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PRE-FEASIBILITY REPORT



1,600 MW (2x800 MW) GODDA THERMAL POWER PROJECT

**Developer:
ADANI POWER (JHARKHAND) LIMITED**

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**SECTION: 1
EXECUTIVE SUMMARY**

1.0 EXECUTIVE SUMMARY

1.1 Introduction:

India and Bangladesh desire to enhance traditional ties of friendship, through economic cooperation. Realizing the ever increasing demand of electricity for the socio-economic development and progress, the Government of India (GoI) and Government of Bangladesh (GoB) have signed a Memorandum of Understanding (MoU) on 11-Jan-2010.

As provided in the MoU, GoB and GoI shall inter-alia undertake to encourage and facilitate joint co-operation between the parties in the following areas:

- i. Power generation, transmission, energy efficiency and development of various types of renewable energy;
- ii. Encourage and facilitate investments in each other's country in the fields of power generation, distribution, including joint venture investments between the two countries subject to their prevailing policies & legislation.

Accordingly, Adani Power Limited (APL) on 11-Aug-2015 signed a MoU with Bangladesh Power Development Board (BPDB), to develop a 2X800 MW thermal power plant on BOO basis in India and supply the entire power generated to Bangladesh Power Development Board (BPDB) through a dedicated Transmission Line.

PPA for this supply is expected to be signed soon between AP(J)L and BPDB. As per terms of the MoU the power plant together with dedicated transmission line (within India) up to mutually agreed interconnection point shall be built owned and operated by APL. BPDB shall be responsible for getting the transmission line constructed by Power Grid Company of Bangladesh (PGCB) from interconnection point onwards in Bangladesh.

NOC from Ministry of Power, Government of India has been obtained to set up Thermal Power Plant in Jharkhand for supplying power to Bangladesh through a dedicated 400 kV transmission line.

Government of Jharkhand has agreed in-principle for setting up the Plant in Jharkhand state and MoU for the same has been signed on 17-Feb-2016.

1.1.1 Company Highlights:

ADANI Group, is one of the leading business houses of the country with combined market capitalisation of around US\$ 14 billion, a sales turnover of US\$ 9.4 billion, employing over 10,000 people and having diverse interests in global trading, development and operation of Ports, IDC Terminal, establishment of SEZ, Oil Refining, Logistics, Gas Distribution, Power Generation, Power Transmission and Power

Trading etc. Adani Port at Mundra promoted by the ADANI Group is operational since 1998.

ADANI Group is manned by experienced and highly qualified professionals including technocrats of repute. The team has demonstrated capabilities in conceptualization and implementation of large projects, excellent records of establishing benchmarks in the industry. ADANI Group has rich and extensive experience of liaison with government agencies, import, funding etc. With this track record of the organization in tying up finances, flow of funds will not pose any problem for implementation of the proposed project.

Adani Power Ltd (APL) has been formed for development of a number of Power Projects along with its associated dedicated transmission systems. Adani Power Ltd commissioned India's first super critical 660 MW unit at Mundra on 22nd Dec 2010. Presently, the company has total installed generation capacity of 10,440 MW, out of which 4,620 MW (4x330 MW + 5x660 MW) at Mundra, 3,300 MW (5x660 MW) at Tiroda, 1,320 MW (2x660) at Kawai and 1,200 MW (2x600 MW) at Udupi.

Also, in the field of Renewable, Adani Group has commissioned 400 MW (40 MW at Bitta, Gujarat & 360 MW at Kamuthi, Tamilnadu). Another 1,058 MW is under implementation stage.

Adani Power (Jharkhand) Limited, AP(J)L is a 100% subsidiary of APL, which has been formed to develop 2x800MW Thermal Power Plant in Jharkhand.

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 Choice of Location:

Various sites in Godda District (Paraspani/ Motia) and Gunihari in Sahibganj District have been evaluated in Jharkhand. The site in Motia, Gangta, Gaighat and adjacent villages in Godda district was found most suitable to set up the power plant as it has several advantages, which are mentioned under Sl. No. 1.2.3.

1.2.2 Salient Features of Proposed Sites:

The plant shall be designed in accordance with Power Purchase Agreement (PPA) for base load operation with the capability for part load operation.

A. Motia-Godda:

Particulars	Details
Location	Village – Motia, Gangta, Gaighat & other adjacent villages, District-Godda, State-Jharkhand, India

Coordinate	24°48'54.84"N, 87°8'30.90"E
Site Elevation (Approx)/Topography	RL (+) 82m to RL (+) 105m.
Rainfall	Average rainfall is 1382.2 mm
Temperature	Ambient Temperature: 4°C to 42° C
Approx. Area	860 Acres
Land Type & Ownership	Single Crop & Barren Land. Breakup of ownership: <ul style="list-style-type: none"> • Private Land: 737 Acre • Government Land: 123 Acre • Forest Land: Nil
Families Affected	Very few (<20)
R&R Policy and Issues	As per Govt. of Jharkhand State Policy 2015.
Proposed plant configuration	1,600 MW (2x800 MW)
Nearest Town (Road Distance)	Godda, approx. 11 km from site
Railway Connectivity	The nearest existing Railway Station is Hansdiha, which is approx. 45 km from the proposed project site. Construction of new rail line from Hansdiha to Godda is proposed by Indian railways, through which the plant would be connected to the nearest station Godda at a distance of approx. 10 km.
Nearest Sea Port	Dhamra Port <ul style="list-style-type: none"> • Approx. 695 km to Godda and further 10 km to site by private railway siding, to be built by AP(J)L • Approx. 600 km from site by Road
Nearby Airports	Patna: (Aerial distance approx. 240 km, Distance by Road 300 km) Ranchi: (Aerial distance approx. 265 km, Distance by Road 365 km)
Approach Road	NH – 133 (Within 9.5 km from Site boundary)
Estimated Coal Consumption	7-9 MMT per annum
Coal Transportation	Imported coal shall be transported from Dhamra Port
Water Requirement	36 MCM per annum
Probable Water Source	The water requirement shall be met from Chir river (approximate 15 km). Proposed intake from Chir river is at a distance of approx. 15 km from site, within Godda Dist.
Ash Utilization	Fly Ash will be utilized in Brick Industry, Light Weight Aggregates, Road Sub-base, Grouting material, Roads/paving, Mine void filling.

B. Paraspani-Godda:

Particulars	Details
Location	Village – Paraspani & Teloliya, District-Godda, State-Jharkhand, India
Coordinate	24° 53' 17.73"N, 87° 19' 15.91"E
Site Elevation (Approx)/Topography	RL (+) 101m to RL (+) 127m.
Average Rainfall	Average rainfall is 1200-1300 mm
Temperature	Ambient Temperature - 4°C to 42° C
Approx. Area	1,036 Acre
Land Type & Ownership	<p>Mostly Barren Land. Breakup of ownership:</p> <ul style="list-style-type: none"> • Private Land: 808 Acre • Government Land: 228 Acre • Forest Land: Nil
Families Affected	221 (approx.)
R&R Policy and Issues	As per Govt. of Jharkhand State Policy 2015.
Proposed plant configuration	1,600 MW (2x800 MW)
Nearby Towns	Godda, approx. 15km from site
Railway Connectivity	The nearest Railway Station is Hansdiha, which is approx. 45 km from the proposed project site.
Nearest Sea Port	<p>Dhamra Port</p> <ul style="list-style-type: none"> • approx. 695 km to Godda and further 15 km to site by private railway siding, to be built by AP(J)L • approx. 600 km from site by Road
Nearby Airports	<p>Patna: (Aerial distance approx. 240 km, Distance by Road 300 km)</p> <p>Ranchi: (Aerial distance approx. 265 km, Distance by Road 365 km, Road from Ranchi is better)</p>
Approach Road	SH – 16 (Within 8.5 Km from Site boundary)
Estimated Coal Consumption	7-9 MMT per annum
Coal Transportation	Imported coal shall be transported from Dhamra Port
Water Requirement	36 MCM per annum
Probable Water Source	The water requirement shall be met from Chir river (approximate 20 km). Proposed intake from Chir river is near Godda, Jharkhand, which is at a distance of approx. 20 km.
Ash Utilization	Fly Ash will be utilized in the nearby cement plants.

C. Gunihari-Sahibganj:

Particulars	Details
Location	Village-Gunihari & adjacent Villages, District- Sahibganj
Coordinate	25° 2'21.09"N, 87°47'36.74"E
Site Elevation (Approx)/Topography	RL (+) 28 m to RL (+) 40 m
Average Rainfall	1,500 mm
Temperature	Ambient Temperature: 4°C to 42° C
Approx. Area	900 Acres
Land Type & Ownership	Single Crop Land. Breakup of ownership: <ul style="list-style-type: none"> • Private Land: 800 Acre • Government Land: 100 Acre • Forest Land: Nil
Families Affected	185 (approx.)
R&R Policy and Issues	As per Govt. of Jharkhand Policy 2015
Proposed plant configuration	1,600 MW (2x800 MW)
Nearby Towns	Rajmahal (Sub-divisional Hq) - 5.5 km by road Sahibganj (Dist. Hq) - 48 Km by road
Railway Connectivity	<ul style="list-style-type: none"> • Rajmahal : 5 Km • Major Railway Station is Sahibganj about 43 Km
Nearest Sea Port	Dhamra Port <ul style="list-style-type: none"> • approx. 650 km from site by Rail • approx. 660 km from site by Road
Nearby Airports	Kolkata: (Aerial distance approx. 272 km, Distance by Road 350 km)
Approach Road	NH 80 : 4.5 Km
Estimated Coal Consumption	7-9 MMT per annum
Coal Transportation	Imported coal shall be transported from Dhamra Port (approximate 650 km) to proposed site through rail/road.
Water Requirement	36 MCM per year
Probable Water Source	River Ganges flows at a distance of 2.5 km from proposed plant location.
Ash Utilization	Fly Ash will be utilized in the nearby cement plants.

1.2.3 Site Location Finalization

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

1) Project Location

- The site at Motia, Gangta, Gaighat and adjacent villages is found preferable in comparison to Paraspani because distance of water source (river Chir) is less.
- In comparison to Paraspani, the PDFs are minimal (<20).
- Gunihari site was found in the range of Udhua Bird Sanctuary, whereas Motia is far away from Wild Life/ Bird Sanctuary.

2) Type of Land – Barren/ Agricultural

Land at Motia, Gangta, Gaighat and adjacent villages are predominantly Single Crop/ barren land in comparison to other locations.

In view of above consideration, site location at Motia, Gangta, Gaighat and adjacent villages is found most suitable for setting up the proposed Thermal Power Plant.

The plant layout for the proposed station has been developed for the site location at Motia, Gangta, Gaighat and adjacent villages 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.

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 utilized for main plant, auxiliaries and sub-systems to ensure safe and continuous operation of the units with minimum unscheduled outages.

It is proposed to use imported coal for this Project; however, it would be designed such that in future, plant would be capable to operate on high ash coal also. Imported coal from Dhamra Port will be transported through rail/ road to the proposed site. The coal handling system of the proposed power project will have the capacity of 2,000 TPH and suitable crushing, stacking, reclaiming & feeding system will be provided. Coal storage of 15 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.

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

Condenser cooling shall be done by closed cooling system and make up water will be drawn from water reservoir in the plant.

The electrical system will be provided with adequately sized equipment and with generous redundancy to ensure uninterrupted operation of the plant. Electrical equipment and systems are discussed and described in Section - 5.3 of the report. A 400 kV Switchyard will be provided for evacuation of power with required number of outgoing feeders.

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 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 less than 30 mg/Nm³. 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 this Section.

Adequate facilities will be developed for execution of the project.

Schedule:

The schedule of commissioning of first unit is envisaged as 44 months from the Zero date. Zero date is considered as the date of Environment Clearance or Financial Closure, whichever is later and second unit shall be commissioned within a gap of 6 months thereafter.

SECTION: 2
PROJECT HIGHLIGHTS

2. PROJECT HIGHLIGHTS

Motia-Godda:

Plant Capacity	: 1,600 MW (2x800 MW)
Location	: Nearest Town : Godda : Nearest Railway Station : Hansdiha (45 Km) : Nearest Airport : Patna (300 Km) : Nearest Sea Port : Dhamra, Odisha (695 km)
Seismological Information	: ZONE – IV as per IS 1893 : 2002
Land for the Project	: Motia, Gangta, Gaighat & other adjacent villages, Dist.: Godda, State of Jharkhand.
Source of water	: Water from Chir river approx. 15 km from the site.
Water Requirement	: 36 MCM per annum
Cooling System	: Closed cycle cooling system
Primary Fuel	: Imported Coal
Coal requirement	: 7-9 MMT per annum
Support Fuel & Source	: LDO/ HSD from nearest refinery/ oil depots by Rail/ Road.
Support fuel (HSD/ LDO)	: 15,000 KL per annum @ 85% PLF (0.5 ml/kwh)
Steam Turbine Generator	: 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.
Steam Generator	: Steam Generator will be Ultra Super-critical pressure balanced draft furnace, single reheat, radiant, dry bottom type, sliding (variable) pressure operating, suitable for outdoor installation designed for firing pulverized coal as main fuel.
Station Operation Philosophy	: Base Load
Chimney	: 275 meter high, Twin flue RCC chimney
Power Evacuation	: Through dedicated double circuit transmission line (400 kV) from plant up to Indian border in the direction of Bogra (Bangladesh)

Zero Date : **Environmental Clearance or Financial Closure, whichever is later**

Project Completion Schedule from the Zero date : Unit-1: 44 months
Unit-2: 50 months.

