JAWAHARPUR VIDYUT UTPADAN NIGAM LIMITED

(A 100% subsidiary of UPRVUNL - U.P. Govt. undertaking)

2x660 MW

JAWAHARPUR THERMAL POWER PROJECT

JAWAHARPUR, DISTRICT ETAH, UTTAR PRADESH

PRE- FEASIBILITY REPORT

SEPTEMBER- 2015

DESEIN PRIVATE LIMITED
CONSULTING ENGINEERS
DESEIN HOUSE, GREATER KAILASH – II
NEW DELHI – 110 048, INDIA
Phone No. : 91-11-41891400, 29213762,
Fax No. : 91-11-29218393, 29219566
E-mail : info@desein.com, Website : www.desein.com

ACCREDITED WITH: QCI-NABET VIDE MOEF, O.M NO. J-11013/77/2004-IA II (I)
DATED 30.09.2011 FOR CAT. A UNDER S.NO. 15 OF LIST 'A'
ISO 9001: 2008 VIDE CERTIFICATE NO. P-BCI/Q/J//10692

JAWAHARPUR VIDYUT UTPADAN NIGAM LIMITED

(A 100% subsidiary of UPRVUNL - U.P. Govt. undertaking)

2 x 660 MW Jawaharpur Thermal Power Project

Jawaharpur, District Etah, Uttar Pradesh

PRE- FEASIBILITY REPORT

CONTENTS

TABLES

FIGURES

ANNEXURE

1.0 EXECUTIVE SUMMARY

Jawaharpur Vidyut Utpadan Nigam Limited (A 100% subsidiary of UPRVUNL - U.P. Govt. undertaking) intends to set up a coal based 2x660 MW Thermal Power Plant near village Malawan in District Etah in Uttar Pradesh.

This is pre- feasibility report (PFR) has been prepared with a view to establishing the need the project, suitability of the selected site among the alternatives studied broad activities involved in the development of the project and for obtaining ToR for EIA study and environmental clearance.

Salient Features of the Project

Location

The proposed site is located towards the north of village Malawan, on Delhi - Kanpur National Highway (NH - 91) and is about 18 kms. from Etah town, which is about 70 kms. from Aligarh on NH - 91.

Land

The total land for the proposed power plant is 865 acres, excluding land required for township.

Water

The estimated consumptive water requirement for the project is about 53 cusec which will be met from the Lower Ganga Canal flowing flows at a distance of about 22 kms from the proposed project site.

Fuel

The requirement of coal for the proposed project is estimated at 5.52 million tonnes per annum (MTPA) @ 85% PLF considering domestic coal of 4000 kCal / kg GCV. Station heat rate has been assumed 2247 kCal / kWh as per latest CERC regulations. Domestic coal for the proposed plant will be sourced from the Rajmahal group of coalfields in Saharpur – Jamarpani Sector, Brahmani Basin, Dumka District of Jharkhand. The useful heat value (UHV) of the coal in these coal fields will be in the range from 1392 kcal / kg. to 5988 kcal / kg. For calculation purposes and financial analysis an average GCV of 4000 kcal/kg. has been assumed.

Power Evacuation

Power from the proposed plant will be evacuated at 765 and 400 kV. The generation voltage is envisaged as 27 kV (or any other voltage as per manufacturer's standard). Provision of power evacuation through 220 kV lines will also be provided.

Construction Power

The construction power at 33 kV for the proposed plant will be drawn from either Malawan substation which is around 2.5 kms from the proposed site or Etah substation which is around 20 kms from the site.

Project Schedule

The project will be scheduled for the first unit to go into commercial operation in 50 months after the „zero date" & subsequent units at four (4) months interval thereafter.

Zero date is considered as the date on which the turnkey EPC contract is awarded.

Project cost & tariff

The estimated Capital Cost, Capitalised Project Cost (including IDC) has been taken as Rs. 807856 lacs and Cost of Generation at 85% PLF for the saleable energy with various other considerations.

2.0 INTRODUCTION OF THE PROJECT / BACKGROUND INFORMATION

2.1 Identification of project and proponent

The project is installed by Jawaharpur Vidyut Utpadan Nigam Limited (JVUNL) a 100 % subsidiary of Uttar Pradesh Rajya Vidyut Utpadan Nigam Limited (UPRVUNL) - U.P. Govt. undertaking. UPRVUNL was constituted on dated 25.08.1980 under the Companies' Act 1956 for construction of new thermal power projects in the state sector. The first Thermal Power Station constructed by UPRVUNL was Unchahar Thermal Power Station of 2X210 MW capacity and it was transferred to NTPC on dated 13.02.1992. Currently it is operating 5 Thermal Power Stations in Uttar Pradesh having a capacity of 4933 MW.

