

**PRE FEASIBILITY REPORT**

**3200 MW (4 x 800 MW) KATNI THERMAL POWER PROJECT**

**DIST. KATNI, MADHYA PRADESH**

**Developer:**

**WELSPUN ENERGY MADHYA PRADESH LIMITED**

**Pre-Feasibility Report  
4 x 800 MW Katni Thermal Power Project**

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**SECTION: 1**  
**EXECUTIVE SUMMARY**

## **1. EXECUTIVE SUMMARY**

### **1.1 Introduction:**

Madhya Pradesh (MP) is a state in central India. Its capital is Bhopal, and the largest city is Indore. It borders the states of Uttar Pradesh to the northeast, Chhattisgarh to the southeast, Maharashtra to the south, Gujarat to the west, and Rajasthan to the northwest.

With an area of 3,08,252 sq. km., Madhya Pradesh is the second largest state in the country by area, and with a population of 72.59 million (as of 2011), it is the sixth largest state in India by population. The State has a population density of 236 per sq. km. The population growth rate over the decade ending in 2011 was 20.3%.

The state has 51 Jila (district) panchayats, 313 Janpad panchayats/blocks, and 23043 Gram (village) panchayats. The municipalities in the state include 14 Nagar Nigams, 86 Nagar Palikas and 238 Nagar Panchayats.

The State has an agrarian economy. The major crops of Madhya Pradesh are wheat, soybean, gram, sugarcane, rice, maize, cotton, rapeseed, mustard and arhar. Minor Forest Produce (MFP), such as tendu leaves used to roll beedi; sal seed, teak seed, and lak also contribute to state's rural economy.

Madhya Pradesh has 5 Special Economic Zones (SEZs): 3 IT/ITeS (Indore, Gwalior), 1 mineral-based (Jabalpur) and 1 agro-based (Jabalpur). Because of the state's central location, a number of consumer goods companies have established manufacturing bases in MP. Further, Madhya Pradesh has 6 Ordnance Factories, 4 of which are located at Jabalpur (Vehicle Factory, Grey Iron Foundry, Gun Carriage Factory, Ordnance Factory Khamaria) and one each at Katni and Itarsi. The factories are run by the Ordnance Factories Board, and manufacture a variety of products for the Indian Armed Forces.

Madhya Pradesh's gross state domestic product (nominal GDP) for 2010–11 was Rs. 2,600 billion. The per-capita figure was US\$ 583. Between 1999 and 2008, the annualized growth rate of the state was very low: 3.5%. However, subsequently, the state's GDP growth rate has improved significantly, rising to 8% during 2010–11 and 12% during 2011–12. M.P. recorded a GDP growth of 11.08% for 2013-14, which was ahead of the major states of the country. With an expected increase in investment and several initiatives taken by the government of MP, the State is likely to register sustained robust growth of around 12% (annual average) during the current decade (2011-20). It is therefore imperative for capacity addition in the power sector to aid sustained economic growth of Madhya Pradesh.

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. In view of above, Welspun Energy Madhya Pradesh Limited (WEMPL) intends to enter into a MoU with the Government of Madhya Pradesh and also to file an application with the Ministry of Coal, Govt. of India for suitable coal linkage/captive coal block for the proposed project.

Power generated by the Project shall be used to meet the power requirement in the state of Madhya Pradesh and the balance power would be sold to the neighboring states.



### **1.1.1 Company Highlights:**

Welspun Energy Ltd (WEL) is an independent power company based in New Delhi, India. It is a subsidiary of Welspun Group, a multinational company whose core industry is Steel, Energy, Oil & Gas, and Textiles. Welspun is one of India's fastest growing conglomerates doing business in over 50 Countries with 24,000 employees and over 100,000 shareholders, with revenues in excess of USD 3.5 Billion (as of 2013). Its clients include Fortune 500 Companies operating in Oil & Gas and retail sector such as Chevron, ExxonMobil, Walmart, and Target.

The company is aiming to commission 1,700 MW of solar and wind power projects across India by 2016. Welspun Energy has also plans to participate in government's program of setting up 4000 MW solar ultra-mega power projects. WEL's solar projects are situated in high radiation sites in states like Rajasthan and Gujarat.

In March 2013, the company commissioned the 50-MW Phalodi solar plant, which that time was the largest solar plant in India. In December 2013 the company commissioned 8 MW solar project in Karnataka. In February 2014, it inaugurated the 151-MW Neemuch solar project in Madhya Pradesh, which is the India's largest and among the world largest solar-power plants. Together with the Maharashtra State Power Generation Company WEL develops a 50 MW solar power plant at Baramati in Pune district. The company aims to develop a total of 550 MW solar capacities in Karnataka, 100 MW in Andhra Pradesh, and 150 MW in Punjab.

Welspun aims to foray into large-scale thermal power generation by developing supercritical technology based 3,200 MW Katni Thermal Power Plant in Madhya Pradesh.

It is expected that Welspun Energy Madhya Pradesh Limited (WEMPL) will be able to ensure sale of power generated at the proposed Katni 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) and State Grid Authority shall be firmed up.

The Pre-Feasibility Report has been prepared in house.

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, Madhya Pradesh is a part of Western Region.

**Pre-Feasibility Report**  
**4 x 800 MW Katni Thermal Power Project**

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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 adjoining states.

### **1.2.2 Basic Requirements:**

Major considerations for selection of the site for establishing the proposed 4 x 800 MW Super Critical TPS :

- **Fuel Requirement @ 90% PLF:-**
  - Coal : 18 MMT per annum on Domestic coal
  - HSD/LDO : 14000 KL per annum
- **Water Requirement:-**
  - Water : 60 MCM per annum
- **Land Requirement:-**
  - The proposed units will be installed over 1220 Acres of land.
- **Construction Facilities:-**
  - Construction Water required for potable & service purposes shall be arranged from bore-wells/local sources.
  - Construction power supply shall be initially arranged through DG sets and subsequently will be drawn at 33kV from Barhi Substation, located approx. 5 KM from Site.

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. 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 Domestic coal for this Project. Any shortfall will be made up by using Imported Coal from Australia/South Africa/Indonesia. The Indian coal from allotted coal linkages will be transported through railway to the proposed site. The coal handling system of the proposed power project will have the capacity of 4600 TPH and suitable crushing, stacking, reclaiming & feeding system will be provided. Coal storage of 10 days requirement shall be kept in plant.

A wet extraction and disposal system is considered for bottom ash and a dry extraction and dry & wet disposal system is considered for the fly ash for the station.

**Pre-Feasibility Report**  
**4 x 800 MW Katni Thermal Power Project**

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Ash utilization will be as per MOEF guidelines. It is proposed to use ash for the manufacturing of cement, building material, road construction etc.

Provision for installation of FGD shall be kept for any future requirement.