SECTION: 3
DEMAND ANALYSIS & JUSTIFICATION

3.0 DEMAND ANALYSIS & JUSTIFICATION:

3.1 Introduction – Bangladesh

Power is among the key infrastructure that contributes towards the economic development of any nation. Installed electricity generation capacity in Bangladesh stood at about 11,877 MW as on Sep'15, with a contribution of 62.59% from Natural Gas. In transmission also, Bangladesh 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.

The peak electricity demand in the country is growing at a rate of more than 10% per annum. Considering the electricity demand growth rate of 10% per annum and GDP growth rate of 8% per annum, the rate of growth of power needs to be more than 10% annually. Further, the average per capita electricity consumption in Bangladesh stands at 321 kWh as compared to the global worldwide per capita consumption of more than 3,000 kWh.

Keeping in view the growth of demand and the gap between demand and supply, the Bangladesh Government has set a target to add about 11,600 MW of power generation capacity in next five years to achieve around 24,000 MW capacity with the aim to provide quality and reliable electricity to all the people of Country for desired economic and social development.

- Surrounded by India on the West, North and Northeast, Myanmar on the Southeast and the Bay of Bengal on the South.
- Strategic location: acts as bridge between South Asia and Southeast Asia.
- World's eighth-most populous country, with over 160 million people, and among the most densely populated countries.

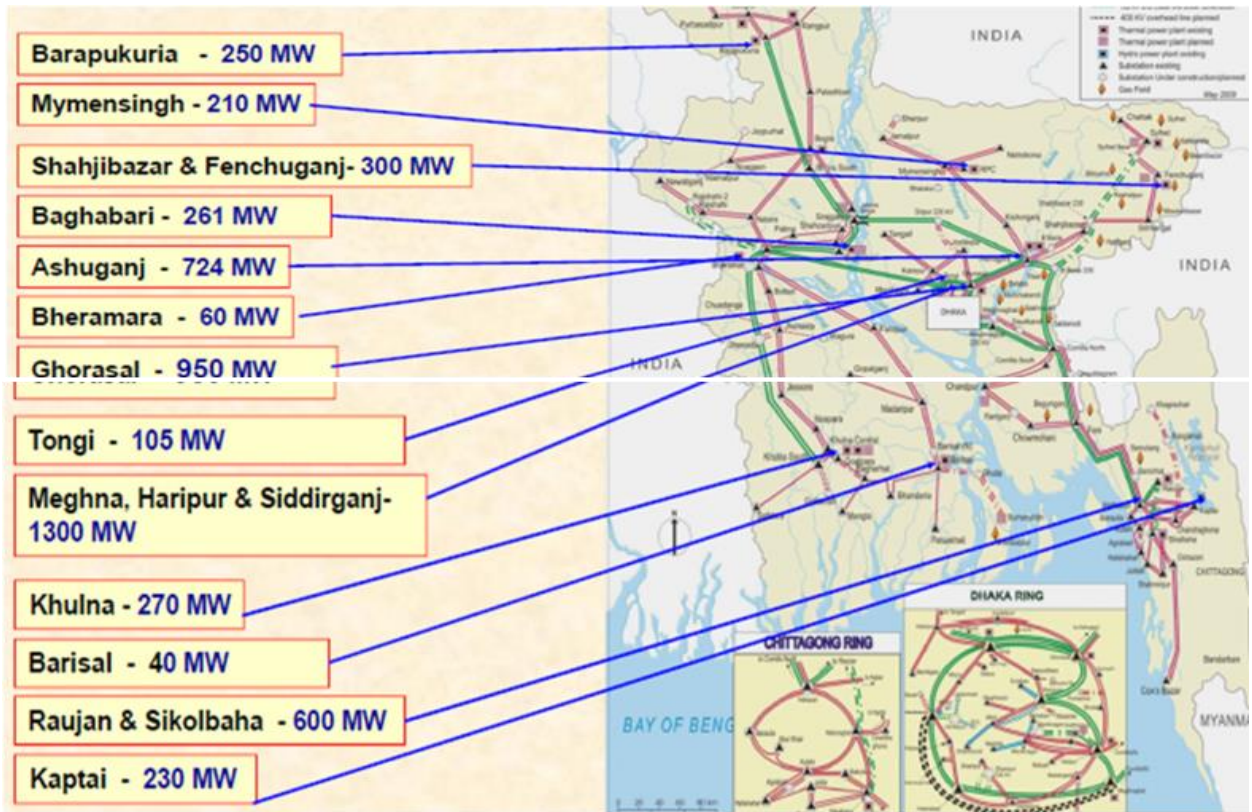
GDP	USD 174 billion (2014 World Bank)
GDP Growth (Constant 2005)	2015 – 6.51%, 2014 – 6.10% 2013 – 6.00% 2012 – 6.50% 2011 – 6.50%
GDP per capita	USD 1284 (2015), USD 1093 (2014 World Bank), USD 954 (2013)
Trade Balance	USD: -14.56 Billion (2014) USD: -9.93 Billion (2013)
Inflation	2014- 7.00% 2013 – 7.50% 2012 – 6.20%
Currency	1 USD = 78.66 BDT 1 BDT = 1.16 INR
Export (2014)	US 14.3%, Germany 13.6%, UK 7.9%, France 5.2%, Spain 4.3%, Italy 4.1%
Import (2014)	China 18.8%, India 14.8%, Singapore 5.8% Malaysia 4.2%

Area	Land: 1,30,168 sq km Water: 13,830 sq km
Population	162 million
Main cities	Dhaka – 15.40 Mln Chittagong – 5.30 Mln Khulna – 1.80 Mln
Religions	Muslim 89.5%, Hindu 9.6%, other 0.9%

BPDB Financial Health:

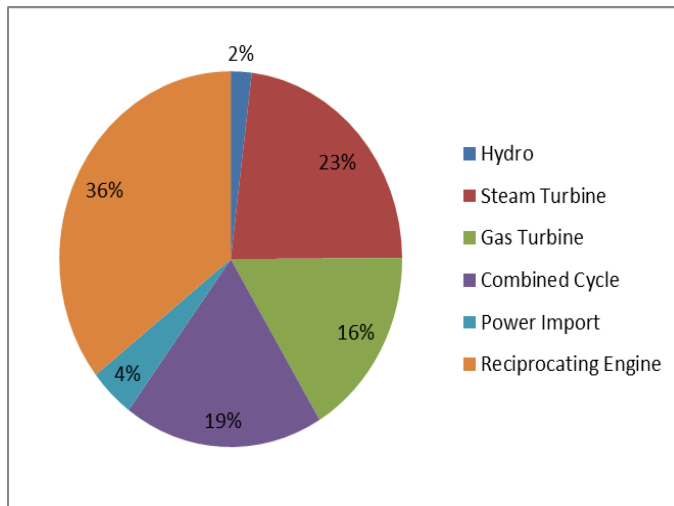
Year	Unit	2014-15	2013-14	2012-13
Electricity Sales	Lakh BDT	20,49,212	18,87,050	4,25,618
Other operating Income	Lakh BDT	69,550	79,170	15,594
Total Operating Revenue	Lakh BDT	21,18,763	19,42,876	4,41,212
Operating Expenses	Lakh BDT	27,49,676	25,43,589	5,07,215
Non-Operating Expenses	Lakh BDT	97,386	80,212	8,399
Total Operating Expenses	Lakh BDT	28,47,062	26,23,801	5,15,614
Net Income/(Loss)		(7,28,299)	(6,80,925)	(67,737)

3.2 Generation Capacity in Bangladesh



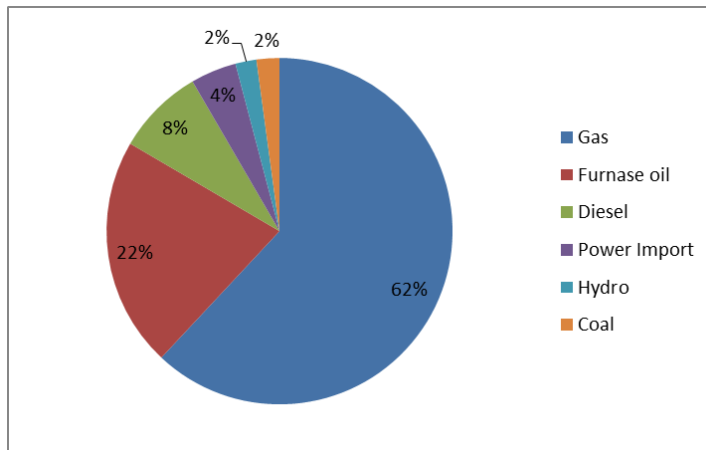
Total Installed Capacity as on August 2015 is 11683 MW

Present Status with Plant Type



Plant Type	Capacity (MW)	% Share
Hydro	230	2%
Steam Turbine	2680	23%
Gas Turbine	1918	16%
Combined Cycle	2201	19%
Power Import	500	4%
Reciprocating Engine	4154	36%
Total	11683	100%

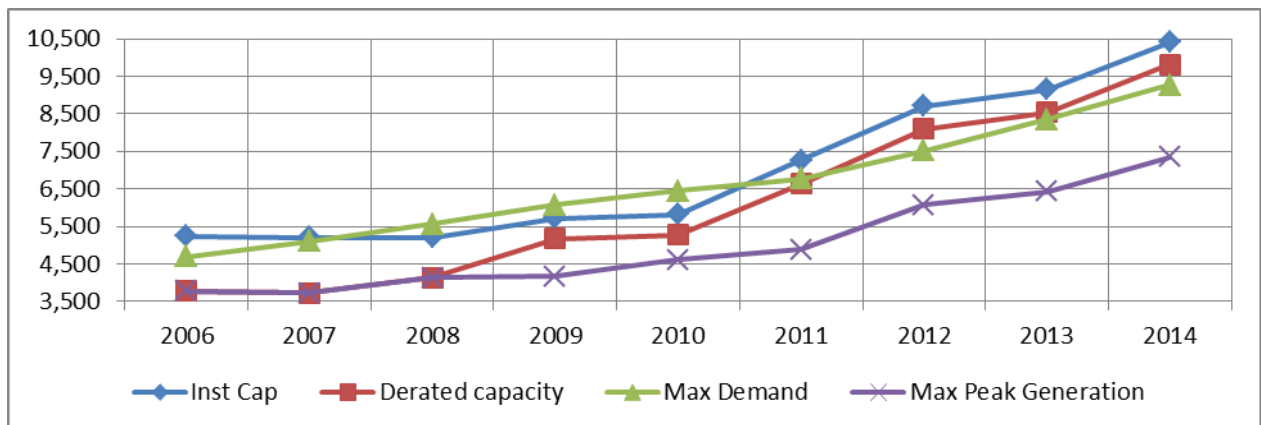
Present Status with Fuel Type



Fuel Type	Capacity (MW)	% Share
Gas	7240	61.97%
Furnase oil	2507	21.46%
Diesel	956	8.18%
Power Import	500	4.28%
Hydro	230	1.97%
Coal	250	2.14%
Total	11683	100%

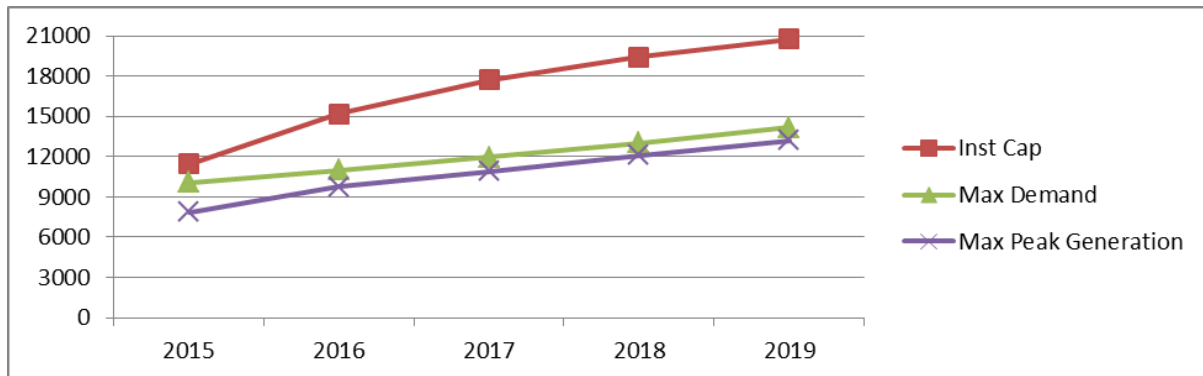
3.3 Present Status of Demand & Availability in Bangladesh:

Demand Supply Gap up to 2014:



Year	Installed Capacity (MW)	Derated capacity (MW)	Max Demand (MW)	Max Peak Generation (MW)
2006	5,245	3,782	4,693	3,782
2007	5,202	3,718	5,112	3,718
2008	5,201	4,130	5,569	4,130
2009	5,719	5,166	6,066	4,162
2010	5,823	5,271	6,454	4,606
2011	7,264	6,639	6,765	4,890
2012	8,716	8,100	7,518	6,066
2013	9,151	8,537	8,349	6,434
2014	10,416	9,821	9,268	7,356
2015	11,534	10,939	10,283	7,817

3.4 Projected Demand Supply gap in Bangladesh



Year	Installed Capacity (MW)	Max Demand (MW)	Max Peak Generation (MW)
2015	11477	10091	7887
2016	15201	10987	9768
2017	17719	11962	10886
2018	19440	13024	12092
2019	20760	14181	13226

3.5 Choice of Fuel

The main fuel considered for the project is Imported Coal. Coal from Dhamra port will be transported to the project site by rail. Coal storage of 15 days requirement of coal is proposed at the power plant.