The present demand for electrical power in Uttar Pradesh is greatly in excess of availability from its own generating capacity and its share in central generation. The power scenario in the state reveals that the demand for power will continue to out strip the available and planned generation capacity for the next few years. In order to meet the energy requirement and to reduce the large gap between the demand and availability, Government is encouraging investment in the public and the private sector in the field of power.

It is in this context that Jawaharpur Vidyut Utpadan Nigam Limited a 100 % subsidiary of Uttar Pradesh Rajya Vidyut Utpadan Nigam Limited (UPRVUNL) proposes to set up a 2 X 660 MW coal based power plant at Jawaharpur in Etah district.

2.2 Salient Features

The proposed project is a 2x660 MW coal-fired thermal power plant based on super-critical technology. The brief outline of the features of the plant and allied information are provided below in Table - 2.1.

Table – 2.1 : Salient Features of the Project

S.No.	Items	Description
1.	Project	Jawaharpur Thermal Power Project
2.	Proponent	Jawaharpur Vidyut Utpadan Nigam Limited (A 100% subsidiary of UPRVUNL - U.P. Govt. undertaking)
3.	Plant Capacity & Configuration	1320 MW 2x660 MW, to be developed in single stage
4.	Location	Near village Malawan, Tehsil & District Etah in the State of Uttar Pradesh

S.No.	Items	Description
		Latitude : 27°28'24"N
		Longituded : 78°49'54"E
		Nearest Town : Etah - 18 km
		Nearest National Highway : NH - 91 - 5 km
		Nearest Railway Station : Etah - 18 km
		Nearest Airport : Agra - 90 km
6.	Site Elevation	160-163 M above mean sea level
7.	Seismic Zone	Seismic Zone III as per IS 1893 (Part-1) : 2002
8.	Climatological Data	Nearest Meteorological Station is Aligarh at 70 km
		i) Daily max. temperature - 40.1 ^{0}C
		ii) Daily min. temperature - 7.4 ^{0}C
		iii) Max. Relative Humidity - 84 %
		iv) Min. Relative Humidity - 28 %.
		v) Annual Rain fall - 751.8 mm
		vi) No. of rainy days in a year - 41
		vii) Mean Wind Speed - 3.8 kmph
9.	Availability of the Land	i) 865 acres for the 2x660 MW power plant ii) Approx.100 acres of non-agricultural / unused land will be acquired or purchased directly from land owners for development of township
10.	Availability of the Water	53 cusecs from the Lower Ganga canal
11.	Availability of the Coal	The annual coal requirement is estimated at 5.52 million tonnes, at a plant load factor of 85 % with GCV of domestic coal 4000 kcal/kg and station heat rate of 2247 kcal/kwh.
		Coal for the proposed plant shall be fed from Saharpur - Jamarpani coal block in the State of Jharkhand.
		Total moisture : Upto 10%
		Ash content : 35%

S.No.	Items	Description
		Gross calorific value : 4000kcal / kg
		Size : 0 to 50 mm
		Estimated quantity of ash produced from the plant at 85% PLF is 1.93 million tonnes per annum with 35% ash content in domestic coal.
12.	Steam Generator	The steam generator (SG) would be designed for firing 100% coal and would be once - through boiler. The SG would be provided with adequate number of coal mills along with gravimetric feeders.
13.	Steam Turbine generator	The MCR rating of the steam turbine generator (STG) would be 660 MW at the generator terminals, with valve wide open capacity of 105% MCR. Steam turbine would be a three cylinder machine.
14.	Stack	One 275 m high twin-flue stack for 2x660 MW units.
15.	Power Evacuation	The power generated from the plant will be evacuated at 765 kV, 400kV and 220 kV voltage level to the nearest grid station.
16.	Project Schedule	Unit - 1 : 50 months from “zero date” Unit - 2 : 54 months
17.	Project Cost	Rs. 8078.56 Crores

2.3 Need for the Project

2.3.1 Power Scenario in Uttar Pradesh

Uttar Pradesh is a large state and the power available is not adequate for the requirements of the State to keep up with the desired socio-economic growth. As a measure of reform of the power sector in Uttar Pradesh, the State Electricity Board (UPSEB) was re-organised into three Corporations in the year 2000. Uttar Pradesh Power Corporation Limited (UPPCL) has been entrusted with the supply of electricity to the entire U.P. state. Another significant step was the setting up of the Uttar Pradesh Electricity Regulatory Commission (UPERC).