The condenser cooling shall be done by closed cooling system and the cooling water will be drawn from Bansagar reservoir.

The proposed electrical system will be provided with adequately sized equipment and with optimal redundancy to ensure uninterrupted operation of the plant. Electrical equipment and systems are discussed and described in Section - 5.3 of the report. A 400KV 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 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 50 mg/Nm<sup>3</sup>. Two (2) Nos Twin flue 275 m high stack 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 debt-equity ratio of capital structure is 70:30. The Project Cost with Interest during Construction (IDC) is estimated at Rs. 19,200 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 42 months from the NTP (Notice to Proceed) to EPC Contractor and subsequent units shall be commissioned within a gap of 6 months thereafter.

**SECTION: 2**

**PROJECT HIGHLIGHTS**

## **2. PROJECT HIGHLIGHTS**

<b>Owner</b>	: Welspun Energy Madhya Pradesh Limited (WEMPL)
<b>Plant Capacity</b>	: 3200 MW
<b>Plant Configuration</b>	: 4 X 800 MW
<b>Location</b>	: Nearest Village : Bujbuja : Nearest Railway Station : Katni (30 KM) : Nearest Airport : Jabalpur (150 KM) : Nearest Sea Port : Dhamra Port (1028 KM)
<b>Seismological Information</b>	: ZONE – III as per IS 1893 (Part-I) : 2005
<b>Land for the Project</b>	: Village Bujbuja in Barhi Taluka, Katni Distt., Madhya Pradesh
<b>Source of water</b>	: Bansagar Reservoir, Approx. 10 KM from site.
<b>Water Requirement</b>	: 60 MCM
<b>Cooling System</b>	: Closed cycle cooling system using river water from Bansagar Reservoir.
<b>Primary Fuel</b>	: Domestic coal
<b>Coal requirement</b>	: 18 million metric tonnes per annum @ 90% PLF (GCV -3300 Kcal/Kg, Ash – 40% (Max), Sulphur - (0.5% Max), SHR – 2150 Kcal / kwh)
<b>Support Fuel &amp; Source</b>	: LDO/HSD from nearest refinery/oil depots by Rail/Road.
<b>Support fuel (HFO/ LDO)</b>	: 14,000 KL per annum (0.5 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 800 MW at generator terminals.
<b>Steam Generator</b>	: 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.
<b>Station Operation Philosophy</b>	: Base Load
<b>Chimney</b>	: 2 Nos. 275 meter high Twin flue RCC chimney
<b>Power Evacuation</b>	: By 400 KV system to Madhya Pradesh State and other utilities depending upon the requirement of the purchaser.

**Pre-Feasibility Report**  
**4 x 800 MW Katni Thermal Power Project**

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**Total Project Cost including IDC** : Rs 19,200 Crores (Approx.)

**Cost per MW** : Rs. 6.00 Crores (Approx.)

**Zero Date** : **Notice to Proceed to EPC Contractor**

**Project Completion Schedule from the Zero date** :

- Unit-1: 42 months
- Unit-2: 48 months
- Unit-3: 54 Months
- Unit-4: 60 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 253.3 GW in Aug'14, with a contribution of 69% 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.

One of the reasons for setting up capital intensive industries is to promote self-reliance in the production of essential raw materials, such as steel, cement, petroleum products, fertilizers, etc., which sustain downstream industrialization, creating employment potential and national growth. In the recent past, core sector industries have failed to achieve the target production rate due to shortage of inputs, particularly electrical power, which is one of main factors inhibiting the attainment of production targets. In the environment of existing energy crisis, any planning to obtain satisfactory and economic operation of core sector industries should concentrate on adequate availability of electrical power, which is restricted in the country to a large extent at present. The demand for electrical power is expected to outpace the supply for a considerable period of time. It should also be noted that increasing emphasis has been laid on the mechanization of agricultural operation, which in addition to expansion in the industrial sector, would lead to higher demand.

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 800 MW set size and assured availability of sufficient fuel at a competitive price, WEMPL 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 400 kV / 765 kV 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.



**Pre-Feasibility Report**  
**4 x 800 MW Katni Thermal Power Project**

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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
- 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

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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.

### 3.4.2 Present Status of Demand & Availability:

A review of the statistics reveals that during the year 2013-14, the country witnessed an energy shortage to the tune of 4.2 % and peak demand shortage of 4.5%. 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 6,103 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.

### 3.5 Power Scenario in Madhya Pradesh

For the purpose of power planning and grid management, Madhya Pradesh is a part of Western Region. The total Installed capacity of Power Utilities as on 31.08.2014 with break-up in Western Region and in Madhya Pradesh in particular is as follows:

**Table 3.1**

	Thermal				Nuclear	Hydro	RES (MNRE)	Grand Total
	Coal	Gas	Diesel	TOTAL				
<b>WESTERN REGION</b>	58,859	10,915	17	69,792	1,840	7,447	11,271	90,351
<b>MADHYA PRADESH STATE</b>	8,968	257	NIL	9,226	273	3,223	886	13,609

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

As per 18<sup>th</sup> Electric Power Survey of CEA, the electric energy requirement in the State of Madhya Pradesh for terminal years of the 11<sup>th</sup>, 12<sup>th</sup> & 13<sup>th</sup> Plan periods have been projected as follows:

**Table 3.2**

Plan Period	Energy Requirement (MU)	Peak Demand (MW)
11 <sup>th</sup> Plan year ending 2011-12	49,878	8,897
12 <sup>th</sup> Plan year ending 2016-17	77,953	13,904
13 <sup>th</sup> Plan year ending 2021-22	1,07,060	18,802

In view of the robust economic growth of 12% the State is expected to witness in the foreseeable future and considering and the schemes for capacity addition taken-up, it

is apparent that capacity addition to the tune of at least about 5,000 MW would be required within this decade to meet the projected maximum demand of the terminal year of the 13<sup>th</sup> plan.

### **3.6 Choice of Fuel**

It is proposed to use domestic coal for this Project. The Indian coal from allotted coal linkages will be transported through railway to the proposed site.

### **3.7 Station Configuration**

The proposed station is planned for total capacity of 3200 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 800 MW 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 four (4) units of 800 MW is considered preferable. These units 800 MW set size have favorable heat rate at high plant load factor and reasonably low operating cost. Several power projects are in service or under implementation with 800 MW units. As such, availability of skilled operating personnel from other thermal power stations in the country render definite advantage in favour of 800 MW sets.

In the light of the above, configuration of 4x800 MW is considered appropriate for the proposed power station.

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

In the recent past, the state's GDP growth rate has improved significantly, rising to 8% during 2010–11 and 12% during 2011–12. M.P recorded a GDP growth of 11.08% for 2013-14, which was ahead of the major states of the country. With an expected increase in investment and several initiatives taken by the government of MP, the State is likely to register sustained robust growth of around 12% (annual average) during the current decade (2011-20). This process of industrialization is expected to further boost the demand for power in the state. Moreover, open access provision of

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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 have decided to establish the power plant of installed capacity 3200 MW.