3.6 Station Configuration

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

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

Station comprising 800 MW Unit is recommended in order to take advantage of economy of scale in specific cost, construction and operation of the units, manpower involved, the heat rate achievable and lower specific auxiliary power consumption.

With higher set sizes, the capital outlay as well as cost of generation is comparatively less.

For the proposed station, installation of two (2) units of 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 favor of 800 MW sets. Further these set sizes are considered appropriate in the light of expansion of both PGCIL and the State Grid to handle the generated power.

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

3.7 Justification of Project:

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

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

The Project proponents have carefully considered all above and decided to set up Thermal Power Plant at site location at Motia, Gangta, Gaighat and adjacent villages.

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 land required for installation of 2x800 MW TPP has been identified in Motia, Gangta, Gaighat & other adjacent villages in Godda Dist. of Jharkhand.

Water:

The water requirement for the proposed power project shall be approx. 36 MCM per annum. Various sources of water have been explored including Sunder Dam Reservoir at Deonapur, which is at a distance of 30 km from the proposed site, but there is not sufficient water storage and also water from this reservoir is used for irrigation purpose.

By water availability study of surrounding areas, it has been emerged that water requirement for the proposed project can be met from Chir river. Accordingly, Water

allocation has been received from Water Resource Department, Government of Jharkhand for drawl of 36 MCM from Chir River.

To meet water requirement during non-monsoon period (approx. 24 MCM), a storage reservoir of 24 MCM capacity will be constructed at suitable location near to project site.

Coal:

The requirement of Coal for the project shall be catered through imported source. The imported coal shall be unloaded at Dhamra port and shall be transported from Dhamra port to proposed site through rail/ road.

Rail Connectivity:

The imported coal shall be transported to the proposed project location through rail from Dhamra Port. Dhamra Port is connected to Jasidih through Indian Railway Network. However, the proposed project site is not connected directly with Railway Network. Rail connectivity is being explored as below:

- The nearest Railway Station is Hansdiha, which is approx. at a distance of 45 km by road from the proposed project site. Considering proposed construction of Hansdiha to Pirpainti line, which would pass through Godda Railway Station, coal transportation from Dhamra to the Power Plant would be via Godda Railway Station. Total distance from Dhamra Port to Godda Station via Rampurhat would be 695 km and the route is:

Dhamra Port - 65 km - Bhadrak – 491 km - Rampurhat – 65 km - Dumka – 42 km – Hansdiha- 32 km - Godda - 10 km (to be constructed by AP(J)L) – Motia, Gangta, Gaighat site.

Power Evacuation:

Delivery point will be mutually agreed interconnection point within Indian border. The dedicated transmission line within Indian border shall be built owned and operated by AP(J)L. BPDB shall be responsible for getting the transmission line constructed by PGCB from interconnection point inside Bangladesh territory.

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

SECTION: 4
PROJECT DETAILS

4.0 PROJECT DETAILS

4.1 Accessibility:

The Project site is located in Motia, Gangta, Gaighat and other adjacent villages in Godda District of Jharkhand.

The Project site is located adjacent to the NH – 133, approx. 9.5 kms from site boundary. Approach Road to site from Godda – Bhagalpur SH is existing which will be widened and strengthened or alternatively, new approach would be developed for the project from Godda – Bhagalpur SH.

The nearest existing Railway Station is Hansdiha, which is approx. at a distance of 45 km by road from the proposed project site. The proposed location of railway station at Godda on the Hansdiha-Godda Railway line (under implementation) is approx. 10 km from the site.

4.2 Land for the Project:

Details of land utilization in various areas of the plant are as below:

Description	Area in Acre
Main Plant Area, WTP, CT etc.	393
Green Belt	203
Township	30
Ash Dyke	234
Total	860

Other technical aspects like wind direction, soil characteristics also have been taken into consideration while developing the Plant Layout.

A canal passing along the western periphery of proposed plant will be preserved.

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 Imported Coal. Coal from International market will be procured from countries like Indonesia, South Africa, Australia and other possible sources. The imported coal shall be received at Dhamra port (Odisha) and the same shall be transported to the project site by rail. Coal storage of 15 days requirement of coal is proposed at the power plant.

The annual requirement of coal is estimated to be about 7-9 MMT for the two (2) Ultra Super-Critical Units of 800 MW,

b) Start-Up Fuel: The boiler will be designed for cold start-up and initial warm-up using Light Diesel Oil (LDO)/ High Speed Diesel (HSD). LDO/ HSD will be received at the proposed plant by means of the rail/ road tankers.

The annual requirement of secondary fuel (LDO/ HSD) is estimated to be around 15,000 KL per annum.

4.3.2 Infrastructure & Mode of Transportation:

Adani Group owns & operates the Dhamra Port. The imported coal from overseas mines for operating the Power plant shall be unloaded at Dhamra port and transported through rail/ road to the Plant site in Jharkhand. Coal will be unloaded in wagon tippler or Track Hopper respectively at Site. The location of the Take-off in Railway line and route survey would be decided in consultation with Railway Authorities & State Govt.

4.4 Water Availability:

Availability of water for the proposed site has been explained in Section- 3.8 "Justification of Project".

4.5 Power Evacuation Plan:

It is proposed to sell power generated from the station to Bangladesh through dedicated 400 kV D/C transmission line which shall be constructed from the proposed site to an interconnection point near Bangladesh border. The Transmission line within Indian Territory approx. 100-120 km (from Motia) will be constructed by AP(J)L. BPDB will construct the Transmission line beyond the interconnection point within the Bangladesh Territory.

Construction Power & Commissioning Power shall be arranged from the Indian grid/ substation for which necessary provision in the Power Plant shall be made. Start-up & Synchronisation shall be done using the dedicated Transmission line connected with Bangladesh grid.

4.6 Environmental Aspects:

In the proposed project, water from existing 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 – 7.0.

4.7 Site Features:

Motia, Gangta, Gaighat and other adjacent villages:

The proposed site has the following inherent advantages:-

- Availability of suitable & adequate land.
- There is no forest land within the proposed location.
- The site is not located in an environmentally fragile area.

SECTION: 5
TECHNICAL FEATURES

5.0 TECHNICAL FEATURES

The power generating Units will be of Ultra Super-critical steam parameters utilizing Imported coal.

It is proposed to use river water from The Chir River 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 existing ash dyke along with bottom ash.

Switchyard will be located near the power block. The power generated at the plant will be evacuated at 400 kV level through proposed dedicated transmission line to be constructed by AP(J)L up to Indian Border in the direction of Bogra (Bangladesh).

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, ASTM, DIN, BS, IEC, IEEE, IS, etc. The plant will comply with all local statutory regulations and requirements, such as Indian Boiler Regulations (IBR), CCOE, Indian Factories Act, Indian Electricity Act, Environmental Regulations, etc.

5.1 PLANT PERFORMANCE:

The general technical description is detailed in Section 5.2 for the steam turbine of 800 MW from each Unit. Plant gross heat rate with performance coal, design ambient conditions and cooling water temperature, is considered to be approx. 2,216 kCal/kWh including operating margin of 6.5% at 100% PLF and the auxiliary consumption is considered as 7.5% of the gross power generated. Availability of the plant of similar size and type is above 85%.

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 Ultra Super-critical, once through, outdoor, pulverized coal fired, balanced draft, single reheat, dry bottom type with two pass or tower type arrangement as per manufacturer's standard. For

improved efficiency at part loads and flexible operability, boiler capable of sliding pressure operation is favoured. An added advantage in this type of boilers is feature of Boiler circulation pumps which shorten the start-up time and heat loss during start-up period.

The combustion system will be provided for pulverised coal firing with Low NOx type coal burners. The steam generators will be designed for continuous satisfactory operation with the range of coal. The furnace would be conservatively designed for fuel to burn completely and to avoid any slagging in the furnace and excessive fouling in the super heater sections of the boiler. The design flue gas velocities would be carefully selected to minimise erosion of pressure parts and other vital components on account of ash. The steam generators would be designed in accordance with the latest provisions of Indian Boiler Regulations.

Capacity of steam generating units would be so selected as to ensure adequate margin over the requirement of Turbine at 100% MCR in order to cater to auxiliary steam requirement for soot blowing operation, and also for start-up of the adjacent unit, and de-aerating of the steam generating units after prolonged use. The steam generators would be designed to operate with "the HP Heaters out of service" condition (resulting in lower feed water temperature at Economiser inlet) and deliver steam to meet the turbo-generator requirement at base load. Economiser section of the boiler would be non-steaming type with provision for recirculation during start-up, chemical cleaning etc. Super heater section would be divided in convection and radiant zones and designed so as to maintain rated steam temperature at outlet over the range of 60% to 100% MCR load. Main steam de-superheating stations with provision for spraying water tapped off from feed water piping would be provided. Air preheaters, preferably of rotary type would be provided with a set of soot blowers of automatic sequential electrically operated type, arranged for on-load cleaning of the heat transfer surfaces.

Draft system of each boiler would be provided with Forced Draft and Induced Draft Fans with suitable capacity and control arrangement, each independently capable of meeting the requirement at 60% boiler MCR load. The forced draft fans would control total airflow to boiler and the induced draft fans will control furnace draft of the boiler through automatic control loops. The coal will be received to the coal bunkers of about 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 NOx coal burners from each mill for combustion in the furnace of the boiler thro' coal conveying pipes.

HSD/LDO will be required as secondary fuel for start-up, load carrying and flame stabilization at low load.

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

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

Electrostatic Precipitator:

Each steam-generating unit would be provided with electro-static precipitators. Each precipitator will have two parallel gas paths, any of which can be isolated for maintenance when required, keeping the other path in operation. Each path will have fields in series for collection of fly ash. The ESP will be designed for outlet dust burden not exceeding 30 mg/Nm³ at 100% MCR.

5.2.2 Steam Turbine:

The steam turbine would be 3000 rpm, tandem compound, single reheat, regenerative, condensing, horizontally split, three-cylinder machine with extractions for regenerative feed heating. The turbine would be designed for main steam parameters of corresponding to the boiler output of pressure and temperature, before emergency stop valves of HP turbine and reheat steam parameters to IP turbine. The LP turbine will exhaust to condenser. At turbine valve wide open (VWO) condition the turbo-generator set will be able to operate continuously with a throttle steam flow of about 105% turbine MCR condition.

The bypass station will act not only as a protection to the unit during pressure rise resulting from sudden load throw off but also enable operation of the unit at loads lower than the controllable range of load. This will also permit quick, repeated hot starts of the unit on its tripping.

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

Generator will be connected to its unit step up transformer. The auxiliary power requirement of the unit will be drawn from its unit auxiliary transformer tapped off from the generator bus duct. All auxiliaries like turbine oil purification system, generator seal oil system etc. as well as necessary protective and supervisory system will be provided to ensure trouble-free, safe and efficient operation of the turbo-generator. The unit will be guaranteed to generate required output at generator terminals continuously. The turbine will be suitable for wet steam washing for which set of auxiliary equipment necessary for the units will be provided.

5.2.3 Condensing Equipment:

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

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

Vacuum pumps will be provided to maintain the vacuum in the condenser by expelling the non-condensable gases. 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:

Coal for this Project would be imported coal. The annual requirement of Coal for the Power Plant would be about 7-9 MMT. Imported Coal would be transported to proposed site through rail/road. Coal shall be unloaded in the Power plant by Wagon Tipplers and Track Hopper, as per requirement. The Coal shall be normally transported to Main Plant bunkers / stockyard through belt conveyor. The Coal received at the Plant Site would be stacked by Stacker Reclaimers for further conveying either to the Plant Bunkers or to the Plant Stock-yard through a series of Conveyors. Provision will be made to keep 15 days stocks at the Plant Stockyard.

- Conveying system:

The rated/ design capacity of coal conveying system shall be 1,800/2,000 TPH. Two (2x100%) coal conveying streams shall be provided. All conveyor belting shall be of the fire resistant plied construction type.

- Crushing & Screening:

Suitable coal crushing equipment shall be included. This shall crush the delivered coal to a suitable size for use by the boiler coal milling plant. Dust suppression equipment shall be included to ensure a safe working environment and to limit the release of dust to the external environment to acceptable levels. In-line magnetic separators

shall be provided to protect the crushing equipment, the main boiler bunkers and coal milling plant from damage or poor operation due to any tramp metal. Screening equipment shall be included to ensure that only correctly sized coal is fed to the main boiler bunkers and coal milling plant.

- Stacking and reclaiming:

A complete, fully operational and safe working coal storage stockyard with all associated equipment and environmental controls shall be provided to meet the functional requirements of the power station. The facilities of the coal storage stockyard shall include:

- Fully automatic stacking and reclaiming facilities
- Bulldozers
- All environmental controls including dust suppression sprays and waste water treatment.
- Auxiliaries like Dust extraction system, ventilation system, metal detector, Inline magnetic separator, Belt scale, Coal sampling unit, Elevator, Material handling system, Bunker ventilation system, Bunker sealing system, V-plough tripper, service water & drinking water shall be included.

The coal handling system shall be designed based on the following parameters:

Design GCV of coal 3,500 – 5,000 kCal/kg

Hours of operation considered -14 hrs

Rated/Design capacity required -2,000/2,200 TPH

5.2.5 Fuel Oil Handling System:

The fuel oil system shall be meant for start-up of the plant and to provide support in flame stabilization while firing coal at and below 40% BMCR capacity. The Light Distillate Oil (LDO) / High Speed Diesel (HSD) shall be used for boiler light up and flame stabilization during low load operation. The LDO / HSD unloading and storage system shall receive LDO / HSD from road tankers and unload it to the LDO / HSD tanks. The road tanker unloading station shall be designed to unload 08 road tankers simultaneously. The oil shall be unloaded through neoprene hoses. The LDO / HSD from unloading header shall be pumped to LDO / HSD storage tanks. LDO storage tanks shall be surrounded by dyke of sufficient capacity to hold the entire contents of the largest fuel storage tank.

