. Allocation of 23MCM is available. Application of Additional 13MCM to be submitted.
3	NOC for setting of Facility - Pollution clearance (Water & Air)	State Pollution Control Board	KWPCCL will do the needful once the EIA Report is ready.
4	Environmental Clearance	Ministry of Environment & Forests (MOEF), GoI	KWPCCL will apply for Environmental Clearance
5	Forest clearance	State Forest Dept. / MOEF, GoI.	Shall be taken up subsequently, if any
6	Civil aviation clearance for Chimney height	Airport Authority of India	Once location of chimney is finalised, KWPCCL will apply for clearance.
7	Rehabilitation and Resettlement of displaced families by land acquisition	State Govt.	The R&R of displaced families for additional 330 acres land required for Ash Dyke, shall be taken care by KWPCCL.

**Table 10.2**

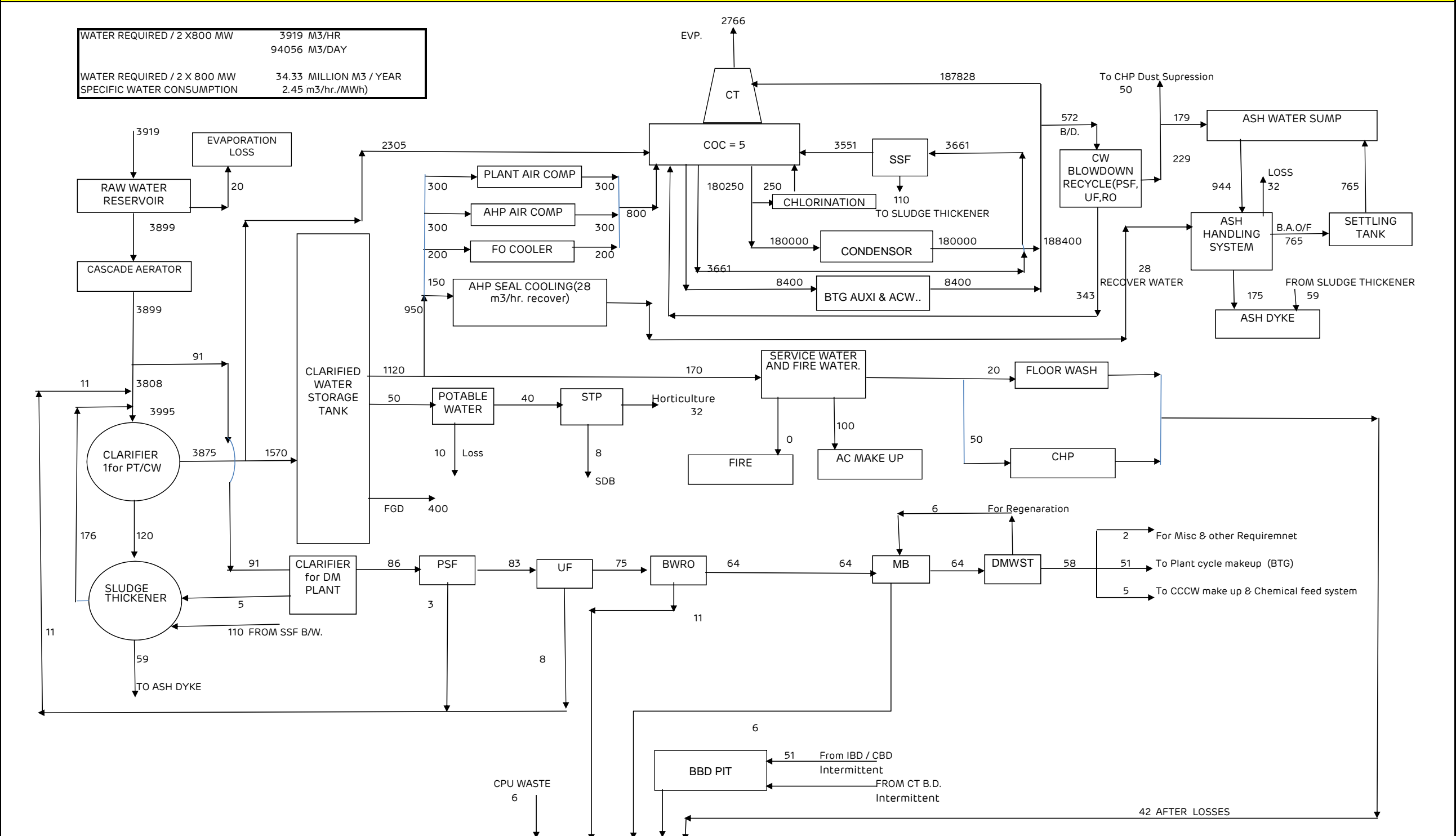
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**Non - Statutory Permits and Clearances**