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:**

The proposed four (4) units of 800 MW will be installed over 1220 Acres of land. The required land is in possession of WEMPL.

**Water:**

The Water requirement for the Project will be met from Bansagar Reservoir, which is located about 10 Kms from the Power Plant site. Water Resource Department, Govt. of Madhya Pradesh has allocated 60 MCM per annum water from Bansagar Reservoir for the proposed power plant.

**Coal:**

The requirement of Coal for the project will met from domestic source.

**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 400 kV voltage level as specified by the STU.

**SECTION: 4**

**PROJECT DETAILS**

## **4.0 PROJECT DETAILS**

### **4.1 Accessibility:**

The Project site is located near Village Bujbuja of Katni District in Madhya Pradesh. Latitude: 23° 54' 0.62" N to 23° 55' 13.83" N and Longitude: 80° 45' 21.61" E to 80° 46' 44.49" E

The Project site is located adjacent to the SH-10 and SH-11 (Within 2 Km from Site boundary).

The nearest railway station Katni is located approx. 30 KM from Site.

### **4.2 Land for the Project:**

The proposed 4 X 800 Thermal Power Plant will be installed over 1220 Acres of land, which is in possession of WEMPL

<b>Details</b>	<b>Area in Acre</b>
Plant Area	422
Reservoir	52
Green Belt	403
Miscellaneous buildings, store, Road etc.	81
Ash Dyke	230
Township	32
<b>Total</b>	<b>1220</b>

Since the site is located nearer to the Highway and railway lines, all infrastructural facilities like access road, railhead, clear means of receiving coal, etc. are available nearby the site. Other technical aspects like wind direction, soil characteristics also have been taken into consideration while developing the Plant Layout.

### **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. Any shortfall will be made up by using Imported Coal. Coal from International market will be procured from countries like Indonesia, South Africa, Australia and other possible sources. WEMPL at appropriate time shall apply for allocation of coal linkage and the same will be transported to the project site by Railway wagons. Coal storage of 10 days requirement of coal is proposed at the power plant.

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The annual requirement of coal is estimated at about 18 MMTPA for the four (4) units of 800 MW, considering a gross calorific value of 3300 kcal/kg at 90% plant load factor and station heat rate of 2150 Kcal/Kwh. The coal shall have Ash Content of 40% (Max.) and Sulphur content below 0.5%.

**b) Start-Up Fuel**

The boiler will be designed for cold start-up and initial warm-up using Light Diesel Oil (LDO)/ Heavy Fuel Oil (HFO) / High Speed Diesel (HSD). HFO/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) for cold start up and Heavy Fuel Oil (HFO)/ High Speed Diesel (HSD) for load stabilization is estimated to be around 14,000 KL per annum.

**4.3.2 Infrastructure & Mode of Transportation:**

Domestic coal from coal-linkages will be transported through railway to the proposed site. Domestic Coal will be transported through rail wagons and will be unloaded in Wagon Tippler or Track Hopper respectively at Site. Private railway siding shall be established from Pipariyakalan Block station (Katni-Sangarauli section) to plant Site.

**4.4 Makeup water Availability & Transportation:**

**4.4.1 Raw Water**

The water requirement for the proposed project will be met from Bansagar Reservoir located at a distance of 10 km from the proposed project site. Water will be transported through pipelines up to the plant reservoir. Water received from the source can be further treated in Pre-treatment plant and then used for power plant purposes. Water requirement for the proposed 4 x 800 MW power plant will be in the order of about 60 MCM per annum.

**4.4.2 Freshwater**

The fresh Water to cater the plant needs such as power cycle make up, auxiliary cooling water, services, potable water, township etc., shall be fed from a Water Treatment Plant for the proposed plant.

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 Madhya Pradesh 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, water from Bansagar reservoir will be used in closed circuit for circulating water system and sweet water needs will be met. 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 – 8.0:

#### **4.7 Site Features:**

The selected site near Bujbuja village has the following inherent advantages:-

- Availability of suitable & adequate land.
- Assured year round availability of water from Bansagar Reservoir.
- The site is not located in an environmentally fragile 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 equipments.
- Strategic location with respect to load centres.

**SECTION: 5**

**TECHNICAL FEATURES**

## **5.0 TECHNICAL FEATURES**

### **5.0 TECHNICAL FEATURES:**

The power generating Units shall be of Super-critical steam parameters utilizing domestic coal.

It is proposed to use river 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/wet form. Fly Ash extracted in dry form and stored in storage silos for the purpose of utilization. Unutilized fly ash will be converted in to slurry form and will be disposed to the ash dyke along with bottom ash in high concentrated slurry mode through high concentration slurry disposal (HCSD) system.

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:**

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 5.75% 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

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pressure operation is selected. An added advantage in these types 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 NO<sub>x</sub> 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 16 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 No<sub>x</sub> coal burners from each mill for combustion in the furnace of the boiler thro' coal conveying pipes.

HSD/LDO shall be used for start-up, load carrying and for low load operations/flame stabilisation. No HFO is envisaged for this project.

An Auxiliary Boiler of suitable capacity is envisaged for this project which shall be taken into service during grid failure/blackout conditions.

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 50 mg/Nm<sup>3</sup> at 100% MCR.

### **5.2.2 Steam Turbine**

The steam turbine would be 3000 rpm, tandem compound, single reheat, regenerative, condensing, horizontally split, Four/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 utilising water as cooling medium.

Generator will be connected to its unit step up transformers. 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. One vacuum pump would operate during normal plant operation and during start-up, both the units may be operated such that the desired vacuum can be pulled within a short time.

#### **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 16 hrs Storage capacity in the bunkers.

For the project, coal will be supplied from the mine end by railway wagons and will be unloaded using wagon tippers for the plant.

Coal in BOX-N wagons will be unloaded by wagon tippers and conveyed to the boiler bunker through crusher house and a number of transfer houses. Provision has been kept for stacking crushed coal in coal stockyard from where coal will be reclaimed as and when the same will be required in coal bunkers.

The sub systems of the Coal Handling Plant are:

- Coal unloading system
- Crushing & Screening System
- Coal stacking & Reclaiming
- Belt Conveyors
- Metal Detectors
- Magnetic Separators
- Belt Scale
- Coal Sampler Stations
- Conveyor Supports, Galleries and Platforms
- Crusher House

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- Bunker Feeding System
- Dust Extraction / Dust Suppression/ Ventilation System

CHP shall be installed with adequate capacity which comprises of Crusher house, stacker cum Reclaimer with Coal stock yard etc. for proposed 4x800 MW.