Two (2) nos. of LDO / HSD storage tank of 2,000 KL will be constructed. From the storage tank LDO / HSD will be forwarded to LDO burners by means of 3 x 50% forwarding pumps. The pumps shall be fitted with duplex suction filters with all necessary piping, valves and instruments etc.

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 2.0 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 hydro bins. Decanted water from hydro bins 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 hydro bins shall be conveyed through the belt conveyors to mixing tank for ultimate disposal to ash dyke in lean slurry mode. Further, provision shall be provided for unloading of semi-wet bottom ash from hydro bins to open trucks for disposal to ash dyke. Bottom ash size shall be reduced to (-) 5mm, by means of suitable bottom ash second stage crushers, before feeding in to mixing tank. Ash from economizer hoppers shall be conveyed in to bottom ash hopper in slurry form by means of flushing apparatus.

Fly Ash Handling System:

The fly ash handling system will extract fly ash pneumatically under vacuum from electro static precipitator (ESP) & Air Preheater hoppers and store fly ash in intermediate surge hoppers. From surge hoppers fly ash will be conveyed pneumatically under pressure to ash storage silos. Three (3) ash silos shall be provided common for 2X800MW Units. Combined storage capacity of all the silos shall be considered as 16 hours minimum. One boiler unit will be provided with one pneumatic conveying system for handling of fly ash collected in the fly ash hoppers. Fly ash from the ESP and APH hoppers of each unit shall be removed in 5.0 hours per shift of 8 hours.

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

5.2.6.2 Ash Disposal:

The fly ash generated from these units will be either used in cement industries around the plant area or exported for its utilization by end users. 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 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 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. Bottom ash shall be disposed to Ash dyke in lean slurry form.

100% fly ash shall be utilized from 4th year onwards as per MoEF norms. However, fly ash generated during first 3 years of plant operation shall be disposed to ash dyke through High Concentration Slurry Disposal (HCSD) System. From 1st year itself Bottom ash shall be disposed to ash dyke through the trucks/ conveyor/ pipeline in lean slurry form.

5.2.7 Plant Water System:

5.2.7.1 Water drawl:

The water will be drawn from the River Chir by constructing a pump house inside the river and pumping to the reservoir through a dedicated pipeline. The total make-up water requirement would be around 4,000 m³/hr (36 MCM).

5.2.7.2 Makeup Water System:

Re-circulating cooling water system using wet evaporative Induced/Natural Draft cooling towers will be deployed for the proposed station. It will be used for the condenser and auxiliary equipment cooling in a semi-open cooling water circuit. The choice of cooling water system is guided predominantly by the GOI guidelines on use of sweet water for cooling purposes.

There will be 3x50% capacity intake pumps in the intake pump house to be constructed on River Chir 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 in outside plant reservoir (25 MCM) to cater 8 months 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.

Two (2) clariflocculator units of adequate capacity is considered. Normally both the clariflocculators will be running at part 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 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 (semi-underground) having a storage capacity of about 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-

Cater to 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. which will be met by three (3) nos. of Service water pumps (2W +1S) each having 50% capacity to meet the requirement of both units.

As feed water to meet the requirement of DM plant which will be met by three (3) nos. of DM Plant feed water pumps (2W +1S) each having 50% capacity to meet the requirement of both 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 both units.

In addition, clarified water will also be used for off-load Air preheater and ESP washing which will be met by three (3) nos. of Air Preheater Wash water pumps (2W +1S) each having 50% capacity to meet the requirement of one unit.

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 Ash water sump, CHP dust suppression, AHP and Horticulture and gardening system.

5.2.7.3 Demineralisation Plant & Heat Cycle Make-up System:

Assuming average 3% make-up for the heat cycle and accounting for three hours regeneration time, demineralising chains, of 3x90 m³/hr capacity have been envisaged for the proposed units. DM plant will supply heat cycle make-up, the make-up requirement for primary water circuit in heat exchangers for the auxiliary cooling system of boiler, turbine generator and other common auxiliaries.

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.

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

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

5.2.7.4 Circulating and Auxiliary Cooling Water System:

The river water will be sourced to meet the water requirements for condenser cooling and also for cooling the plant auxiliaries. The plant cooling water system will be of re-circulating type cooling system with Natural/Induced Draft Cooling Towers, which consists of 2 numbers of Concrete Volute Circulating Water pumps per unit.

Circulating Water pump house shall consists of 2 x 50 % (both Working with no standby) Concrete Volute Circulating Water pumps for each unit to circulate cooling water to condenser and plant auxiliaries. The capacity of each pump would be 46,000 cum/hr approximately.

The hot water return from condenser and auxiliaries will be routed through CT for cooling and will be recirculated through Cooling Water Pumps via fore bay channel.

It is proposed to install Two (02) induced draft cooling towers, one for each unit and of approx. capacity 92,000 m³/hr per tower. The cooling tower would be designed for a cooling range of 10°C. The design hot and cold water temperatures of the cooling towers would be 43°C and 33 °C respectively.

In order to prevent/minimise growth of algae in the CW system, Chlorine dosing system is envisaged.

Clarified water will be used as makeup water for the cooling tower. Make-up water to the CW system will be by gravity from the clarifier outlet.

5.2.7.5 Closed Cycle Cooling Water System:

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

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 2x60% capacity mixed bed trains, consisting of service vessels for each unit. The resins to be used would be strong acid cation and strong base anion type appropriate for the influent condensate quality. The resins will be separated and regenerated externally by transferring to a dedicated regeneration station. A common external regeneration facility will be provided for both units.

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

5.2.7.7 Service Water & Potable Water System:

Drinking water requirement for the plant will be met from the output of 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 m³. There will be 2x100% drinking water pumps, which will supply drinking water to various facility area overhead tanks. Plant service water requirement will be met from the Overhead Service water tank and 2x100% 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 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. Similarly separate system shall be provided for oily water in fuel oil unloading and storage area.

Rain Water:

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

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

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

Miscellaneous:

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

5.2.9 Fire Detection and Protection System:

General:

The Fire Detection and Protection system will be designed in conformity with the recommendations of the Tariff Advisory Committee of Insurance Association of India. While designing the fire protection systems for this power station its extreme ambient conditions need special attention. Codes and Standards of National Fire Protection Association (NFPA), USA will be followed, as applicable.

The Power Plant is classified as Ordinary Hazard Occupancy as per TAC. Hence, the entire system will be designed accordingly. The different types of fire protection/detection system envisaged for the entire power plant are described below.

The water shall be drawn from the Clarified water storage tank in which reserve capacity of 2,000 cum shall be provided.

Fire Water Tank:

The water required for firefighting system would be drawn from the desalinated water storage Tank and reserve capacity would be ear marked for the system. Volume of the tank will be designed to satisfy the fire water demand of plant in the worst assumed scenarios as per TAC/NFPA requirement. A reserve water level will be maintained in the water storage reservoir as per TAC/NFPA requirements.

Fire Water Pumps:

The fire water pump capacity and head will be designed as per the system requirement. The fire hydrant system will have a dedicated fire water main pumps. The adequate number of main fire pumps will be motor driven and one standby diesel engine driven pump. A separate motor driven fire pump of adequate capacity including one standby diesel engine driven pump will serve the HVWS/MVWS system. The entire fire water network will be pressurised and maintained by the hydro pneumatic tank along with common jockey pumps and with air compressors functions to make up the system leakage losses.

All the main and standby pumps will be capable of operating at 150% flow with a head drop less than or equal to 65% of the operating head. The shutoff head of the pump will not be more than 140 % of operating head in the case of vertical pumps. Fire pumps will conform to IS: 5120 and will be certified by TAC as approved Fire pumps.

Fire Detection and Alarm System:

A microprocessor-based Fire Detection and Alarm system will be provided for the entire plant area consisting of Intelligent Analogue Addressable type detectors. The system will consist of a central monitoring station and the main Fire Alarm Panel (FAP) located in unit control room and one fire alarm and control panel and repeater panel provided in the fire station office. Manual Call point (MCP) shall be provided at different strategic location in the entire power plant as per TAC/ NFPA 72.

5.2.10 Plant Air & Instrument Air System:

For instrument/service air requirement of main plant and auxiliaries, air compressors having a required capacity and a discharge pressure of 8 bar (g) with Air Drying Plants of same capacity will be provided. For the complete plant, Four (4) numbers (2W+2S) of Instrument 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:

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.

In addition to the above area, Air Conditioning System will be provided for ESP Control Room, Coal Handling Plant Control Room, Switchyard Control Room including Computer Rooms, Telemetry Room, PLCC & Telex Room, Required areas in Service/Facilities Building/Administration Building, Plant/Demineralization plant Control Rooms, Water and Fuel Analysis Room, Instruments Room and any other area, which contains control and instrumentation equipment requiring Space Conditioning or otherwise required to be air conditioned.

For the above 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:

- All other rooms of turbine building which are not air -conditioned.
- Switchgear rooms and cable galleries of main plant.
- Non air conditioned area of ESP control room.
- 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 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 Ultra 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:

Hydrogen generation plant of adequate capacity shall be installed to cater the requirements of 2X800 MW units.

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:

EOT Crane in the Turbine hall will be used for lifting/unloading of heavy equipment from Trucks at the unloading bay and also for erection and maintenance of equipment. Two EOT cranes of 160 Tons/ 35 Tons are considered in Turbine hall block of two units. One number EOT crane of 25 Ton capacity shall be provided for boiler feed pumps in BC bay.

5.2.19 Chimney:

One (1) no chimney with 2 flues, of 275 m with RCC construction is envisaged for 2X800 MW Units to comply with environmental regulations. The chimney will be concrete shell type, MS flues with top one third SS liner to cater to two (2) units of 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, SO₂ and NO_x monitoring system, CO monitoring and Flue Gas Oxygen analysers etc. The Chimney will be provided with rack & pinion type elevator to facilitate maintenance.

5.2.20 Elevators:

One (1) goods-cum-passenger elevator of about 2,000 kg carrying capacity will be provided for each of the steam generating units. Another two (2) passenger elevator will be provided at the entrance of the power house building for movement of personnel.

5.2.21 Painting & Corrosion Protection:

All mechanical and electrical equipment including piping system and structures will be painted with international standards / IS standard colour code for ease of identification. All steel structures will be painted with epoxy resin based paints. Galvanised structures will have minimum 610 mg/m² 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. Catholics protection system shall be provided for all underground structures wherever it will be felt necessary.

All equipment, buildings, structures etc. exposed to atmosphere shall be painted to suit marine climate and protect against salt / saline water carry over from sea with the blowing wind.

5.2.22 Workshop & Laboratory:

The power plant shall be equipped with a work shop capable of catering to the routine maintenance requirements of the plant. A central chemical laboratory adjacent to the DM plant buildings shall also be established for the station. This would have 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 Generator and Excitation System:

The Generator shall be three phase, two pole, cylindrical rotor, wye connected machine with phase and neutral terminals brought out for connection to isolated phase bus duct. Generator Neutral will be grounded through a dry type Distribution

Transformer having Secondary loaded by resistor to limit the Ground Fault current.

It shall be ensured that when the Generator is working at this capability and Cooling Water Temperature is 39 deg C, no part of Generator shall attain a Temperature Limit specified for Thermal class 130(B) insulation as per IEC-600034.

The Generator shall have following rating:

Sr. No.	Description	Rating
1	Rated output excluding excitation power	941 MVA
2	Power Factor	0.85 lagging
3	Terminal Voltage	24 – 27 kV
4	Frequency	50 Hz (+3%)
5	Short Circuit Ratio	not less than 0.5
6	Efficiency	99.8%
7	Minimum Capacitive MVAR rating at zero MW	Minimum 30% of rated MVA
8	Maximum Hydrogen Pressure	4.5 bar
9	Class of Insulation	Class F but limited to class B temperature rise

The maximum permissible temperatures of different parts of the generator shall be as per IEC 34-1, 34-3 as applicable.

The Generator rating listed above shall be guaranteed on the basis of continuous operation without exceeding the temperature limits at rated hydrogen pressure.

Voltage Variation	+/-5% continuously at rated power factor Reduced MVA operation at 110% of the rated voltage. (to be indicated by the Bidder)
Frequency Variation	50 HZ (+3%)
Combined voltage and frequency variation	5 %
Power factor variation	0.85(lag) to 0.95(lead)
Operation under unbalanced load	As specified in IEC 34-1
Operation under unsymmetrical short circuit	Negative sequence current I ₂ expressed in per unit of rated unsymmetrical short current for a duration of 't' second such that the value of I ₂ t circuit current shall comply to IEC 34-1.
Voltage Wave form	The telephone harmonic factor (T.H.F) shall be within the limit specified in IEC 34-1.
Short Circuit withstanding capacity	Capable of withstanding of 3 phases short circuit at the generator terminals when operating at rated MVA and power factor with 5% over voltage for a period of not less than 3 secs.

Special operating conditions	Capable of withstanding the electrical, mechanical and thermal stresses developed during fast reclosing of high voltage line, transmission line switching, faults, out of step operation and out of phase synchronization etc.
Line charging Capability	Not less than 30% of its rated MVA at zero pf. leading
Operation with one gas cooler out of service	The generator shall be capable of delivering at least two thirds of the rated output.
Generator Neutral	Non-effectively earthed through a distribution transformer loaded with a resistor. The core design to permit the flow of earth fault of at least 15 amperes for one (1) second without any core damage.

Lightning arrestor of suitable rating shall be provided for the surge protection of generator winding. In case surge capacitors are recommended, the same shall be also be provided.