2.3.1.1 Installed Generation Capacity in Uttar Pradesh

The State of Uttar Pradesh is part of the Northern Regional Electricity Grid. Northern regional grid comprises SEBs of Delhi, Haryana, Himachal Pradesh, J&K, Punjab, Rajasthan, Uttar Pradesh, Uttaranchal and Chandigarh The present installed capacity of Uttar Pradesh is provided below in Table - 2.2.

Table - 2.2 : Uttar Pradesh Installed Capacity (in MW)
of State Power Utilities and Central Sector Utilities Located in the state

S.No.	Project	Unit	Installed Capacity (MW)	Available Capacity (MW)	C.O.D.
1.	Obra	1	50	50	15.08.1967
		2	50	50	11.03.1968
		7	94	-	14.12.1974
		8	94	-	01.01.1976
		9	200	200	15.03.1980
		10	200	-	06.03.1979
		11	200	-	14.03.1978
		12	200	200	29.05.1981
		13	200	200	19.07.1982
	Total	**1 - 13**	**1288**	**700**	-
2.	Anpara	1	210	210	01.01.1987
		2	210	210	01.08.1987
		3	210	210	01.04.1989
		4	500	500	01.03.1994
		5	500	500	01.10.1994
	Total	**1 - 5**	**1630**	**1630**	-
3.	Panki	3	105	105	29.01.1977
		4	105	105	29.05.1977
	Total	**3 - 4**	**210**	**210**	-
4.	Harduaganj	5	60	60	14.05.1977
		7	105	-	Aug. 1978

S.No.	Project	Unit	Installed Capacity (MW)	Available Capacity (MW)	C.O.D.
		8	250	250	01.02.2012
		9	250	250	10.10.2013
	Total	**5 - 9**	**665**	**560**	-
5.	Parichha	1	110	-	01.10.1985
		2	110	110	Dec. 1985
		3	210	210	24.11.2006
		4	210	210	01.12.2007
		5	250	250	17.07.2012
		6	250	250	18.04.2013
	Total	**1 - 6**	**1140**	**1030**	-

2.3.1.2 Likely capacity additions in the Twelfth Plan and beyond

The likely capacity additions during the Twelfth plan & beyond for the State is provided below in Table - 2.3.

Table 2.3: Likely capacity additions in the Twelfth Plan and beyond

S.No.	Promoter	Capacity (MW)	Location
1	NTPC Ltd.	500	Unchahar, Rai Bareilley,
2	Jaiprakash Associates Ltd.	1320	Karchana, Allahabad
3	NTPC Ltd.	1320	Meja, Allahabad district
4	UPPCL	1980	Bara, Allahabad district
5	Unitech Machines Ltd.	250	Auraiya
6	Creative Thermolite Power Pvt. Ltd.	600	Bargarh, Chitrakoot district
7	IL & FS Ltd.	500	Muzaffarpur district
8	UPRVUNL	1000	Obra, Sonebhadra district
9	Parekh Aluminex Ltd.	250	Barabanki
10	GMR group	1200	Mathrapur

S.No.	Promoter	Capacity (MW)	Location
11	Jaiprakash Associates Ltd.	240	Churk, Robertsganj
12	NTPC – SAIL Power company Ltd.	500	Gonda
13	NTPC Ltd.	500	Jagdishpur
14	Kanpur Fertilizers and Cements Ltd.	75	Kanpur
15	UPRVUNL 1980	1980	Ghtatampur
16	UPRVUNL 250	250	Panki
17	UPRVUNL 660	660	Harduaganj
18	UPRVUNL 1000	1000	Anpara
19	Bajaj Power Generation Pvt. Ltd.	2400	Bargarh, Chitrakoot district
20	Bajaj Power Generation Pvt. Ltd.	1980	Lalitpur
21	Kanti Bijlee Utpadan Nigam Ltd.	290	Muzaffarpur district
22	Torrent Power Ltd.	1320	Sandila, Hardoi district

2.4 Need for the Power Project

Substantial additional installed capacity over and above the 12th Plan targets is required if the Northern Region is to be free of power shortages.

In all the regions, there is considerable uncertainty with regard to the location, capacity and fuel for future generation projects.