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.

Two streams (2x100%) of conveyors and associated equipment shall be provided for coal handling system with rated capacity of 4600 T/hr. each up to bunker feeding conveyors.

Conveyor will feed crushed coal to bunker through motorised travelling tripper for storage purpose. Metal detector, coal supply unit, electronic belt conveyor 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.

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

HSD/ LDO will be used for commissioning activities, hot / cold start-up and for flame stabilisation at low loads. The steam generator will require oil flame support when coal is fired below 30% BMCR.

HSD/LDO system consists of unloading system, storage tank and forwarding skid. The HSD / LDO is unloaded from the road tankers by 2 x 100% capacity unloading pumps to storage tank. Two (2) nos. of HSD / LDO storage tank of 2000 KL will be constructed. From the storage tank HSD/LDO will be forwarded to boiler burners by means of 3 x 50% forwarding pumps. The pumps are fitted with duplex suction filters with all necessary piping, valves and instruments etc.

Specific auxiliary fuel consumption (HSD / LDO) of 0.5 ml/kWh is considered as per the CEA norm for arriving at the fuel consumption. This works out to about 14000 kiloliters per annum.

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

##### **5.2.6.1 System Description and Capacity**

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:

### **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. 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 slurry tank in slurry form by means of flushing apparatus.

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

The fly ash handling system will remove fly ash from electro static precipitator (ESP), Air Preheater hoppers and transport it to the storage silos. This will be carried out by vacuum and/ or pressure conveying system on a continuous basis. One boiler unit will be provided with one pneumatic conveying system for handling fly ash collected in hoppers. Fly ash from the ESP and APH hoppers of each unit shall be removed in 5.0 hours per shift of 8 hours.

The fly ash handling system will include aeration blowers and heaters, 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:

- |  |                      |
|--|----------------------|
| a) Ash content in coal                                 | : 40%                |
| b) Coal consumption per boiler at BMCR condition       | : 563 TPH/unit       |
| c) Capacity of fly ash handling system                 | : 360 TPH/Unit       |
| d) Capacity of bottom ash handling system              | : 225TPH/Unit        |
| e) Capacity of HCSD system for bottom ash and fly ash  | : 225 TPH/Unit       |
| f) Bulk density of bottom ash (for volume calculation) | : 0.65 T/M3          |
| g) Bulk density of Fly ash (for volume calculation)    | : 0.75T/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 in Brick industries, in construction of roads, in making fly-ash bricks. 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.

## **5.2.7 Plant Water System**

### **5.2.7.1 Water drawl**

Required water for the plant shall be drawn from Bansagar Reservoir. 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**

Bansagar Reservoir is considered as the source of water for the station. The consumptive water requirement of the proposed 4x800 MW station is estimated at around 6945 m<sup>3</sup>/hr (60 MCM per annum). The requirement of plant water will be met by drawl of water through an intake structure with pump house to be constructed near the Bansagar Reservoir.

Re-circulating cooling water system using wet evaporative Induced 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 choice of cooling water system is guided predominantly by the GOI guidelines on use of sweet water for cooling purposes.

The tentative Raw water analysis is furnished as Annexure-1.3

The total raw water requirement of 6945 m<sup>3</sup>/hr considers High concentration slurry disposal (HCSD), heat cycle make-up, make-up to cooling towers 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.

There will be 3x50% capacity intake pumps in the intake pump house to be constructed on Bansagar Reservoir to meet the plant requirement. Raw water from this pump house will be pumped through carbon steel underground coated pipeline which will be protected with suitable coating and wrapping.

Raw water at the plant end will be received from raw water reservoir, which will have an overall storage capacity of about fifteen (15) days' raw water requirement of the Plant. Raw water will thereafter, be pumped to the Raw water pre-treatment plant and Ash handling plant by 3x50% capacity Raw water pumps.

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For this power station, Four (04) clariflocculator units each having rated capacity of about 2400 m<sup>3</sup>/hr is considered for PT plant of CW system. More two (2) clariflocculator / tube settlers each having rated capacity of about 300 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 then the other clariflocculator will be run at overload condition to cater to the total clarified water requirement. Lime, alum, ferric chloride and other coagulant aids will be dosed in the clariflocculator to accelerate the coagulation.

Clarified water will, thereafter, be used as make-up for the Circulating water system directly and also stored in a twin chamber RCC reservoir having a storage capacity of about minimum 4-hours clarified water requirement for the proposed power station. From the Clarified water reservoir clarified water will be pumped to the following major consumers-

The requirement of Air Compressors coolers, Air Conditioning and ventilation plant, service water for washing, cleaning and other housekeeping needs and for Ash Handling Plant for sealing and cooling purpose, etc. shall be met by three (3) nos. of Service water pumps (2W +1S) each having 50% capacity to meet the requirement of all four units.

As feed water to meet the requirement of DM plant which will be met by five (5) nos. of DM Plant feed water pumps (4W +1S) to meet the requirement of all four units.

As feed water to meet the requirement of Potable water which will be met by two (2) nos. of Potable water feed pumps (1W +1S) each having 100% capacity to meet the requirement of all four units.

Cooling water in circulation is estimated at 90,200 m<sup>3</sup>/hr per unit including the requirement of auxiliary cooling circuit and considering temperature rise across cooling tower as 9.3 degree C.

The makeup water requirement for cooling circuit at full load is estimated at 6537 m<sup>3</sup>/hr for four units. The cooling tower blow down is expected to be about 1248 m<sup>3</sup>/hr. Blow down water qty shall cater in CHP for dust suppression and AHP for HCSD.

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 recycled for use in Horticulture and gardening system.

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

For water requirement 2% DM water make up is considered but DM plant equipment will be designed by assuming average 3% make-up for the heat cycle and accounting for three hours regeneration time, demineralising chains, of 360(4X90) m<sup>3</sup>/hr capacity have been envisaged for the proposed units. DM plant will supply heat cycle

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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.

Clarified water will be pumped to the DM plant for demineralisation. 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 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 (4X3000 m<sup>3</sup>).

DM water from the storage tanks will be transferred to unit condensate storage tanks by Five (5) nos. DM transfer pumps (4W +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, Induced Draught Cooling Tower (IDCT).

It is proposed to provide single circulating water pump house in the plant for four (4) units with eight (8) numbers of pumps in pump house, two (2) for each unit. CW shall be supplied to each condenser through CW piping which shall be MS pipes as per IS: 3589 / AWWA C 200 coated with epoxy mortar anticorrosive coating inside and Concrete encasement outside. All valves / butterfly valves, RE joints and other fittings shall be suitable for water application.