The Excitation system may be static or brushless. The excitation system shall meet the performance requirements specified hereinafter.

- a) The Generator and its Excitation system shall be capable of continuous stable operation without any excessive Temperature rise at the peak output of the associated Steam Turbine under VWO and HP heater condition etc. as available for secondary Cooling Water Temperature of 39 deg C.
- b) Maintain the Generator terminal Voltage constant within +5% of the preset value over the entire load range of the machine.
- c) The response time must be short so that the Automatic Voltage Regulator (AVR) can control the Generator during system disturbances or transients in which rapid changes in Excitation are required to maintain system stability margins both in steady state and transient condition.
- d) Brushless or Static Excitation system is envisaged for the Generator.
- e) The reference voltage set point shall be adjustable over a range of 85 to 110% of the nominal rated voltage under all load conditions.
- f) The rated current and voltage of the excitation system shall be 110% of the machine excitation requirements at rated output. The ceiling voltage shall not be less than 150% of the machine excitation voltage.
- g) The system shall be capable of supplying the field forcing requirement for at least 30 seconds. The nominal exciter response ratio shall not be less than 3 per second.
- h) If brushless excitation system is adopted, sufficient parallel diodes to allow for 20% failure without de-rating exciter.
- i) The Excitation system shall have matching characteristics suitable for satisfactory parallel operation with other Generators.
- j) The necessary inputs and interface equipment shall be provided with Generator Excitation and Automatic Voltage Regulator for hooking up with Turbine Automatic run-up system and Electro Hydraulic System.

The following features/functions shall be incorporated in the regulator:

- Cross current compensation
- Slip stabilizer
- Load angle limiter
- Stator current limiter
- Rotor current limiter
- Volt/Hz. ratio controller
- Rotor temperature transducer/transmitter with remote mounted indicating recorder
- Field current and voltage measuring equipment
- Under excitation limiter for operation of generator within stability limits and to avoid stator core end heating.

5.3.2 400 kV & 132 kV Air Insulated Switchyard:

400kV Switchyard with one and half breaker bus configuration layout shall be installed. The layout shall be I type with 04 diameters.

- Line Bays to 400 kV AC yard – 03 nos.
- Switchable Shunt Bus Reactors - 01 no.
- Station Transformer bays – 02 nos.
- GT bays – 02 nos.

For 400kV Switchyard control, protection, indication, local/remote operation & monitoring shall be by Substation Automation System (SAS) consisting of star coupler, RTU units, I/P & O/P cards for digital / analog, air conditioned bay kiosks, hard wares, soft wares, LCD screens, video cameras for switchyard area, communications, optic fiber cables etc., The SAS would integrate the SCADA functions and the numerical protection systems provided for various bays.

Control and monitoring of complete switchyard shall be done using suitable number of operating work stations in the switchyard control room. One (1) no. Engineering Station would be provided in the Switchyard control room to make the SAS configuration changes, DR analysis and system settings.

Each line feeder shall be provided with both main and a check meter of ABT type. HV side of Generator transformer, Station Transformer and ICT will have energy auditing meter. Accuracy class of tariff meters / energy auditing meter shall be of 0.2S.

Switchyard shall be provided with redundant 220 V DC batteries, redundant Chargers and DC Board to cater the DC loads.

Redundant 48 V DC batteries, redundant Chargers and DC Boards shall be provided to cater the Power line carrier communication (PLCC).

Switchyard structures shall be hot dip galvanized and thickness of galvanizing shall be not less than 910 gm/sq.m.

5.3.3 COMMISSIONING POWER AND CONSTRUCTION POWER:

For commissioning and construction power demand is estimated of the order of 50 MVA. This shall be availed through a 132 kV Switchyard having at least 3 bays. One shall be incoming line bay and balance two shall be Transformer bays.

- The incoming line would charge a 50 MVA, 132 kV / 11kV/ 11kV three winding transformer of secondary windings rated for 45 MVA and 5 MVA.
- 45 MVA winding which in turn shall charge 11kV Commissioning switchgear. Outgoing feeders on this 11kV switchgear shall feed station switchgear. Each unit shall have individual station transformer to cater station loads. Two outgoing feeders from the commissioning switchgear shall be connected to each 11kV Station Switchgear.
- 5 MVA winding of the transformer shall be connected to 11kV Construction Power Switchgear with bus-coupler, which shall be used for construction power. A separate 5 MVA, 132kV/11kV transformer shall be used to cater construction power load through 11kV switchgear.

5.3.4 STARTUP/COMMISSIONING PHILOSOPHY:

The commissioning power will be sourced through 132kV Transmission line from Lalmatia substation of Jharkhand State Electricity Board. The start-up power will be drawn by back charging the 400 kV Transmission line from Bangladesh Grid.

5.3.5 GENERATOR TRANSFORMER

The generated voltage of 24~27V will be stepped up and fed to 400kV Switchyard by Generator Transformer (GT) connected directly to the Generator terminals through Isolated Phase Bus-duct (IPBD).

The Transformer will be a bank of three Single Phase Units of 330 MVA, 24~27/400/ $\sqrt{3}$ kV, YNdII and 50 Hz suitable for maximum utilization of Generator capacity. The total capacity of Generator Transformer will thus be 990 MVA. One number Single Phase Unit of 330 MVA, 24~27/400/ $\sqrt{3}$ kV, 50 Hz Generator Transformer shall be kept as spare.

- The Transformer would have OFAF or ODAF type of cooling.
- It will be provided with Off-circuit Tap Change system on HV side having range of tap of +5% to -5 % of nominal Voltage in 5 steps of 2.5 %.
- The High Voltage terminals of the Transformer will be connected to the 400 kV outdoor Switchyard by overhead conductors.
- To protect the GT against atmospheric disturbances, Lightning Arrestors will be provided near HV terminals.
- Maximum Flux Density in any part of the core and yoke at rated MVA, Voltage and Frequency shall be 1.9 tesla.
- Withstand capability of the GT for 25% above rated Voltage shall be 1 minute and for 40% of above rated Voltage shall be for 5 seconds.
- The temperature rise at full load shall be limited to 45°C / 50°C over ambient of

50°C for oil / winding.

Total cooling system of transformer shall be so designed that during total failure of power supply to cooling fans & oil pumps, the transformer shall be able to operate at full load for at least ten (10) minutes without the calculated winding hot spot temperature of the transformer under any operating condition shall not exceed 140°C Online DGA and online PD monitoring shall be considered.

5.3.6 STATION TRANSFORMER:

Station Transformers shall be 3 Phase units and will have three winding rated for 80/40/40MVA, 400kV/11/11kV, Vector Group YNyn0 yn0 and Impedance Voltage of 10~15% on 40 MVA base.

- The ST will have 60%/ 80%/ 100% capacity for ONAN /ONAF / OFAF cooling.
- The temperature rise at full load shall be limited to 45°C / 50°C over ambient of 50°C for oil / winding.
- In order to take care of Grid Voltage variation, these Transformers will be provided with On-load Tap Changer to accommodate Voltage variation of plus 10% to minus 10% @1.25 % per tap.
- HV side of this Transformer shall be connected to 400 kV Switchyard through overhead conductor. LV side of these Transformers will be connected to 11kV Indoor Station Switchgear installed in the Main Plant through Phase Segregated Bus-ducts (SPBD).
- To protect the ST against atmospheric disturbances, Lightning Arrestors will be provided near HV terminals.
- These transformers shall be provided with Online DGA equipment.

5.3.7 UNIT TRANSFORMER:

Two (02) Unit Transformers per unit have been envisaged for feeding the Unit Bus Each of these Unit Transformers will be 3 Ph, 45/ 50MVA, 21~24kV/11kV, ONAN/ ONAF cooling, Dyn1, Impedance Voltage 10~13% on 45 MVA base,

- The temperature rise at full load shall be limited to 45°C / 50°C over ambient of 50°C for oil / winding.
- These transformers shall be provided with On-load Tap Changer system on the High Voltage side to take care of voltage variation to the extent of +/-10% @1.25% per tap.
- The capacity of Unit Transformer shall be chosen on the basis of the Unit Auxiliary load requirements with due consideration to the starting of the largest motor, available CB capacity and voltage regulation requirements.

5.3.8 REACTORS:

Bus Reactors shall be capable of operating continuously at a voltage 5% higher than their rated voltage without exceeding hot spot temperature of 150 deg C at any part of the reactor.

The reactor shall be of gapped core type. Five limbed core construction shall be adopted to achieve high zero sequence impedance. In addition to the three gapped core limbs with windings, there shall be two continuous outer return limbs. The core sections between consecutive air gaps shall be molded in epoxy resin to prevent movement between individual laminations. The spacers forming the air gaps shall be blocks of ceramics with a high modulus of elasticity and the whole stacking of core modules shall be cemented together during the assembly to form a solid column without possibility of rocking, or rubbing between individual parts. The core segments shall be of radial laminated configuration. The radial laminations shall prevent fringing flux from entering flat surfaces of core steel which would result in eddy current overheating and hot spots.

5.3.9 LV SERVICE TRANSFORMERS:

LV Service transformers shall be provided to meet the demand at 415 V levels of auxiliary power systems. Each switch gear shall be fed by two numbers 100 % rated transformers.

- Each transformer shall be rated to meet the loads connected on both the bus section of Switchboard with 10 % design margin.
- Maximum rating of the transformer will be limited to 2.5 MVA, so that short circuit rating of 415 V systems is not exceeding 50 kA. Further, Transformer voltage impedances shall be so optimized that the auxiliary system voltages under various loading conditions and fault currents are always within permissible limits and equipment are not subjected to unacceptable voltages during operation and starting of motors.
- HV winding will be delta connected rated for 11 kV or 6.6kV as per distribution and LV winding will be Star connected rated for 415 V. LV neutral shall be solidly grounded. No load voltage ratio shall be at least 5% higher than the nominal voltage to account for voltage drop in the transformer during loaded condition. Accordingly LV voltage will be 0.433 kV.
- All Service transformers shall be Dry Type, 3 phase 2 winding type.
- Dry type transformers shall be designed with Class C insulation with temperature rise limited to Class H. Dry type transformers envisaged shall be of open ventilated dry type transformer with IP 33 enclosure.
- The transformers shall be provided with off circuit tap changer on HV side.

5.3.10 ISOLATED PHASE BUSDUCT (IPB):

For connection between Generator and Generator Transformer/Unit Transformers, Isolated phase Bus duct shall be provided. Bus duct shall be continuous welded type. The Bus duct shall be with aluminum conductor and aluminum enclosure.

The continuous current rating of the main Bus duct shall be arrived at considering continuous MVA capacity of Generator at Turbine Valve wide open condition with a design margin of 10%.

The continuous current rating of the tap-off Bus duct shall be selected to carry Unit Transformer rating with a design margin of 10%.

The short time current rating of the main bus duct shall be arrived at higher the value of the followings: Short circuit current contribution from generator plus contribution of 6.6kV auxiliary system through Unit transformers (OR) Short circuit current contribution from 400 kV systems through generator transformer plus contribution of 6.6kV auxiliary system through Unit transformers.

The short time current rating of tap-off Busducts (to Unit transformer, excitation transformer cubicle and SPVT cubicle) shall be combined contribution of Short circuit current from generator and from 400 kV system through generator transformer and also the contribution of 11kV auxiliary system through one Unit transformer.

The bus duct design in the outdoor areas shall take into account heating effect due to solar radiation. The bus duct shall be natural air cooled. Degree of protection shall be IP55. Positive air pressurization arrangement shall be provided for the Bus duct to prevent dust ingress.

5.3.11 SEGREGATED PHASE BUSDUCT (SPB):

Segregated Phase Bus ducts are envisaged for 11 kV system for connection between respective Unit Transformer / Station transformers and 11 kV Switchboards and tie between 11 kV Switchboards.

The Bus duct shall be with aluminum conductor and aluminum enclosure. The Bus duct shall be natural air-cooled. Degree of protection shall be IP: 55.

Current rating shall be selected to carry transformer rating with 10% design margin. Bus duct shall be rated for short circuit withstand rating for 3 sec. Current rating and Short circuit withstand rating of Bus duct shall be not less than respective switchboard rating.

5.3.12 LV BUSDUCTS:

Non-segregated phase Bus ducts are envisaged for connection between LV service Transformer and 415 V PCC for rating of 1000 kVA and above. For lesser ratings, cables shall be provided.

Current rating shall be selected to carry transformer rating with 10% design margin. Size of Neutral Bus duct shall be 50% of Phase Bus duct. Bus duct shall be rated for short circuit withstands rating 50 kA for 1 sec.

The Bus ducts shall be non-segregated type with aluminum alloy conductor. The

enclosure shall be steel up to 2000 A rating and with aluminum alloy enclosure for higher rating. The Bus duct shall be natural air-cooled. Bus duct shall be suitable for indoor duty. Conductors shall be treated with mat black paint for efficient heat dissipation.

5.3.13 11 kV and 6.6 kV SWITCHGEARS:

11kV and 6.6 kV Switchgear shall be of Indoor, single front, single tier, metal clad, fully draw out type. Switchgear shall have IP 4X degree of protection.

SF6 breakers and Vacuum circuit breakers (VCB) are popular in medium voltage range. In recent years, for medium voltage application, vacuum technology has become more popular than SF6 alternative and every major manufacturer adopts VCB technology. In Europe and other countries, measures are being considered, to minimize the use of SF6, as SF6 gas leak/release may contribute to 'greenhouse effect'. Hence, vacuum circuit breaker has been proposed only for 6.6 kV systems.