A number of hydro plants operate mainly during the monsoon period. The generation from these plants is minimal during the non-monsoon period mainly due to lack of adequate storage facilities or other operational constraints like meeting upstream irrigation requirements and the need to maintain levels at various reservoirs. Hydropower production is low during the peak demand period and not all the hydro capacity can be utilized to generate power during peak demand period due to the low or minimal flow and lack of adequate storage capacity. Because hydro production is seasonal and its maximum production does not coincide with the system peak, the system could rely only upon firm hydro capacity. Thus the actual shortfall of capacity may even be more than the figures based on installed capacities.

In conclusion it can be stated that the gap between availability of power and the demand is not likely to be closed in the foreseeable future either in Northern region or in

Uttar Pradesh and all out efforts are called for to add capacity considering the fuel availability and evacuation system.

In this context, the proposal of Uttar Pradesh Rajya Vidyut Utpadan Nigam Ltd., for setting up of the 2 X 660 MW Coal based Jawaharpur Thermal Power Station is timely. The generating capacity of the proposed power plant will be helpful in meeting a part of the shortfall in generating capacity in the state.

2.5 Demand – Supply Gap

2.5.1 Demand and Energy Absorption Plan

The peak Demand in the Northern region for the period of April 14-January-15 was 51,977 MW peak met was 47,642 MW so peak deficit recorded was 4,335MW. The proposed Coal Based Power Plant in Uttar Pradesh will therefore, play an important role as a reliable source of power in the grid to narrow the gap between the demand and supply.

CEA/ Power grid has prepared a long-term transmission system conceptual plan for integrated utilization of hydro and thermal power to be generated throughout India through a network of 765 kV AC, 500 kV HVDC, 400 kV and 220 kV AC systems. There will be no difficulty in connecting the proposed power plant to this system and evacuation of the total generation through 765 kV, 400 kV and 220 kV AC lines.

Necessary transmission facility for bulk power transmission will have to be provided by Power grid and UPPCL.

The requirements of transmission have been developed on the basis of the power system studies and will be firmed up through Regional Standing Committees for transmission system planning.

2.5.2 Evacuation of Power

The power generated from the plant will be evacuated at 765 kV, 400 kV and 220 kV. However the scheme will be decided based on the Load flow study and other parameters. The permissible line loading limit depends on many factors such as voltage regulation, stability, thermal capacity of conductor etc. The surge impedance loading (SIL) capacity for a line gives a general idea of the load, which can be carried by a line. However, it is usual to load the short lines appreciably above SIL and longer lines below their SIL capacity to maintain the stability considerations of the grid.

The total power generated from the proposed power plant will be 1320 MW. After meeting the power requirement of the station auxiliaries, about 1250 MW will be

available for evacuation.

2.5.3 General Philosophy and Design Criteria

All electrical equipment and components will confirm to latest applicable standards published by Bureau of Indian Standards (BIS) and or other internationally recognized codes and standards and the recommendations of Central Electricity Authority (CEA) / Central Power Utility (CPU). The electrical system will be designed to enable trouble free and safe operation of the Plant.

2.5.4 Insulation Coordination

The 765 kV, 400 kV and 220 kV systems are being designed to limit the switching surge over voltage to 2.3 per unit and power frequency over voltage to 1.5 per unit. All the materials/equipment shall perform all its functions satisfactorily without undue strain under such over voltage conditions. Consistent with these values, protective levels for the equipment shall be decided in co-ordination with the lightning arrestor.

2.5.5 Generator and Generator Transformer System

The system consists of two number STG of 660 MW rating, the generation voltage being 27 kV (or any other voltage as per as Manufacturer standard). Three voltage levels i.e. 765 kV, 400 kV and 220 kV are envisaged for evacuation of power from the plant. Two nos. 765 / 400 kV ICT's shall be provided to step down the voltage level to 400 kV. And one no. 400 / 220 kV ICT shall be provided to further step down the voltage level to 220 kV.

The generator shall be connected to the proposed 765 kV switchyard of Jawaharpur Thermal Power Station through step-up Generator Transformers. Startup power will be taken from the 00 kV switchyard through the station transformers. Once the unit is synchronized with the system through generator transformer, the unit auxiliary power requirements will be drawn through the unit auxiliary transformers. The unit auxiliary transformers will be of 2 windings design with primary winding corresponding to generation voltage of 27 kV and secondary winding connected to the 11 kV switchgear. Isolated Phase Bus Duct will be provided for connection of each Generator with its respective Generator Transformer Set and Neutral Earthing Equipment and tap off connections will be provided to respective Unit Auxiliary transformers, Voltage Transformers and Surge Protection Cubicles.