For each unit, 2x100% auxiliary cooling water pumps for primary circuit as well as 2X100% pumps for secondary circuit will be provided for supply of auxiliary cooling water to 3x50% Plate Heat Exchangers (PHE). DM water which will be used for cooling the equipment in closed cycle shall be cooled in PHE's. The secondary auxiliary cooling water pumps will be located within the CW pump house near the respective units. These pumps will take suction from the CW forebay and return back to the CW outlet line from the condenser for rejecting heat to main IDCT.

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 IDCT 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. 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.

#### **5.2.7.6 Condensate Polishing Plant (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 3X50% 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 all 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 potable water 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.

Common auxiliaries like air compressor, ash handling equipment & fuel oil cooler shall cool by SW pump located at clarified water Pump house. Return hot water shall discharge to CW forebay & get cool by IDCT of CW system. 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 before final disposal.

The oily waste from main plant, fuel oil unloading and storage 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.

Waste water will be collected in CMB (Central monitoring basin) and from CMB it will be used in horticulture.

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.

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

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

For protection of the plant against fire, all yards and plant will be protected by any one or a combination of the following systems:

- a. Hydrant system
- b. High velocity & Medium velocity water spray system.
- c. Automatic fixed foam system.
- d. Portable and mobile chemical extinguishers

The system will be designed as per the recommendation of Tariff Advisory Committee (TAC) of the Insurance Association of India. Applicable Codes and Standards of National Fire Prevention Association (NFPA), USA, would also be followed.

The source of water for the firewater pumps of the hydrant system, water spray and sprinkler system etc. will be clarified water. Firewater will be supplied from the firewater pumps located in the pump house at a rated pressure. The Fire water system network will be designed considering simultaneous pumping by three (3) pumps, for hydrant system and one (1) pump for spray system. There shall be One (1) no. diesel engine driven horizontal centrifugal pump as common standby both for Hydrant and spray network. In addition to these, two (2) jockey pump sets, hydro-pneumatic tanks, compressors, pipes and fittings as required will be provided. The hydrant system will feed pressurized water to hydrant valves located throughout the plant and also at strategic locations within the powerhouse.

Spray system network would be interconnected with hydrant network so that in case spray system network demands water, water can flow from hydrant network to spray network but not the vice-versa.

Automatic medium velocity spray system will be provided for cable galleries, cable trenches/vaults, coal conveyors, main fuel oil/LDO storage tank etc. Automatic medium velocity sprinklers will be used for protection of burner zone of boiler front.

Automatic high velocity spray system would be provided for the following equipment's:

- a) Generator transformers
- b) Unit auxiliary transformers
- c) Station transformers
- d) Auxiliary Power transformers

- e) Turbine oil storage tanks
- f) Boiler burner front
- g) Other transformers (greater than 10 MVA)

Suitable fire detection system as necessary for all the above mentioned firefighting system with adequate supervisory circuitry will be provided. Automatic fixed foam installation is envisaged in fuel oil storage and handling areas.

In addition to these, adequate number of portable and mobile (wheel mounted) chemical fire extinguishers of foam and soda acid type and carbon-dioxide type will be provided. Portable units would be placed at suitable locations throughout the plant area. The extinguishers may be used during the early stages of fire to prevent spreading.

One centralized total flooding clean inert gas extinguishing system shall be provided for Control Equipment room and Unit Control room.

#### **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, Six (6) numbers (4W+1 Hot Standby + 1 maintenance standby) of air compressors will be provided. These compressors will be oil-free screw 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 24.1 degree C dry bulb temperature and relative humidity not exceeding 60% is proposed to be maintained in all air-conditioned areas.

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

- a) 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. 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. This system also consists of 2 x 60% capacity chilled water pumps, 2 x 60% capacity condenser cooling water pumps, 2 x 60% capacity induced draft FRP cooling towers, adequate number of air-handling units for circulating the conditioned air through air-distribution system.
- b) ESP Control Room

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- c) Coal Handling Plant Control Room
- d) Switchyard Control Room including Computer Rooms, Telemetry Room, PLCC & Telex Room
- e) Required areas in Service/Facilities, Building/Administration Building
- f) Plant/Demineralization plant Control Rooms, Water and Fuel Analysis Room, Instruments Room.
- g) 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:**

Ventilation system will be designed to supply fresh outdoor air and will be selected for maintaining inside conditions for those areas where close control of temperature is not required, but nevertheless have a stipulated maximum temperature.

For Ventilation of Station building, forced ventilation system is envisaged. The exhaust of hot air out of the station building will be achieved by provision of roof extractors and wall mounted exhaust fans. With this system the dry bulb temperature (DBT) within the turbine building will be maintained at a temperature not exceeding 40 degree C at all times of the year.

The following areas will be provided with forced ventilation system with filtered supply air and exhaust fans / roof exhausters:

- a) All other rooms of turbine building which are not air -conditioned.
- b) Switchgear rooms and cable galleries of main plant.
- c) Non air conditioned area of ESP control room.
- d) Any other areas where equipment heat load is high.

Battery rooms, Chemical stores and toilets will be provided with exhaust ventilation with minimum 20 air changes. All other buildings / areas will be ventilated by mechanical ventilation process using combination of filtered supply air fans and roof exhausters or wall mounted exhaust fans.

#### **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, 347HFG 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.

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:**

Suitable capacity hydrogen generation plant will be designed and installed. Also possibility of hydrogen cylinder from market will be explored.

#### **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 80/32T main hook capacity each are envisaged 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 6% over and above the heaviest component / equipment (including lifting beam and slings etc.) to be handled in TG hall.

CW pump house, Secondary ACW pumps, Air Compressors, Workshop and other Facility requiring frequent handling of heavy loads will also be provided with goliath 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:**

Two (2) nos chimneys each with 2 flues, of 275 m with RCC construction is envisaged for 4x800 MW Units to comply with environmental regulations. The chimneys will be concrete shell type, MS flues with top one third SS liner to cater to two (2) units of 800 MW. The chimney will be provided with lightning arrestors and aviation warning lights. System design will include on-line Opacity / Suspended Particulate matter monitoring system, SO<sub>2</sub> and NO<sub>x</sub> monitoring system, CO monitoring and Flue Gas Oxygen analysers etc. The Chimneys 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. Another two (2) passenger elevator 1360 kg for 20 Person 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 cannot 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 as per relevant codes and standards.

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

Workshop building with adequate equipment, tools & tackles shall be developed to cater routine maintenance requirements of the plant.

A central chemical laboratory shall be established for the station. The laboratory shall be equipped with 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 24 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 from the lines provided in the switchyard.

For start-up power of the Power Plant, lines shall be back charged from the State substation. Start-up power will be taken from the switch yard through the station transformer. In this scheme the station auxiliaries will not get the power in case of failure of station transformer or tripping of station transformer breaker. Hence to have redundancy two nos station transformers are envisaged. Voltage levels i.e. 11KV, 6.6 kV and 415V are adopted for feeding the plant auxiliaries.