<b>Sr. No</b>	<b>Description</b>	<b>Authority</b>	<b>Status</b>
1	Land availability		Presently 889.9 acres land is available. Expansion by further 2x800MW can be taken up within the same available land. However for expansion of ash dyke further 330 acres of additional land may be required.
2	Fuel Linkage	Domestic Coal	Domestic coal shall be used for this Project.
3	Transportation of fuel	Indian Railways Transport Agency	KWPCL shall transport coal directly to CHP within the plant premises.
4	Clearance from Archaeological department	Not Required	Not required, as no archaeological / religious monument / site is located in the close vicinity.
5	Import Licences & Formalities	Controller of Import Authorities	Will be applied after selection of EPC contractor.

<u>PRELIMINARY WATER BALANCE DIAGRAM</u>	
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**NOTE :**

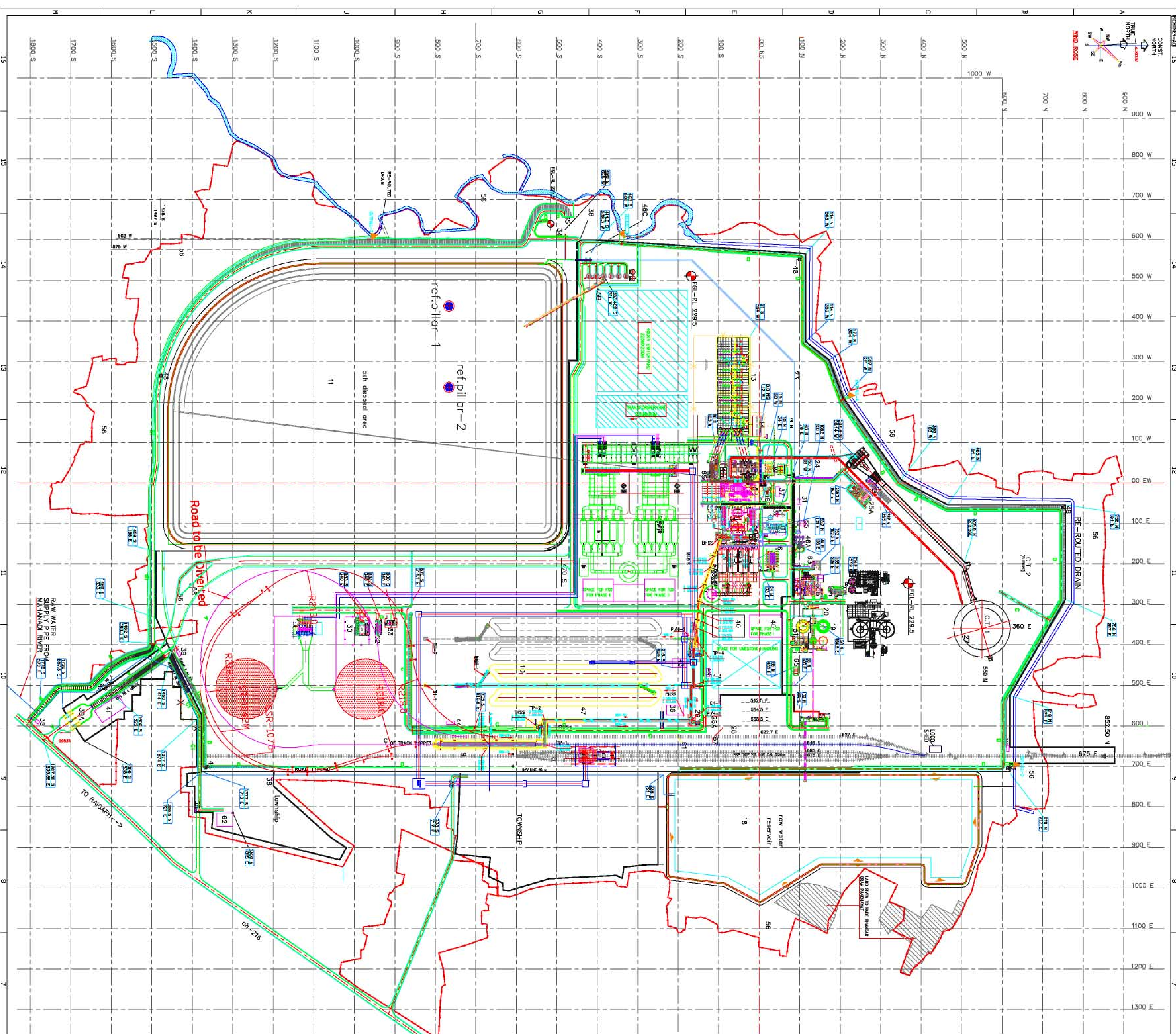
1. COC Considered is 5
2. All flows as shown of are weighted average figure.
3. Temp diff across condensor will be 9.0 degree, evaporation loss calculated for 9.5 degree and across the CT is considered 10 degree
4. BMCR Flow considered is 2525 TPH
5. All units are in M3/Hr
6. Plant cycle make up is considered as 1% on BMCR However WTP will be designed for 3% BMCR