Two (2) no. Unit Auxiliary Transformers (UATs) for each unit has been envisaged to cater to total unit auxiliary loads of each 660 MW Unit. The transformers will be rated to

meet the auxiliary loads required to run the Unit at MCR. Further, two nos. three windings 420/11.5/11.5kV Station Transformers (ST) have been envisaged for two units. Each of the Station transformers will be rated to meet the total station auxiliary loads required to run the Plant at MCR. These Station Transformers will be supplied power from the 400kV switchyard of the proposed Jawaharpur Thermal power plant.

The overall system will be designed such that failure of any piece of equipment has a minimum possible effect on the plant's availability and capability. In particular failure of an auxiliary transformer, a DC battery or charger will not reduce the plant's generating capability or affect the shutdown requirement of the Unit. All transformers other than generator transformer are sized to have 10% margins after considering the maximum load.

All 11kV switchgears, 3.3 kV switchgears and 415 V switchgears/ MCC and Distribution boards will have 2x100% rated incomers and will be sectionalized. All the 11kV, 3.3 kV and 415V switchgear, motor control centres and distribution boards will have positive foolproof interlocking to ensure that different supplies cannot be operated in parallel and fault level does not exceed the switchgear capability.

2.6 Employment Generation

The project will open up new employment opportunity in the region. With the population centre located in Etah town, local human resources could be used during the construction phase of the project. About 500 - 600 people would be required to operate and maintain the 2x660 MW power station. It is expected that a fair percentage of skilled and unskilled personnel would be available from the nearby areas for operation and maintenance. This will not only open employment opportunities to the local residents, but would reduce the demand for the residential quarters in the colony. Further, the industrial infrastructure available in the area can be gainfully utilized for developing ancilliary manufacturing and service industries for power plant operation and maintenance. The power plant will lead, thus, to substantial economic development of the area.