#### **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 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. Motors rated including and up to 200 KW will be connected to 415V system and motors rated above 200 KW will be connected to 6.6 kV 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 fused contactors. HT Motors will be controlled by SF6/Vacuum Circuit Breakers. HT motors of Coal handling system will be controlled by fused vacuum contactors considering frequent starting.

#### **System Neutral Grounding**

System neutral grounding shall cover:

- a) Generator Neutral Grounding

- b) 400 KV System Grounding
- c) 11 KV & 6.6 KV System Grounding
- d) 415 V System 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	:	To suit the Turbine rating
Stator cooling	:	By Hydrogen / water
Rotor cooling	:	By Hydrogen
Rated power factor	:	0.85 lag
Rated Terminal Voltage	:	24 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
Rated Speed	:	3000 rpm

Generator shall conform to IEC-34. The generator shall be capable of withstanding short circuit level as per IEC. Short circuit ratio shall not be less than 0.5. Generator will be suitable to operate continuously with a negative sequence current of 8% of the rated value, and I<sup>2</sup>T will not be less than 8. 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 40% 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 above 10 amps.

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

The generator will be provided with either brushless excitation system consisting of exciter with rotating diode assembly along with Permanent Magnet Generator (PMG) or static excitation achieving high degree of operational reliability and minimum maintenance.

The excitation system will have fast response time to meet the system requirement. The excitation system will have automatic voltage regulator to maintain steady generator terminal voltage under variable load conditions and for parallel operation with the grid. Ceiling voltage for exciter will be 200%.

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.

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.

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 CO<sub>2</sub> 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 /24 kV (Generator Voltage)
Frequency	:	50 Hz
Vector group	:	YNd11
Percentage impedance	:	14.5% approx.
Capacity	:	310 MVA
Cooling	:	ONAN/ONAF/OFAF
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 Auxiliary Transformer
- Station Transformer
- Auxiliary Transformers
- Bus ducts
- Generator Bus duct
- 11KV & 6.6 kV Bus duct
- LT Bus duct

- Bus duct Supports & Enclosures
- 6.6 kV 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 Protection
- Line Protection
- Distance Protection, non-switched scheme
- Auto reclose relay
- Fault Locator
- Backup over current and earth fault protection
- 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
- 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
- Buchholz protection
- Oil/winding temperature protection

#### **Unit Auxiliary transformers**

- Differential protection
- Restricted Earth Fault protection for LV winding
- Over current protection on HV side & LV side
- Backup Earth fault protection
- Buckholz 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
- Buchholz 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 1000 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**

The 400 kV will be provided to evacuate the power. The generator is connected to the 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 type.

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



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Sequential Event Recorder (SER) of the switchyard signals will be provided. These signals as a minimum will contain all protective relays, lock-out relay and breaker auxiliary contacts. These will be hardwired to SER cabinet. The control, monitoring and operation of the switchyard will be through SCADA in the Central Control Room of the power plant.

The switchyard shall be designed considering the following parameters.

Nominal System Voltage	:	400KV
Highest System Voltage	:	420KV
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 equipments 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	:	0-0.3 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
Mounting	:	Horizontal, Upright
No. of phases	:	3

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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
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, ensuring 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 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 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.

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 PLC 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 LCD monitor, keyboard/Mouse and also through Large Video Screen (LVS).

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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, Flue Gas Desulphurisation, etc. will be controlled and monitored through the dedicated operator interface units in the central control room. These packages will have independent and stand-alone PLCs in hot redundant configuration, while the remaining BOP plant packages will have non redundant PLC based systems. All the PLC based packages will be integrated by Ethernet at CCR. Additionally, all the BOP package systems will be provided with LCD HMI Operator Interface Units (OIU) with printer in the Local control room.

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:

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- 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 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 packaged control system.
- Emission monitoring instruments and all flue gas analyzers.
- Uninterruptible Power Supply and Distribution.
- Final Control Elements.
- Field 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).

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

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. Communication link (Software/Hardware) will also be provided between DDCMIS and control system of other plant areas such as Ash Handling Plant (AHP), Coal Handling Plant (CHP) and Demineralised Plant (DM Plant) etc.

#### **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 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 redundant 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:

- Electro hydraulic Governing Control System (EHGC)
- 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/DCS based and these shall be integrated by Ethernet at the Central control room for centralised operation, control and 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
- Mill reject system
- HVAC
- Fire detection and protection systems.
- Condenser on line tube cleaning system.
- Vibration monitoring system.
- Condensate polishing system.

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, Condensate polishing unit, Fuel oil unloading and storage will have dual redundant PLC based control system. For non-critical BOP packages non-redundant PLC based system is envisaged. The entire PLC based package systems will be integrated by Ethernet at the central control room. Dedicated BOP OIUs in the CCR will be provided for operation, control and 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 System for Major Plant Auxiliaries:**

The Vibration Monitoring System will be provided for all critical equipments 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 system will be provided with necessary interfaces with DDCMIS for centralized monitoring purpose.

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

One common Central Control Room and electronic equipment room is envisaged for all units of the plant. The control room will be designed keeping in mind the ergonomics and overall aesthetics of the operating floor of the plant.

#### **5.4.10 Central Control Room Equipments:**

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.
- 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.

#### **5.4.11 Unit Control Desks/ Unit Control Panels:**

##### **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 systems will be done from the Operator interface units (OIUs).

##### **Unit Control Panel:**

The unit control panel is a free standing vertical panel which will house, in addition to the Large Video screens, furnace flame TV, a limited number of Emergency pushbuttons for Tripping of Boiler, Steam Turbine and major auxiliaries for safe shutdown of plant. The vertical panel will house all back up instruments, Measuring Indicating Instruments, and Annunciation windows.

#### **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 PLC 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 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 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.

CEMS will be complete with flue gas sample extraction and conditioning and analysing system. PC based Emissions Monitoring System with 22" Colour Graphic LED / TFT Monitor with Keyboard, Mouse along with Laser jet Printer. A software link 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:**

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 or any other internationally accepted protocol. Portable digital calibrator/HART communicator is envisaged for on line calibration of the transmitters. Accuracy of process transmitters is envisaged as 0.1%.

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 system 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.

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,

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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 analogue 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:**

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 conform 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-III as per IS: 1893 (Part-I):2005 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 47 m/s. 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.

Roof will be provided with suitable drainage arrangement through rainwater down corners. Necessary 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

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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.

TDBFP and Coal Mills will be provided with vibration isolation spring system mounted foundations. The vibration isolation system supplied will be of proven make, consisting of steel helical spring units and viscous dampers (providing damping resistance in all three planes).

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

If minor equipment's 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:

- 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 framed structure / block foundation of RCC. Equipment foundation will be separated from adjoining part of building and other foundations joints at floor/slab will be suitably sealed.