The breakers shall have interrupting current rating to meet system fault level requirement. The switchgear shall be rated to withstand short circuit rating for 3 seconds.

Suitable surge limiters shall be installed on the cable side to limit switching over voltages for VCB.

The continuous current rating of the Switchboard buses and their incomer breaker shall be rated for secondary winding current of their upstream transformer with 10% margin.

Numerical multifunction relays with self-monitoring and diagnostic features shall be provided for protection.

For all incomers multifunction meter shall be provided for energy audit.

5.3.14 LV SWITCHBOARDS:

Power Control Centre (PCC) shall have two bus sections and a bus coupler. Each section shall have 100% rated incomer fed from service transformer. However ESP PCCs shall have two incomers, each 100% rated, without bus coupler. The PCCs shall distribute power to the following

- To breaker operated LT motors (Rating >110kW)
- To motor control centers (MCC).
- To Distribution Boards
- To Feeders rated > 100A

The 415 volt Distribution boards shall distribute power to small 415/240V non motor loads. The continuous current rating of the PCC buses and their incomer breaker shall be the rated for secondary winding current of their upstream transformer with 10%

margin. Redundant mechanical loads shall be fed from separate MCC buses. PCC/MCC/ DB shall be rated for 415V, 50Hz, 3-phase, 4 wire supply. Normal/Emergency MCC shall have 3-phase, 3 wire supply. PCC & MCC shall be draw out type and distribution boards shall be fixed type.

All the motor starters shall be 'Direct on Line' type. All MCC feeders shall conform to Type 2 co-ordination. Motor feeders shall be of conventional "SFU – Contactor – Relay" combination type. Multifunction numerical relay also can be considered for LT motors, in place of conventional bi-metallic overload relay.

The continuous current rating of the bus bars, incomers, bus couplers of the MCC shall be the maximum load on the bus due to all the running auxiliaries during any operating condition plus 10% margin and the biggest spare feeder rating.

The PCC, MCC and Distribution boards shall be located indoors. Type of outgoing feeders shall be as follows:

- Motors rated $> 110\text{kW} \leq 200 \text{ kW}$: Air circuit breaker (ACB) controlled.
- Feeders rated $> 400\text{A}$: Air circuit breaker (ACB) controlled.
- Motors rated $\leq 110\text{kW}$: Fused Contactor controlled.
- Feeders rated $\leq 400\text{A}$: Switch fuse units controlled.

5.3.15 MOTORS AND ACTUATORS:

All AC Motors shall be squirrel cage induction type rated for continuous duty. DC Motors shall be shunt wound type. Power supply for AC motors shall be as follows:

- Single phase motors: 230 V, 1 Phase, 50 Hz.
- Up to $\leq 200 \text{ kW}$: 415 V, 3 Phase, 50 Hz
- 200 kW & above : 6.6 kV, 3 Phase, 50 Hz

Motors shall be capable of delivering the rated output with supply voltage variation of $\pm 10\%$ and frequency variation of $+3\%$ to -5% and absolute sum of 10% . DC Motors shall be rated for 220 V DC with supply voltage variation of -15% to $+10\%$.

Motors shall be considered of energy efficient type. Variable frequency drives can be envisaged for drives like ID fan. All the motors shall be suitable for 'Direct On line' starting. While sizing the motor, deration due to voltage and frequency fluctuation need to be accounted. A design margin of minimum 10% shall be considered in Motor sizing unless otherwise specified in the Mechanical system criteria.

Motors shall be capable of starting and accelerating the load with the direct on line starting without exceeding acceptable winding temperatures when supply voltage is 85% of the rated voltage for LV motors and 80% for HT motors.

Motors shall be suitable for the following starts under the specified conditions of load, torque and inertia in the motor initially at its normal operating temperature.

- No. of consecutive cold starts : 3
- No. of consecutive hot start : 2

Locked rotor current of the AC motors shall be limited to 600% of the full load current of the motors. The BFP motor start up current shall be limited to 450% of full load current of the motor. Type of enclosure/cooling for LT motors shall be TEFC and for HT motors CACA/TETV/TEFC. All insulated winding shall be of copper. All the motors shall have class F insulation. Temperature rise shall be limited to 120 deg C.

Motors rated 1500 kW and above shall be provided with differential protection. Required current transformers, one for each phase shall be mounted in the neutral side terminal box. Actuators shall be integral type. Starter module required for the actuators shall be provided in actuator itself (Integral to actuators)

5.3.16 PROTECTION SYSTEM:

Fully graded protection system with requisite speed, sensitivity and selectivity shall be provided for the entire Station. For Generator redundant relays shall be considered for each protection function. For generator transformer, unit transformers (UTs) protections shall be connected to two independent groups/relays, such that one protection system shall always be available for any type of fault.

All the protection relays shall be multifunction numerical type with self-monitoring and diagnostic features and communication link/port.

Current Transformers: Accuracy class of CT core meant for tariff Metering/Energy auditing shall be 0.2S and other power metering core shall be 0.5. However for current metering it can be 1.0. Instrument security factor shall be < 5. Accuracy class for Protection core shall be 5P20 for protection in general. For differential protection, based on the type of differential relay, CT can be either PS class or 5P20.

Voltage Transformers: Accuracy class of VT core meant for tariff Metering/Energy auditing shall be 0.2 and other power metering core shall be 0.5. However for voltage metering it can be 1.0. Accuracy class for Protection Core shall be 3P.

5.3.17 PLANT COMMUNICATION SYSTEM:

The following communication equipment's are proposed:

- Public address system with page and party line
- Telephone system with 25 external lines and 500 intercoms
- Walky-Talkies

5.3.18 LAYOUT ASPECTS:

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

Generator Transformers, Unit Transformers, Unit Auxiliary, Station Auxiliary and Station Transformers shall be located in the Transformer Yard. 11kV Unit Switchgear, 11kV Station Switchgear, 415V Turbine PCC, 415V Boiler PCC, Emergency Switchboard, Ventilation MCC, Air condition MCC, 220V Battery & Charger, 240V UPS and 415V dry type Transformers shall be located in rooms of Power house building in A-B Bay.

Minimum clearance of 1000mm shall be provided on rear of panel for single front boards. For double front boards, clearance from wall/column shall be minimum 1500 mm. For installations with two rows of boards facing each other, minimum clearance of 2500mm shall be maintained between fronts of boards. Clearance between adjacent panels in a row shall be 800mm minimum.

Generally all Switchgear/MCC rooms shall have cable spreader rooms. For cable spreader rooms, doors shall be fire rated. Cable trench can be considered for smaller MCC Rooms.

A minimum clearance of 800 mm shall be provided between transformer and wall for LV transformers. For HV transformers the clearance shall be higher based on maintenance requirements. Oil soak pit shall be located at more than 5 meters from the transformer. In transformer yard one common soak pit shall be proposed for each unit sized to accommodate 110% of the volume of oil of the largest transformer

Where oil capacity of the transformer (individual or aggregate) is > 2300liters, firewall shall be provided unless equipment/ building are located at specified distance stipulated in regulations. Fire wall shall be two hour fire rated. 355mm thick brick or 200mm thick RCC or suitable hollow block masonry wall shall be considered, extended at least 600mm above the highest point of oil containing part of the transformer.

The batteries shall be located in a separate ventilated room. For batteries, the acid/alkaline resistant protective treatment shall be proposed for the battery room floor and on the wall surfaces. An eye wash basin shall be provided in each battery room.

400kV & 132 kV Switchyard shall have a common control room to accommodate relay panels, SAS system, DC system, PLCC panels, Tariff metering panel etc.

In the transformer yard, rail track shall be provided for transformer movement during installation and maintenance. These rail tracks shall be extended up to nearby road.

Electrical Lab shall be set up and adequate instruments and equipment for the same shall be provided.

5.4 CONTROL & INSTRUMENTATION SYSTEMS:

These design criteria will govern all aspects of the design basis and philosophy of the control systems engineering work, systems, and equipment. The criterion is intended to provide system level requirements. Proven control technologies and conventional

instrumentation will be used for equipment and systems vital to the availability and reliability of the plant.

The intent of this design basis report is to cover the basic design criteria for whole plant I&C package for this project. A brief description and salient feature of the various sub systems are defined here for the basis of design.

5.4.1 PLANT DESCRIPTION

The scope would involve design, supply & erection, calibration, testing & commissioning of BTG equipment including main plant and its associated control system, DCS, DEH, ETS, SWAS, CPU, LVS, BTG OCAMMMS (Including TSI), other related field instruments, BOP DCS and related instruments, C&I Laboratory Instruments, CEMS, BOP Vibration Monitoring etc. Important operational parameters, alarms and equipment status of the balance of plant packages will be linked to DCS for the centralized supervision and monitoring from central control room.

Main Plant & Balance of Plant (BOP) systems is sub divided into the following Systems:

- DCS
- Cable and Cable Tray
- C&I Erection
- SWAS
- CEMS
- Control & Instrumentation Lab
- Condition monitoring system (OCAMMMS)
- CCTV

5.4.2 DISTRIBUTED CONTROL SYSTEM (DCS):

A Distributed Control System (DCS) will be provided as the main operator for control and monitoring functions of this project. The system offered will be functionally and geographically distributed. All the Control System shall be time synchronized through GPS. The controls and instrumentation for the operation and monitoring of this project will be split in both centralized control and localized mode of control. The BTG (Boiler - Turbine - Generator) control is centralized from the Central Control Room whereas the control, monitoring & operation of the offsite and auxiliary plants will be carried out from control desk of the Combined Common DCS. The packages like fuel oil pressurizing and heating system, CW & ACW pumps, condenser make-up system, compressed air system, Condensate Polishing Unit and Mill Reject system etc will be controlled from CCR through DCS whereas other BOP auxiliaries will not have any control from CCR. However, major operational parameters of such auxiliaries will be monitored in DCS in CCR.

The BOP auxiliaries not controlled from CCR will include coal-handling plant, ash handling plant, DM plant and Fire detection system etc. All such systems will be controlled by Common DCS and will have redundant data communication link to main

plant DCS. The fundamental objective of the various control systems provided for this Thermal Power Plant is to facilitate effective plant operations by ensuring the following:-

- Personnel safety.
- Equipment protection.
- Ease of operation (automation).
- Equipment and cycle efficiency.
- Equipment and system reliability.
- Equipment and system maintainability.
- Minimization of incidence of operator error.
- Maximization of efficiency of operator.

To implement these criteria, normal control and monitoring of the unit will be from a Central Control Room (CCR) provided. The CCR will employ state of the-art control system hardware configured for ease of operator interface. The general design philosophy for the control & instrumentation system will meet the following objectives.

- High level of automation
- High degree of overall system reliability, Low downtime & high MTBF
- Enhanced availability of plant, taking into consideration proper
- Redundancies at various levels
- Operational convenience, user friendly
- Consideration of maintainability and accessibility.
- Consideration of long-range economy and better spares management.

The Instrumentation and Control System shall mainly realize the following functions in order to assist the operator to perform safe start up / shutdown and normal / emergency operation of the plant.

- Closed loop modulating control of parameters for optimized operation of turbine, boiler and balance of the plant.
- Open loop control for automatic sequential operation, interlock and protection of various drives.
- Continuous supervision of system parameters and equipment operating conditions
- State-of-the-art-practices prevailing in the field of instrumentation & control for power plant will be considered to ensure safe, efficient and smooth operation of the plant and equipment with minimum interference of the operating personnel during normal working of the plant.

The system design will be such that no single point failure will result in total system paralysis under any operational eventuality. Redundancy will be provided at appropriate levels for critical control system functions. In the event of loss of a major plant item, activities of binary and analog controls will be coordinated to ensure that the plant is automatically brought to a safe holding condition consistent with

maintaining maximum generation permissible under reduced plant availability. Local monitoring and control facilities will be provided for operations, which demand local attention. Local monitoring will be provided in cases where such indications are required for maintenance like pressure gauge for pump, commissioning and tuning of equipment and where recommended by equipment manufacturers for local supervision in case of emergency.

In line with the latest trend of control & monitoring, for centralized control & monitoring of the plant, the I & C system will be built around a Distribution Control System (DCS) with functionally distributed multifunction controllers, suitable Man Machine Interface (MMI) devices and other required peripherals and hardware. However, control of CHP, AHP, and WTP etc. auxiliary workshop will be from Common Control rooms by DCS. All auxiliary operating with Common DCS is provided with communication link / hardwired with CCR DCS system so that the CCR shift in-charge can have information of the most plant.

The principal functions of the DCS are as follows:-

- Provide the control of the steam turbine generator (STG).
- Provide control of the steam generator, main steam cycle, steam re-heat cycle, steam bypass and water cycle.
- Provide control of pulverizes, combustion air, burner ignition, and flame management.
- Receive input signals that represent the status of process variables and equipment status; condition the signals; and utilize them for control, protection, monitoring, status display, annunciation and SER.
- Provide the output signals to modulate and control the final devices, such as control valves, control drives, dampers and pumps.
- Provide communication for control room monitoring of control and information systems such as (i) DM plant; (ii) coal handling; (iii) ash handling; (v) ESP (hardwired interface for few signals) etc.
- Provide alarm logging and sequence-of-events recording (SER) capability with 1mS resolution. The SER will be envisaged to be performed as an inbuilt function of DCS itself.
- Perform information processing functions including logging and printout of historical data, trend displays, elapsed time monitoring, and summation of fuel and energy usage and generation.
- Provide a means to coordinate the load control of the prime movers in response to remote dispatch load change requests. Status of all drives, pumps, tanks, etc. should also be available in central control room.
- The automation offered by the system will include boiler master, boiler ignition control, furnace pressure control, Pulverizes load control etc. and turbine master, turning gear control etc.