7. Drift loss considered is 0.02%
8. Total dissolved solids considered as max. 400 ppm
9. Total suspended solids considered as max. 400 ppm
10. In case of 100% fly ash utilization, Bottom ash will be disposed from hydrobins to ash dyke through truck. Water consumption may vary based on coal quality
11. HCSD system is considered for both fly ash and bottom ash disposal.
12. Station Heat Rate : 2150 Kcal/KWH, GCV: 4200 Kcal/kg, %Ash: 30%
13. To optimize water consumption CW Blow down recycle is considered.
14. Lime based FGD system is considered for water requirement estimation.

**NOTE :**

1. COC Considered is 5
2. All flows as shown of are weighted average figure.
3. Temp diff across condensor will be 9.0 degree, evaporation loss calculated for 9.5 degree and across the CT is considered 10 degree
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		RELEASE STATUS		DATE	PROJECT -2x800 MW Korba West Power Company Limited (Phase-II)				
		√	Preliminary	19.10.2015	<div> KORBA WEST POWER COMPANY LIMITED</div>				
			For Information						
			For Approval						
			For Construction						
Rev no.	Drawn by	Checked by	Approved by	DATE					
P0	DSS	NKP	PR	19.12.2015	WATER BALANCE DIAGRAM				
P1	NP	PR	PR	01.02.2016					
					Dwg no. - KOR2-E-GEN-WBD-BM-I-I-001			Sheet 1 of 1	REV A