All building will be provided with 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 1.75 and seismic load as per IS 1893:2005 as applicable for zone-III.

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 shall 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.

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

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

Induced draft cooling tower for each unit to handle 90700 cum/hr of 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., shall be constructed. Suitable draining and pumping arrangement from the drain box outside shall be 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 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:**

Three nos of Wagon Tipplers, 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 rest 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 with suitable materials from inside. 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 of buildings shall be taken to natural drainage system through a designed storm water drains through open drains, pipes etc. Plant rainwater drainage will be connected to the nearby existing natural drainage system.

For the main power plant building sewage treatment plant with adequate capacity shall be installed in the nearby 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. shall be 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, cable trenches, roads drains and chain-link fencing.

**5.5.11 Civil works for Chimney:**

Two (2) nos Twin-flue RCC chimneys having steel flues with insulation from outside shall be provided. The height of the chimney as per CPCB will be 275 M. Chimney shell shall be constructed using slip form technology. The chimney will be fitted with 500 kg capacity elevator and staircase will be provided inside of the shell. 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 envisaged for O&M employees. It shall consist of various types of dwelling units like 1BHK, 2BHK, 3BHK, Bachelor hostel, Villas, commercial centres, clubhouse, school, health centre and other common amenities.

It shall have its own water supply, sewerage and power supply networks. Ample parking and recreation space shall also be provided.

**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 4 x 800 MW project is proposed to be synchronized in 42 months from "Zero date" and subsequent units 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. The colony would be executed through a separate contract.

WEMPL shall carry out pre-EPC preparatory works such as carrying out feasibility studies for construction water, construction power and arranging the same up to single point of plant boundary, carrying out soil investigation etc. WEMPL shall

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develop its own site office & necessary facilities for proper monitoring & execution of project in scheduled time.

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 for off-shore structures, 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 WEMPL 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,

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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 will be 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 proposed Site is near to State Highway no 10 & 11, which is within a distance of approx. 2 km from plant boundary. The nearest railway station (broad gauge) is located at Katni at about 30 km away from the proposed 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 exist.

The list of main equipments, which fall in the heavy category are Generator Stator, Generator Rotor and Generator Transformer, Deaerator, HP Heater and Ceiling Girder.

Route survey shall 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, water from Bansagar Reservoir will be used in closed circuit for circulating water system and sweet water needs will be met. 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

Sr. No.	Type of Pollution	Source of Pollution
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 have been envisaged to reduce the NOx generation and consequent emission.
- High efficiency Electrostatic Precipitators has been envisaged to limit the particulate emissions to 50 mg/Nm<sup>3</sup>.
- Two no. 275 mtr. Height RCC stacks, each having 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.

**7.1.2 Pollution Monitoring and Control Measures:**

There are no important archaeological monuments located at the Site. Bandhavgadh Tiger Reserve buffer zone is located at more than 10 KM from Site. 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 Madhya Pradesh State Pollution Control 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, CO, NOx and SO<sub>2</sub> constituents in the flue gas on continuous basis.

The plant waste water will be periodically analysed on a weekly basis so that the waste water are 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 50 mg/Nm<sup>3</sup>.

In order to meet the guidelines of State Pollution Control Board for SO<sub>2</sub> emission, two no. 275 mtr. Height RCC stacks, each having twin-flue chimney is envisaged. The chimney would be provided with personal access for regular monitoring of stack emissions. FGD is envisaged for each unit to keep the SO<sub>x</sub> emissions within admissible limits.

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 coal bunkers. Collected dust will be returned to coal bunker. The dust collector outlet emission will be restricted to 50 mg/Nm<sup>3</sup> to trap the dust in the bunkers.

Plant equipment design and operation will ensure SO<sub>2</sub> emissions are limited below the State PCB norms. Ground level concentration will be verified for compliance with local pollution control board prescribed ambient air quality norms.

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 510 mg/Nm<sup>3</sup> will be used in the Boiler.

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

Fly ash has high pozzolonic properties and form cementaceous material when mixed with lime and water and it is suitable for the following commercial uses:

- a. Cement Industry
- b. Brick Industry

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- c. Light Weight Aggregates
- d. Road Sub-base
- e. Grouting material
- f. Roads / paving - used as filler in asphalt mix for roads.
- g. Road enlargement
- h. Land filling material

MoEF in their notification dated 3<sup>rd</sup> November, 2009 had specified that the fly ash utilization has to be 100% from within 4 years of commissioning of the plant.

Fly ash will be collected in dry form and transported to silos for discharging to the consumers. The ash utilization will be partial during the initial period and will be gradually increased to 100% within 4 years. In order to implement the stipulation by MoEF, Appropriate handling arrangement would be envisaged for the following option:

- Disposal of fly ash from silos to nearby small scale industries by road tankers.
- Bottom ash generated shall be supplied to the Road Mix Concrete (RMC) / brick producers thereby eliminating the need for separate area shall be explored.

In case of any exigencies, unutilized ash will be transported to the ash dyke as high concentrate slurry using high concentrate slurry pumps.

Fly ash evacuated from ESP/Economiser/Air Preheater collecting hoppers is transported in closed pipe lines by pneumatic means. At the time of unloading fly ash into the silos, some ash laden air would get vented out. In order to restrict the fly ash dust particles to the limits of 50 mg/Nm<sup>3</sup>, a vent filter will be installed on top of each of the fly ash silos.

The following pollution control measures will be installed for ash disposal:

- It is proposed to use closed trucks for fly ash transportation in order to avoid dust nuisance. To reduce the dust nuisance while loading the ash into the trucks from fly ash silos, pneumatic loading technique will be used.
- Water sprinkling system has been commissioned in the ash disposal area to restrain flying of fine ash to wind.
- It is also proposed to dispose un-utilised fly ash to ash dyke.

The dust nuisance in the ash disposal area will be contained by ensuring that the ash is always kept wet.

### **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 with in the stipulated limits.

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

- 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:**

Water from Bansagar Reservoir 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 zero discharge concept. It is envisaged to utilize cooling water blow down 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. The storm water from the storm water drainage 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.

#### **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:**

R&R plan has already been approved by GoMP.

**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.

#### **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.

#### **Green Belt Development:**

A green belt development program in line with the MoEF guidelines will be prepared for the project. The objective of the green belt development around the plant site is to capture the emissions, attenuate the noise generated, improve the aesthetics in general and maintain a balanced environment. The green belt of the project site will form an effective barrier between the plant and surroundings.

Tree plantation will be undertaken in a large scale on land vacated after cessation of construction activities. Open spaces, where tree plantation is not possible will be planted with shrubs and grass to prevent erosion of topsoil. Appropriate type of trees and plants suitable for this region would be planted in compliance of conditions of environmental clearance.

#### **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.

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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/HFO/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 make up 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.