Coordinated master control will be used to help achieve such automation and to maintain balance between fuel input in boiler and corresponding turbine generator output. The operator will be able to control the equipment via the station operator's

consoles in the central control room. Upon synchronization, the unit will be loaded in any one of the following ways:

- Manual loading by the operator Automatic loading to pre-select load set points initiated manually by the operator through boiler-turbine coordinated control loop.
- All emergency trip or runback action will be fully automated. No operator action is envisaged for any protection related logics under routine operation and running of the plant.
- Alarm and data acquisition will be on-line continuous function. Operator's action will be limited to accepting the alarm and recognizing the malfunction or upset parameters of any equipment or drives.
- The control system will provide the schemes and logic for startup, shutdown, and control of plant operation within limits, and will provide protection for the equipment.
- The hierarchy based control strategy will be implemented so as to reduce operator intervention during plant start-up, shutdown, and normal operation without compromising on the equipment protection and safety.
- Interlock and logic systems will be provided in various hardware and software forms.
- Process switches / Transmitters (i.e., pressure, temperature, level, etc.) used for protective functions will be connected directly to the DCS, FSSS, etc.
- DEH based control system shall be used for Turbine Governing system as well as TD- BFP supplied by the Turbine Vendor and TD-BFP Vendor respectively.
- Turbine Protection & TD-BFP Protections shall be PLC/DCS based control system supplied by their respective Vendor
- The Control System provides the overall coordination between all the elements of the various protection systems. The Control System provides the following safety related functions.
- The Control System will provide the automatic start-up and shutdown of standby auxiliary in a safe, fast and coordinated manner thereby limiting major plant disturbances. The Control System also controls auxiliary plant to prevent damage to main plant components.
- The Control System provides interlocks and protections thereby ensuring that the capability of all plant in service is to maximum and properly matched thus preventing the unit from reaching potentially hazardous conditions.
- The turbine control system prevents over speed conditions, inadmissible stress, and other functions to limit operation in potentially hazardous conditions. For critical applications like protection of Turbine, triplicate sensors and Triple Modular Redundant (TMR) hardware (I/O units and processors in failsafe configuration shall be used. The system shall be TUV certified safety system to SIL-3 per IEC 61508.
- The operators have access to all significant process information and all controls that normally require adjustment through the DCS by a single-window concept sitting at one place. Other packaged systems are interfaced with DCS and monitored for major upset conditions. If necessary, a manual

communication (Paging / phone or radio set, as per availability) from Central Control room (CCR) will be done to take all required corrective action. No control is envisaged for remote balance of plant package from CCR console.

- The DCS will have various details of plant operating conditions and various operating parameters in the form of alarms, reports, trends and other graphical information. And hence it reduces the operator error.

DCS control system shall consist of measurement system, interlock and microprocessor based annunciation system for control with the process.

- Application software to suit the project specification requirement.
- Laptop with license software shall be provided which is used for engineering services like any logic changes.
- Engineering software's.
- Licenses software for all the software being used in the DCS. The software licenses shall be provided for the project and shall not be hardware specific. That is, if any hardware/software is upgraded or changed, the same license shall hold good and it shall not be necessary for employer to seek a new license/renew license due to up gradation / change of hardware / machine in the DCS at the site. All licenses shall be valid for continuous service life of the plant.

5.4.3 COMMON DCS:

The following sub systems listed below will have control through Common DCS:

- Coal Handling Plant
- Ash Handling System.
- River Water Intake
- Raw Water Intake
- DM Plant
- CW Treatment System
- H₂ generation station
- Sanitary waste water treatment
- Industrial waste water treatment
- Reuse water treatment / coal bearing water treatment
- HVAC
- Chlorination
- Compressed Air System
- Fire Protection & Detection System.

Common used for various sub system will be communicating to DCS through redundant data link. Details of BOP packages including design philosophy are covered in DBR for respective package.

5.4.4 STEAM & WATER SAMPLING AND ANALYZING SYSTEM:

SYSTEM FUNCTION:

- To detect and measure the quality of steam & water in thermal system.
- To provide control signals to chemical dosing system.
- To monitor the condenser's leakage.

SYSTEM DESCRIPTION:

Each unit has been equipped one set of steam & water sampling and analyzing system which comprise steam & water sampling rack (WET Panel) and instrument panel (Dry panel).

Sample conditioning system shall be designed and constructed to receive and condition all samples as required by the respective analyzers connected to the sample streams. This shall include all conditioning equipment mentioned herein and covers the following:

- Sample filtering
- Primary and final sample cooling and temperature control
- Pressure reduction and control, as required
- Flow rate control
- Pressure and Temperature Protection
- Other treatment as required by individual analyzers or mentioned herein.

All the analyzers shall be microprocessor based with drift free, auto compensation and calibration provision. Analyzers shall have facility to programme from the front key pad and shall have necessary fault diagnostic features. Each analyzer shall have a self-contained read out meter.

The system design should ensure that pH and conductivity transmitters are mounted close to the respective sensors.

Multichannel analyzers are acceptable only for Silica, pH, Conductivity & dissolved oxygen measurements, as these measurements are more to monitor the trend. In all other measurements, such as, Sodium & Hydrazine measurements, Single channel analyzers must be offered.

Cooling water for steam & water sampling and analyzing system will come from the closed circulating cooling water system.

The sampling points and analysis instruments for each unit are as follows:

- Make-up D.M. Water
- Main C.E.P. Discharge

- Condensate Polisher Unit Outlet
- Deareator Inlet Deareator Outlet
- Feed water at Economizer Inlet
- Main Steam Left side, Right Side)
- Reheat Steam (Left side, Right side)
- Start-up Separator Drainage
- Closed Circulating Cooling Water
- LP Heater Drainage
- HP Heater Drainage

5.4.5 ONLINE COMPUTER AIDED MICROPROCESSOR BASED MACHINERY MAINTENANCE MANAGEMENT SYSTEM (OCAMMMS):

The vibration monitoring of all plant equipment is split in four groups:

Group - A: All BTG HT drives

Group - B: All BOP HT drives

Group - C: Turbine/Generator supervisory Instruments (TSI)

Group - D: Turbine driven Feed water Pump supervisory Instruments (MTSI)

For all above system, there will be one common online computer aided microprocessor based machinery maintenance management system (OCAMMMS). The system shall have predictive analytics for operator guidance.

TSI and MTSI will be two separate system hooked up to OCAMMMS through suitable communication link. Also BOP and BTG HT drives vibration monitoring system will be hooked up to main plant OCAMMMS.

Group - A and B drives as well as raw buffer signals from TSI, MTSI are routed to OCAMMMS through communication for analysis besides the 4~20mA signals connected to DCS / DEH. The important signal required for trip or any other protection related logic, hardwired contracts / analog signals are wired from local condition monitor relay output to DCS or PLC directly. Similarly, turbine / MBFP all related protection contacts are hardwired from TSI / MTSI to turbine / MBFP protection system. Communication link to OCAMMMS from TSI, MTSI will be non-redundant.

It will be used for condition monitoring of main STG, Turbine driven BFP and main plant HT drives / motors. OCAMMMS will take care of predictive maintenance of machine / equipment.

It will also have the capability to be accessed remotely through a telephone line and to interface via Modbus serial or Ethernet link to one or more plant process computers or controllers, as well as to interface with network devices to obtain process data.

The monitoring / protection system will be complaint to API670.

5.4.6 AAQMS:

The analyzers for the Ambient Air Quality Monitoring System (AAQMS) shall be designed to monitor the NOx, SOx, SPM 2.5/10 to meet the requirements laid down by appropriate regulatory authorities. The system to be provided shall include all necessary hardware, firmware and interfaces, all special and field signals cabling required for implementing a fully functional system

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:

Seismic load to be considered 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 1.75 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 for the zone in which the proposed power station is located. Design wind speed to be considered as 55m/sec. 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. The Deaerator bay (B-C bay) will have side cladding of brickwork (cement plastered with architectural finishes); B-row and C-row duly painted. Floor slabs and roof covering of B-C bay will be of cast in situ RCC construction. A-B bay will be equipped with EOT cranes. B, C, D row wall will be of bricks.

Roof will be provided with suitable drainage arrangement through rainwater down comers, 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 removed from the operational frequency of the equipment. The dynamic behaviour of the foundation will meet the requirements of IS: 2974 (Part I to IV) -Code of Practice for Design and Construction of Machine Foundations.

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

The vibration isolation system will be capable of vibration isolation not less than 95%. If minor equipment is 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 –

For decks of spring supported machine foundations and substructure.

- 1) M30 Foundation chimney shell and substructure of spring supported machine foundation.
- 2) M25 structural RCC work in foundations and superstructures, water retaining structures and chimney raft foundation.
- 3) M20 Grade slab & other miscellaneous items
- 4) M15: Sub-grade filling, mud-mat etc. (depending upon the aggressiveness of foundation soil)

Brickwork in cement mortar 1:4/1:6 will be used for plant buildings as applicable. Ductile detailing of RCC structures will be as per IS: 13920.

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

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-IV.

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 Civil Works for Cooling Tower:

Induced draft cooling tower for each unit to handle approx. 1,00,000 cum/hr water with leak proof underground basin and separation of whole basin in two parts by means of partition wall, internal platform arrangement, hot water duct system and CW channel etc. Suitable draining and pumping arrangement from the drain box outside is provided for sludge disposal. Cooling Tower will be RCC framed structure as per the requirement of BS: 4485-1996 Part I to IV.

5.5.6 Civil Works for Coal Handling Area:

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.

5.5.7 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 compressed air system will be provided.

5.5.8 Civil works for Chimney:

One (1) Twin-flue RCC chimney having flues of steel with insulation (insulated outside the flue) will be provided. The height of the chimney as per CPCB will be 275 M. The chimney will be fitted with 500 kg capacity elevator, staircase inside the windshield of RCC slip form construction. Chimney will be fitted with pollution measuring apparatus & warning lights at top.

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

SECTION: 6
PROJECT IMPLEMENTATION

6.0 PROJECT IMPLEMENTATION

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

6.1 Project Implementation Schedule:

The first Unit of 2X800 MW project is proposed for commercial operation in 44 months from "Zero date" and for subsequent unit with a gap of 6 months. 'Zero date' is the date of Receipt of Environmental Clearance or Financial Closure whichever is later.

6.2 Project Management:

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

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

The Project will be managed by the Project Company under the overall direction and control of its Project Director. 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.

AP(J)L 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. Project Company shall 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, Deareator, 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

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

6.5 Manufacturing, Inspection & Expediting Phase:

6.5.1 Inspection & Expediting:

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

6.5.2 Quality Assurance:

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

and / or through the appointed offsite approved agencies for shop as well as field activities.

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

6.6 Transportation / Handling of Equipment:

The proposed Site is located at Motia, Sondiha, Gangta & adjacent villages in Godda distt. of Jharkhand. The approach road from nearest Highway Godda – Bhagalpur SH connecting Motia would be required to strengthen for transportation of heavy equipment.

The main equipment which fall in the heavy equipment category are Generator Stator, Generator Rotor and Generator Transformer, ~~Deaerator~~–Deaerator, HP Heater and Ceiling Girder.

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

6.7 Construction & Commissioning Phase:

6.7.1 Construction Planning, Monitoring & Control:

Site activities would 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 Project Director of the Project Company with members from the Head Office and site will be constituted to review the progress of project on a 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 the river Chir 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 – 7.1
Type & Source of Pollution**

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

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:

- Low NO_x burners have been envisaged to reduce the NO_x generation and consequent emission.
- High efficiency Electrostatic Precipitators has been envisaged to limit the particulate emissions to 30 mg/Nm³.
- One no. 275 mtr. Height twin-flue chimney is envisaged for the plant, in line with the MoEF guidelines, which will help dispersion of air borne emissions

over larger area and thus reducing the impact of the power plant on ground level concentrations.

- Closed cooling water system with cooling towers envisaged, thus reducing significantly the makeup water requirement for the plant.
- The Plant will be designed to treat all waste water that generated from plant. The waste water will be discharged as per the prevailing environment norms.
- Dust extraction and dust suppression systems have been envisaged in the coal handling plant.

7.1.2 Pollution Monitoring and Control Measures:

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

Environmental Management Plan (EMP) is proposed to be established for the plant to detail out the environmental quality measures to be undertaken during the construction and operational phases. EMP will also discuss the post project monitoring measures to be adopted by the plant authorities in order to maintain the waste water qualities within the acceptable limits specified by the Jharkhand 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. Each flue will be provided with Continuous Emission Monitoring System (CEMS) to monitor the PM, CO, NO_x and SO₂ 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 30 mg/Nm³.

In order to meet the guidelines of State Pollution Control Board for SO₂ emission, one (1) no. twin-flue chimney of 275 m height has been envisaged. The chimney would be provided with personal access for regular monitoring of stack emissions.

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

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

Dust collection system with ventilation system having bag filters will be provided to evacuate dust and hazardous gases like Methane from the coalbunkers. Collected dust will be returned to coal bunker. The dust collector outlet emission will be restricted to 50 mg/Nm³ to trap the dust in the bunkers.

Limestone based flue gas desulphurization system (FGD) will be provided to minimize emission of SO_x. FGD systems shall be designed to remove SO_x at all loads starting from minimum continuous load to BMCR load to meet the limits as per MoEF regulations.

After fly ash removal, the flue gas is bubbled through the scrubber, and the limestone slurry is added to it. The lime or limestone reacts with the SO₂ in the flue gas to create insoluble calcium sulfite (CaSO₃). The resultant calcium sulfite may be further reacted with oxygen to produce gypsum. The end product (gypsum) is utilised in different types of industries for process purposes.