NO.	DESCRIPTION
1	STEAM TURBINE BUILDING
2	CENTRAL CONTROL BUILDING
3	STEAM GENERATOR AREA
4	ELECTROSTATIC PRECIPITATOR
5	ELECTROSTATIC PRECIPITATOR CONTROL ROOM
6	WATER TREATMENT PLANT
7	WATER TREATMENT PLANT CONTROL ROOM
8	WATER TREATMENT PLANT
9	RAILWAY MARSHALLING YARD
10	CRUSHED COAL STOCK PILE
11	ASH DISPOSAL AREA
12	TRANSFORMER YARD
13	SWITCH YARD
14	SWITCH YARD CONTROL ROOM
15	SWITCH YARD
16	PLANT WATER TREATMENT & PWT WATER PLANT/HOUSE
17	PLANT WATER TREATMENT & PWT WATER PLANT/HOUSE
18	PLANT WATER TREATMENT & PWT WATER PLANT/HOUSE
19	PLANT WATER TREATMENT & PWT WATER PLANT/HOUSE
20	CLARIFIED WATER STORAGE TANK/PUMP HOUSE
21	DM PLANT
22	DM STORAGE TANKS
23	ASH PIERHEAD
24	C.W. PUMP HOUSE
25	C.W. PUMP HOUSE
26	CHEMICAL TREATMENT BUILDING
27	2500 SPS STEAM FILTRATION
28	2500 SPS STEAM FILTRATION (LOCATED IN T-6 AREA)
29	2500 SPS STEAM FILTRATION
30	2500 SPS STEAM FILTRATION
31	2500 SPS STEAM FILTRATION
32	2500 SPS STEAM FILTRATION
33	2500 SPS STEAM FILTRATION
34	2500 SPS STEAM FILTRATION
35	2500 SPS STEAM FILTRATION
36	2500 SPS STEAM FILTRATION
37	2500 SPS STEAM FILTRATION
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COORDINATES OF REFERENCE PILARS	
REF. PILLAR-1	REF. PILLAR-2
GPS	GPS
COORDINATES	COORDINATES
AS PER DRAWING	AS PER DRAWING
COORDINATES	COORDINATES

- NOTES:**
- ALL COORDINATES ARE IN METERS.
  - COORDINATES 0.0 NS AND 0.0 EW REFERS TO COLUMN NO. 01 AT STEAM TURBINE BUILDING WHICH CORRESPONDS TO GPS COORDINATES N=2206250.0, E=723150.0.
  - POWER HOUSE FINISHED GRADE FLOOR LEVEL, E.L. 0.0M SHALL BE 300MM ABOVE FINISHED GRADE LEVEL, WHICH CORRESPONDS TO RL 228.5M.
  - WIDTH OF THE ROADS EXCLUDING PAVEMENTS & DRAINS SHALL BE AS FOLLOWS:
    - A) MAIN ROADS (10M WIDE)
    - B) OTHER ROADS (7.5M WIDE)
    - C) PERIPHERAL ROADS (5M WIDE)
    - D) PERIPHERAL ROADS (4M WIDE)
    - E) PERIPHERAL ROADS (3M WIDE)
  - FINISHED TOP OF ROADS SHALL BE 250MM ABOVE SURROUNDING AREA GRADE LEVELS.
  - PIES/CURB MARKS SHALL HAVE MINIMUM CLEARANCE OF 6.5M FROM TOP OF RAIL/ROADS AT CROSSINGS.
- LEGEND:**
- COMPOUND WALL
  - FENCING
  - RAILWAY LINE
  - EXISTING DRAIN
  - RE-ROUTED DRAIN
  - BLACK TOP ROAD WITH SHOULDER
  - CONCRETE ROAD WITH DRAIN
  - GREEN BELT
  - PIPE BACK
- REF. DRAWINGS:**
- TOPOGRAPHIC SURVEY FOR THE PROPOSED POWER PLANT AREA NEAR RAILWAY (C/S) - SEC/AN/SIN/RY/RA/FT/03
  - TOPOGRAPHIC SURVEY FOR THE PROPOSED POWER PLANT AREA NEAR RAILWAY (C/S) - SEC/AN/SIN/RY/RA/FT/04
  - KEY PLAN OF ROADS - 0.00-0.00-7514
  - EQUIPMENT LAYOUT PLAN AT EL. 0.0M - PE-00-330-10-0003

FIGHTER	
KORBA WEST POWER COMPANY LIMITED	
CHATTISGARH	
1 X 600 MW+2X800MW KWPCL RAIGARH PROJ	
CHATTISGARH	
PLOT PLAN	
DWGNO. 10-3170830002-M-004	
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