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 in the control room and at site / on the field.

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- 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
- 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 Corporate 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 4 x 800 MW Units is estimated to be around 560 excluding contract labour.

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

The following facilities shall be developed in the station:

- i. Administrative Building and technical office
- ii. Construction offices and stores (at construction stage only)
- iii. Time and security offices
- iv. First Aid and firefighting 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:**

It is estimated that a total of about 545 employees would be working for operation, maintenance and administration of the proposed 3200 MW station. This excludes security and canteen staff, as these functions would be contracted out. Since the area is basically a rural area with improved infrastructure, a satisfaction level of about 80% is considered for planning the residential township of the proposed station.

**SECTION: 9**

**PROJECT COST ESTIMATES AND FINANCIAL ANALYSIS**

## **9.0 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 guidelines, 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 four (4) Units of 800 MW 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 @ 10.0% has been considered on the cost estimate for EPC and Non EPC works.

#### **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 12.50 %. 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 up to COD of 4th Unit.
- Working Capital - The rate of interest on working capital loan is assumed to be 12.50% p.a.
- Taxes and Duties - Taxes and Duties have been considered as per prevailing rates.

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4 x 800 MW Katni Thermal Power Project**

## 9.2 Project Cost

On the basis of assumptions discussed above, the estimated costs of the project amount to Rs. 19,200 Crores. The specific cost of the project is Rs 6 Crores per MW. The summary of break-up of the project cost is indicated in Table 9.1 below.

**Table – 9.1  
Project Cost Break Up**

Particular	Estimated Cost(Cr)
Land & Site Development	25.00
Engineering, Procurement & Construction Cost	13970.00
Water Arrangement	50.00
Coal Supply Arrangement	100.00
<b>Total Hard Cost</b>	<b>14145.00</b>
Preliminary & Pre-operative Expenditure	700.00
Interest During Construction Period	3111.00
Insurance	60.00
Contingencies	1184.00
Margin Money for working capital	0.00
<b>Total Cost</b>	<b>19,200.00</b>

(All figure in Rs. Crores)

The Project cost is estimated at Rs. 19,200 Crores & is proposed to be finance with senior debt, sub debt & equity in ratio of 70:30.

The proposed components of financing are:

Particular	Rs Crores	%
Capital Contribution – Equity	5760	30
Debt Finance	13440	70
<b>Total</b>	<b>19,200.00</b>	<b>100</b>

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### 9.3 Phasing of Expenditure

Date of Financial Closure has been considered as Zero Date/Notice to Proceed (NTP) to EPC Contractor. The quarterly expenditure for the Project cost including IDC has been spread for the Project Schedule of 60 months from Zero Date, considering the completion schedule of 42 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 4 x 800 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 @ 5.75%.
- The gross calorific value (GCV) of coal has been considered as 3300 Kcal/Kg

#### 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).

**Pre-Feasibility Report**  
**4 x 800 MW Katni Thermal Power Project**

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### **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 @ 20% of operational & maintenance expenses
- Receivables for 2 months

### **O&M Expenses**

Annual fixed operation and maintenance cost has been considered as Rs. 1.44 million per MW of generation which shall be escalated at the rate of 6.30% per annum as per CERC norms.

### **Fuel Cost**

Blend of Indigenous Coal & Imported coal is considered for the plant. Coal cost is considered as Rs. 3500 per Tonne including the transportation cost. The escalation rate of 2.5 % per annum is considered on the coal cost. Secondary fuel cost is considered as Rs. 58000 per KL with an escalation of 4.5% per annum.

### **Depreciation**

Depreciation rate of 5.28% (on an average) by straight line method has been considered as per CERC norms. The economic plant life has been taken as 25 years.

### **Taxes & Duties**

The rates of corporate tax has been considered as 34.00% 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).

MAT has been considered at 19.055 % for the Income Tax Holiday Period.

Under the existing section 80-IA of the IT Act, tax holiday is available to an undertaking engaged in generation and if the generation starts before March 31, 2013. However, since the first financial year after COD starts only in the year 2018-19, income tax holiday will not be applicable under existing regulations. It is expected that the income tax holiday may be extended for the generation of power beyond 2017. So, the tax holiday of 10 years has been assumed.

### **9.4.3 Tariff Calculation**

In accordance with CERC guidelines



**SECTION: 10**

**PERMITS AND CLEARANCES**

**Pre-Feasibility Report  
4 x 800 MW Katni Thermal Power Project**

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## 10.0 PERMITS AND CLEARANCES

Certain permits and clearances are required to be obtained by WEMPL from different Government and Statutory Agencies at various stages of development phase of the project. These are classified into two broad categories: 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	Registrar of Companies	Completed
2	Water availability	Water Resource Dept /WRD GoMP	Water allocation to the tune of 60 MCM per annum is already available.
3	NOC for setting of Facility - Pollution clearance (Water & Air)	State Pollution Control Board	WEMPL will do the needful once the REIA Report is ready.
4	Environmental and Forest Clearance	Ministry of Environment & Forests (MOEF), Gol	WEMPL will apply for Environmental Clearance
5	Forest clearance	State Forest Dept. / MOEF, Gol.	Diversion of 19.37 Acre forest land has been applied for. Approval from RO Bhopal is awaited.
6	Civil aviation clearance for Chimney height	Airport authority of India	WEMPL will apply for clearance.
7	Coastal Regulatory Zone clearance	Not Required	
8	Rehabilitation and Resettlement of displaced families by land acquisition	State Govt./ MOEF, Gol.	R&R plan has been approved by GoMP.
9	Site Clearance regarding Bandhavgadh Tiger Reserve	Forest Department, Madhya Pradesh	Site clearance received.

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4 x 800 MW Katni Thermal Power Project**

**Table 10.2**

**Non - Statutory Permits and Clearances**

Sr. No	Description	Authority	Status
1	Land availability	Govt. Land / Private Land Owner	Out of total 1220 Acre of land, 1180.63 Acres already in possession & possession of balance 19.37 Acres is in process.
2	Fuel Linkage	GoI, MoC	Indigenous Coal from allotted coal linkage/captive coal block by GOI.
3	Transportation of fuel	Indian Railways Transport Agency	Preliminary study has been carried out by M/s Aarvee Associates. However, detailed study/proposal/DPR shall be prepared for approval from Railway Dept.
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.
6	Tax concessions under Mega Power Project	Ministry of Power, Government of India; State Government	WEMPL shall apply for Mega Power Project status at later stage.
7	Sanction of Construction Power	MP Poorv Kshetra Vidyut Vitran Company Limited, Jabalpur	WEMPL shall apply for the same.
8	Power Tariff	Electricity Regulatory Commission	At Later Stage.
9	Consent of relevant Panchayat	Panchayat Union / Board of State Government	At Later Stage.