3.0 PROJECT DESCRIPTION

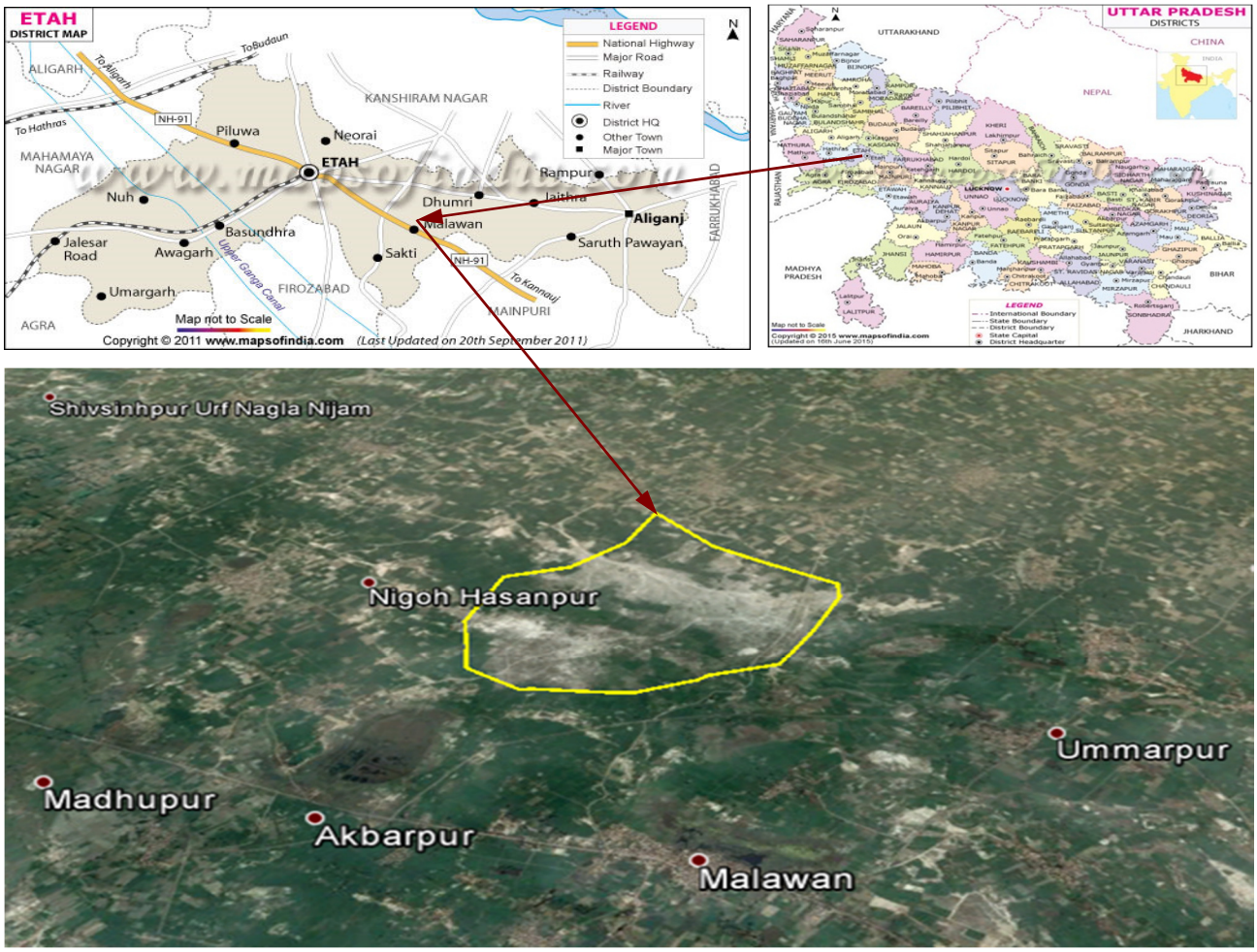
3.1 Type of Project

The proposed project is to establish as a greenfield project having power generating capacity of 1320 MW by using coal as primary fuel. There will be two units of 660 MW capacities.

3.2 Location

The Jawaharpur project site is located near village Malawan in Etah district of Uttar Pradesh. The site is at around 18 kms distance from Etah town which is 70 kms from Aligarh. The proposed project site is situated at a distance of around 5 km from national highway (NH - 91) and has road access to major cities of India. Nearest airport to the site is at Agra around 90 kms from the proposed site.

The site is located close to the broad gauge line of Northern Railway and the nearest railway station is Etah. Location of the site is shown in below Figure 3.1.



3.3 Details of Alternate Sites

Main considerations for thermal power plant site selection are:

- Availability of adequate non-arable land
- Avoidance of forest land /green cover and overall environment compatibility
- Avoid /minimize displacement of people
- Proximity to fuel and water sources
- Road/Rail connectivity
- Availability of construction power
- Power evacuation facility

Three (3) potential sites in Etah district were selected based on the above considerations. These are Malawan, Lothra and Sardalgarh. A comparative statement is given below Table 3.1.

Table - 3.1 : Site Alternative Analysis

S.No.	Parameters	Malawan (Selected Site)	Lothra	Sardalgarh
1.	Location with Latitude & Longitude	27°28'24.08 N 78°49'54.82 E	27°23'34.3 N 78°47'46.1 E	27°42'06.5 N 78°30'50.6 E
2.	Type of Land	Unused land with irrigation in patches	Irrigated land	Irrigated land
3.	Requirement of R&R	Minimum (no residence or structure affected) displacement	R & R issue involved	R & R issue involved
4.	Forest Land	Nil	Nil	Nil
5.	Intake Location	Lower Ganga Canal (22 km)	Lower Ganga Canal (13 km)	Lower Ganga Canal (18 km)
6.	Seismic / Cyclone History	None	None	None
7.	Industries Around	None	None	None
8.	EHV Substation	18 km – UPPTCL Substation	30 km – UPPTCL Substation	4 km – UPPTCL Substation
9.	Mode of Coal Transportation	By rail to site 18 km	By rail to site 30 km	By rail to site 5 km

S.No.	Parameters	Malawan (Selected Site)	Lothra	Sardalgarh
10.	Land Grading Requirement	Fairly leveled	Levelling required in some areas	Levelling required in patches
11.	Road Access	NH-91, 5 km	NH-91, 13 km	NH-91, 7 km

Site selection team comparing the State Government officials and consultants visited the sites and based on the environmental, techno-economic and infrastructural considerations Malawan site was selected and finally approved.

The selected site was also accepted by MoEF in the earlier Form-1 presentation and ToR was issued vide letter No. J-13012/121/2009 - IA. II (T) dated March 11, 2010.

3.4 Size or Magnitude of Operation

The proposed plant have the generating capacity of about 1320 MW (2x660 MW). About 5.52 MTPA coal will be required to run the plant @ 85% PLF considering domestic coal. Consumptive water requirement for the project is about 53 cusec which will be met from the Lower Ganga Canal at a distance of about 22 kms. About 865 acres of land is available for the installation of the proposed plant. The land for the project has already been acquired and mutated in the name of UPRVUL for nom-agricultural use. Approx.100 acres of non-agricultural / unused land will be acquired or purchased directly from land owners for development of township. Estimated quantity of ash produced from the plant at 85% PLF is 1.93 million tonnes per annum with 35% ash content in domestic coal. Cement industries located in the region can use the generated fly ash during plant operation.