Advanced Low NO_x combustion technology will be used in boiler combustion system with Low NO_x burner and over fire air system; this will reduce the NO_x emission to a large extent. In addition, post combustion NO_x control technology such as Selective non-catalytic reduction (SNCR) / Selective Catalytic Reduction (SCR) will be installed to limit the NO_x level to 100 mg/Nm³.

SNCR

Selective Non-Catalytic Reduction (SNCR) uses no catalyst, but uses aqueous ammonia or a solution of water and urea distributed in the hot flue gas to reduce NO_x in the flue gas path at a temperature range of 850-1100degC to achieve maximum reduction.

SCR

Selective Catalytic Reduction (SCR) uses a catalyst and requires a system to meter and inject aqueous ammonia/ urea solution into the flue gas such that it mixes before passing through the catalyst.

NOx reduction is effective in a limited temperature range from 350°C to 450°C, depending on gas composition and catalyst type. SCR will be installed between economiser and Air pre-heater. At off-design, temperature excursions reduce effectiveness and increase NOx emissions.

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:

- Cement Industry
- Brick Industry
- Light Weight Aggregates
- Road Sub-base
- Grouting material
- Roads / paving - used as filler in asphalt mix for roads.
- Road enlargement
- Land filling material

MoEF in their notification dated 3rd 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 3 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/Nm³, 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, the fly ash is conditioned with water spray.
- 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-super heater 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 assess the noise level limits to be kept at the proposed plant boundary considering the background noise level.

7.1.2.4 Water Pollution:

Water from the river Chir is required for makeup to the closed cycle re-circulation system of condenser cooling. It is proposed to utilise the power plant waste water for plant reuse to achieve minimum discharge concept. It is envisaged to 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 runoff water during monsoon season will be led to a pond. Coal particles will settle down in the pond and clear water will be allowed to overflow to the central monitoring basin for treatment.

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

The rain (storm) water removed from the building roofs, non-process area and grade level surfaces will be directed through the open ditches and culverts to the storm drainage piping. The storm water from the storm water drainage piping shall be discharged outside the plant boundary. All ditches will be concrete lined and located along the roads. All drainage ditches will be located to provide the shortest practical drainage path while providing efficient drainage for the yard. Grade level will be contoured such that storm water runoff 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 1/3rd 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:

Rehabilitation & Resettlement (R&R) shall be done as per R&R rules.

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 SO₂, NO_x 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, SO₂, NO_x 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.

The main objectives of risk assessment are as follows:

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

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

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

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

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

Disaster Management Plan:

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

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

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

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

- Recognising the possibilities and probabilities of each kind of accident
- Assessing the on-site and off-site implications of such incidents and deciding the emergency procedures that would need to be carried out.

A number of elements makeup a good and workable disaster management plan. They are briefly discussed below:

Identification and assessment of hazards:

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

Procedure for Personnel and Equipment:

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

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

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

Reporting to Authorities:

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

- Identification/notification of a major hazard installation
- 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 experience O&M Contractor.

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

8.3.1 Maintenance Management System:

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

8.3.2 Spare Parts Management System:

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

- Proper codification / identification & retrieval of all spares & consumables
- Proper storage & protection
- Spare parts indenting and procurement policy
- Judicious fixing of inventory levels and spare part ordering based on experience of similar Units or other benchmarks.
- Development of indigenous sources/in-house capability for imported spare parts.
- Development of more than one source wherever applicable.

8.3.3 Special Tools & Tackles:

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

8.3.4 O&M Training:

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

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

8.3.5 O&M Manuals:

All plant equipment supply contracts will include provision for supply of sufficient copies of detailed O&M manuals for distribution to the different user departments of Project Company.

O&M manuals will be made available to all concerned at least 12 months prior to the commissioning date of first Unit to avoid problems in preparation of commissioning documents as well as proper installation & commissioning of equipment.

8.3.6 Coal Supply Management:

The minimum requirement of coal will be based on operating norms. However, the monthly requirements will be finalized during the quarterly meetings with the concerned authorities or through the Coal Supply Agreements. The coal handling plant of the Power Plant will be designed to meet the peak requirement on daily basis with adequate reserve capacity to take care of normal breakdowns and maintenance requirements.

8.4 Employee Facilities:

8.4.1 General:

Employees required for 2X800 MW Units O&M are estimated to be around 190 nos. excluding contract labour.

8.4.2 In-Plant Facilities:

The following facilities shall be developed in this station:

- Administrative Building and technical office
- Construction offices and stores (at construction stage only)
- Time and security offices
- First Aid and firefighting station
- Canteen and welfare centre
- Toilets and change rooms
- Car parks and cycle/ scooter stands
- 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 Township:

Township/Residential colony required for the O&M staff has been considered.

SECTION: 9
PROJECT COST ESTIMATES AND FINANCIAL ANALYSIS

9.0 PROJECT COST ESTIMATES AND FINANCIAL ANALYSIS:

9.1 Basis of Project Cost

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

9.1.1 Assumptions for Hard Cost Input

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

- Total two (2) Units of 800MW capacity with super critical steam condition have 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.
- Capital Investment for external coal transportation arrangement upto 1st in plant Junction Tower for Project has not been considered in the cost estimate.

9.1.2 Assumptions for Soft Cost Input

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

- Financing - Debt: Equity - The project is considered to be financed by domestic equity and rupee term loan with 70:30 Debt Equity Ratio. The rate of interest of debt is considered as 11.00 %.
- Interest During Construction (IDC) - has been included in the Project Cost based on the phasing of the expenditure upto COD of 2nd Unit.
- Working Capital - The rate of interest on working capital loan is assumed to be 11% p.a.
- Taxes and Duties - Taxes and Duties have been considered as per prevailing rates.
- Exchange Rate - BTG components have been considered to be domestic.

9.2 Project Cost

On the basis of assumptions discussed above, the estimated costs of the project amount to Rs. 13,906 Crores. 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
Land & Site Development	83.00
Engineering, Procurement & Construction Cost	6292.00
Water Arrangement	416.00
Coal Supply Arrangement	650.00
Cost of SCR, FGD & ESP for compliance of new MoEF Guideline	1600.00
Taxes & Duties	1173.00
Total Hard Cost	10214.00
Preliminary & Pre-operative Expenditure	356.00
Interest During Construction Period	2044.00
Insurance	28.00
Contingency	1264.00
Total Cost	13906.00

(all figure in Rs. Crores)

The Project cost is estimated at Rs. 13,906 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	4172	30
Debt Finance	9734	70
Total	13906	100

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 50 months from Zero Date, considering the

completion schedule of 44 months for the first Unit and within a gap of 6 months for subsequent units.

9.4 Cost of Generation & Tariff Calculation

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

9.4.1 Technical Input Assumptions

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

- Plant gross capacity has been considered as 2x800 MW.
- Plant load factor of 85 % has been considered
- Station heat rate of 2216 Kcal/kWh has been considered.
- Plant Auxiliary power consumption has been considered @ 7.5%.
- The gross calorific value (GCV) of coal has been considered as 3500-5000 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	%	11%
Repayment Period	Years	20
Repayment Mode	Instalments	Quarterly

Return on Equity

ROE has been considered as 15.5%

Working Capital

Working Capital covers the following:

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

SECTION: 10
PERMITS AND CLEARANCES

10.0 PERMITS AND CLEARANCES

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

Table 10.1
Statutory Permits and Clearances

Sr. No.	Description	Authority	Status
1	Water availability	Water Resource Dept. /WRD GoJ	Allocation of 36 MCM/ Annum water from Chir River has been received from WRD, GoJ on 27-Apr-2016
2	NOC for setting of Facility - Pollution clearance (Water & Air)	State Pollution Control Board	AP(J)L will do the needful once the EIA Report is ready.
3	Environmental and Forest Clearance	Ministry of Environment & Forests (MOEF), GoI	AP(J)L will apply for Environmental Clearance.
4	Forest clearance	State Forest Dept. / MOEF, GoI.	Not Required as No forest land is involved.
5	Civil aviation clearance for Chimney height	Airport Authority of India	Once location of chimney is finalised, AP(J)L will apply for clearance.
6	Coastal Regulatory Zone clearance	National Coastal Zone Management Authority	Not Required
7	Rehabilitation and Resettlement of displaced families by land acquisition	State Govt./ MOEF, GoI.	Necessary action shall be taken for R&R of displaced families as per rules.

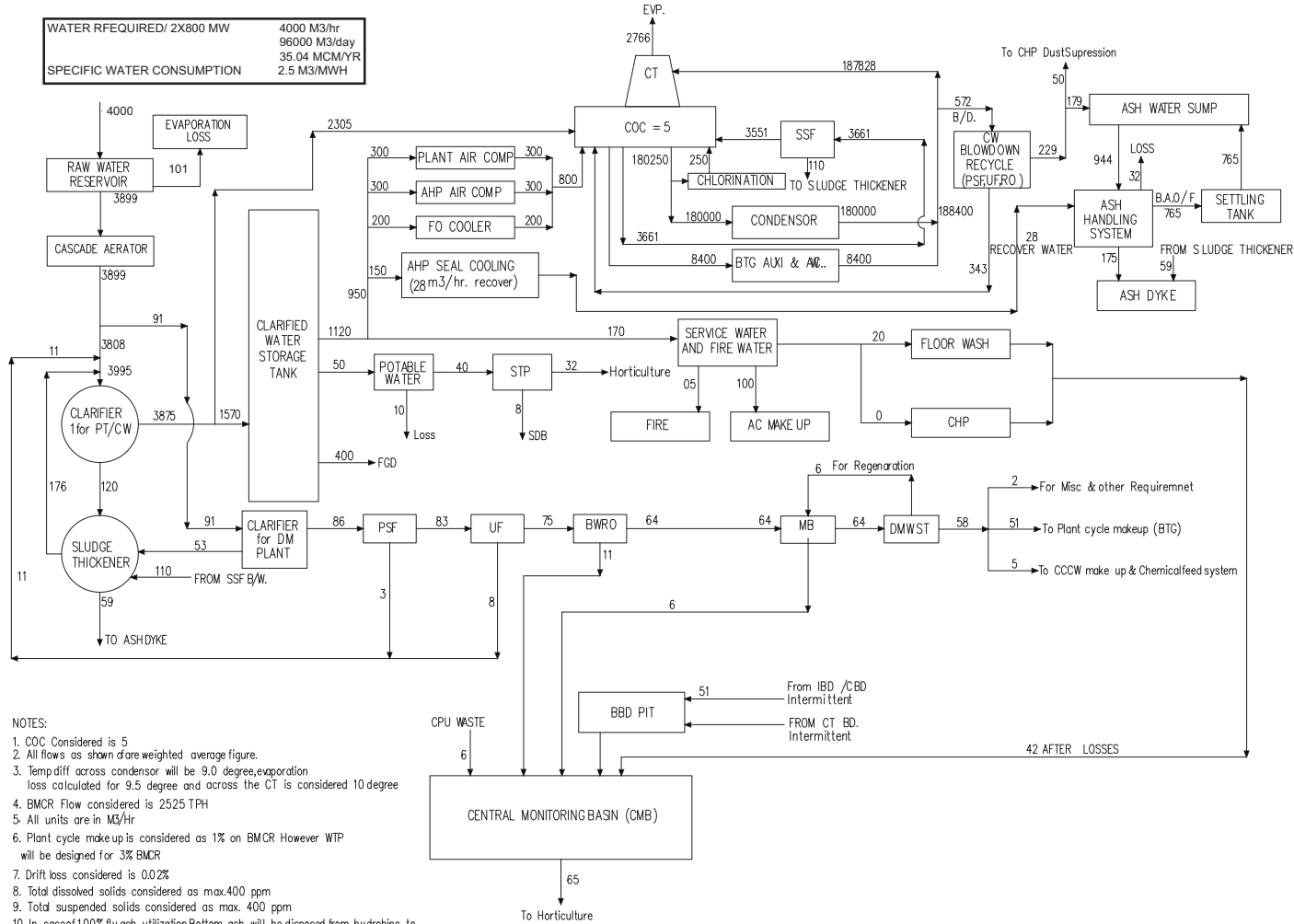
Table 10.2

Non - Statutory Permits and Clearances

Sr. No	Description	Authority	Status
1	Land availability	Govt. Land / Private Land Owner	Necessary action shall be taken as per rules.
2	Fuel Linkage	Not Required	Fuel (Coal) shall be sourced from relevant imported sources.
3	Transportation of fuel	Indian Railways/ Transport Agency	AP(J)L shall engage consultants for study of transportation logistics from Dhamra Port to Plant Site for Imported Coal.
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	Approval for Construction power	State Discom.	The approval shall be taken after availability of land.
7	Consent of relevant Panchayat	Panchayat Union / Board of State Government	At Later Stage.

PRELIMINARY WATER BALANCE DIAGRAM

WATER RFEQUIRED/ 2X800 MW 4000 M3/hr
96000 M3/day
SPECIFIC WATER CONSUMPTION 35.04 MCM/YR
2.5 M3/MWH



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

FOR DPR PURPOSE ONLY

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0	24.02.16		PRELIMINARY ISSUE
ADANI POWER (JHARKHAND) LIMITED			
LAHMEYER INDIA		LAHMEYER INTERNATIONAL (INDIA) PVT. LTD. CONSULTING ENGINEERS, GURGAON, INDIA	
CONTRACT NO. :		PROJECT : 2x800 MW GODDA	
DESIGNED BY : SRS		DATE : 24.02.16	
DESIGNED BY : AA		DATE : 24.02.16	
CHECKED BY : ASH		DRAWING TITLE : WATER BALANCE DIAGRAM	
APPROVED BY : CMW		DATE : 24.02.16	
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