Construction material will be available within reasonable distance from the site. Required materials will be brought to the proposed plant mainly by road transport.

3.5 Process Description / Main Equipment Selection

3.5.1 Steam Cycle Parameters

The primary factors, which govern the steam cycle selection are - efficiency, equipment cost and the fuel type or analysis. With higher steam parameters though there is efficiency improvement, the investment cost goes up on account of increase in the cost of boiler and turbine island equipment. The steam parameters for 660MW units shall be

247 bar(a), 565℃ main steam temperature and reheat steam temperature 593℃. The heat cycle consists of a steam turbine with single reheat cycle, condensate pumps, low-pressure and high-pressure feed water heaters, a deaerating feed water heater, and electric motor driven feed water pumps. Heat rejection is accomplished by a closed loop circulating water system utilizing natural draught cooling towers to supply cooling water to a condenser operating at an absolute pressure of 0.0992 bar(a). The steam generation and steam cycle described are based on conventional, proven thermal plant technology currently operating throughout the world.

3.5.2 Selection of Technology

Steam generators using either pulverised coal (PC) combustion technology or Circulating Fluidised Bed Combustion (CFBC) Technology are available. CFBC is a mature technology with more than 300 CFBC boilers in operation world wide ranging from 5 MW to 250 MW. The CFBC technology is principally of value for low grade, high ash coals which are difficult to pulverize, and which may have variable combustion characteristics. The direct injection of limestone into the bed offers the possibility of economic Sox removal without the need for flue gas de-sulphurisation. The advantage of fuel flexibility of CFBC units made it a popular choice for different installations.

Pulverized Fuel Firing (PF) combustion is most common and well proven among all the other technologies. PF fired boilers are most suited for higher capacity power plants and have the distinct advantage of better combustion efficiency with less auxiliary consumption as compared to any other technology in the market today. The domestic coal used for the proposed station will have gross calorific value of 4000 kcal/kg. So, pulverised coal fired boiler is more suitable in comparison to any other technology. Hence, this report considers installation of pulverised coal fired boilers.

3.5.3 Fuel Linkage and Transportation to Site

Type of Fuel

The steam generator would be designed primarily for coal firing. A fuel oil system will be used for boiler start – up as well as for flame stabilization during low load.

Light diesel oil will be used for furnace light up and boiler start-up while HFO will be used for flame stabilization.

Source of Fuel and Quality

The requirement of coal for the proposed project is estimated at 5.52 million tonnes per annum (MTA) @ 85% PLF considering domestic coal. The gross calorific value (GCV) of domestic coal has been considered 4000 kCal / kg for calculation purposes

Domestic coal for the proposed plant will be sourced from the Rajmahal group of coalfields in Saharpur - Jamarpani Sector, Brahmani Basin, Dumka District of Jharkhand. The coal will be unloaded at project site by wagon tipplers. Merry-go-round system is proposed at site.

There shall be light diesel oil (LDO) / HSD firing in at least one burner elevation to facilitate a cold start up of the unit when no auxiliary steam is available for HFO heating and atomization. LDO & HFO will be brought through rail at site. Necessary arrangements shall be provided at site for unloading LDO & HFO.

Transportation of Fuel from Source to the Power Plant

Coal will be transported to the site through Indian Railways wagons and brought to the Plant siding. It is envisaged that coal would be transported by BOXN wagons and will be unloaded at site through 3 nos. wagon tipplers. However, provision of track hopper shall also be made at site.

3.5.4 Main Plant Equipment and Systems

Introduction

Power Generating equipment and auxiliary systems required for two units of 660 MW will be installed.

The equipment will be designed for a gross generation of 660 MW by single unit. A valve wide-open margin will be provided to increase the swallowing capacity of the steam turbine by 5%. With this the plant and facilities will be designed to give a gross generation of 1320 MW. The major features of main plant equipment and systems are covered under this section.

Steam Generator and Accessories

The steam generators shall be once through, single/double pass (Tower type/ two pass type), single reheat, radiant furnace, dry bottom, balanced draft, outdoor type, pulverised coal fired steam generating units having supercritical steam parameters with all necessary auxiliaries, integral piping, elevator etc.

The furnace will be radiant, dry bottom type with tangential or opposed wall firing and enclosed by water-cooled and welded membrane walls. The furnace bottom shall be suitable for installation of a water impounded bottom ash hopper. Spray type attemperator is envisaged to control the superheater outlet temperature for varying loads. The superheater and reheater tubes will be a combination of radiation and convector types. Economiser will be non-steaming type and shall be of modular construction so that addition of loops is possible.

The fuel oil system will be provided for boiler start up and for flame stabilization during low load operation with or without coal firing. Two (2) types of fuel oils will be used:

- LDO system shall be sized to meet 7.5% BMCR requirement.
- HFO system shall be sized for 30% BMCR capacity.

The boiler auxiliaries /systems such as air heater, Electrostatic precipitators, fans etc shall also be designed to deliver maximum continuous rating when firing range coal. The boiler shall be capable of being started with LDO during cold start up. LDO shall have the facility for air atomization. The BMCR gross generation capacity shall be 2180 T/hr for 660 MW at 537 deg C. The reheat steam shall be heated to the temperature of 565℃. The reheat flow of the steam generator varies with the turbine load and operating condition. The parameters are worked out as per heat balance diagrams. For all conditions, re-heater flow is approximately 90 % of main steam flow. The plant shall be suitable for variable pressure operation and in case of load rejection; boiler firing rate shall be brought down to a safe level to maintain stability of boiler. The boiler shall be suitable for accepting feed water at a lower temperature corresponding to HP heater out condition at TMCR. PLC / DCS based Burner Management System (BMS) shall be provided for the control, sequencing and protection of Steam Generator.

3.5.5 Furnace

The furnace shall be designed to fire coal. The furnace will be radiant, dry bottom with tangential firing and enclosed by water cooled and all welded membrane walls. The furnace bottom shall be suitable for installation of a water impounded bottom ash hopper. The furnace design and construction shall be in accordance with the requirements of internationally accepted ASME Boiler and Pressure Vessel codes and in conformity with Indian Boiler Regulation (IBR) requirements.

The water walls shall have seamless tubes and will be of membrane wall construction. Rifled tubes will be used in high heat absorption areas in the furnace. Equipment will include a structural steel backstay system complete with necessary attachments,

stirrups and levellers, required for integral stiffening and support of the furnace walls. The superheater will include radiant heating surface and platen surface consisting of intermediate temperature superheater and high temperature superheater arranged in vertical loop. The low temperature superheater will be horizontal loop type convection surface and located in the second pass. Thickness of all tubes will be calculated as per ASME code and IBR.

Spray type attemperator is envisaged to control the superheater outlet temperature for varying loads. Spray water will be provided from the BFP discharge. The water will be admitted at inter stage location so as to ensure stable and dry final steam to the turbine. The economizer will be of drainable and non steaming type, and will be located under the low temperature superheater in lower part of boiler rear pass and will have seamless bare tubes. Safety valves will be provided for superheater outlet, steam drum, reheater inlet and outlet. Start up vents and drains will be provided on reheater and superheater headers.

Platforms and stairways as required for proper operation and maintenance of the boiler will be provided. A steel inner casing with protective refractory will be provided for the portion of the boiler not covered by welded walls. Outer casing will be provided with suitable lagging and insulation. Galvanized steel make boiler roof will be provided.

An electrically operated automatic sequential steam soot blowing system will be provided.

3.5.6 Pulverised Coal Preparation System

The system consists of storage bunkers, feeders, mills, primary air fans, distribution pipe work to the coal compartment, nozzles and all ancillary equipment. The function of pulverised coal preparation system is to provide the coal admission nozzles with an evenly distributed coal of fineness not less than 70% through 200 mesh and in the correct quantities and proportions with air to meet the requirements of the boiler operating regime.

The pulverising system will include one raw coal bunker for each mill complete with feeders, chutes etc. Each bunker will be designed for a total effective capacity of 16 hours of boiler operation at BMCR with worst specified coal. The bunker sloping sides will be lined with stainless steel. Bunker level measurement system shall be provided.

Gravimetric feeders will be provided for automatic control of coal flow to the mills. Each feeder will be provided with a motor operated coal isolation slide gate at bunker outlet. The feeder will have weighing device with microprocessor based local control cabinet and precision load cells.

The pulverized coal will be pneumatically transported through coal pipes from classifier outlet to the coal compartment nozzles. All bends and straight lengths up to suitable diameter after the bend and the total length from the last bend to the coal nozzles will be lined with wear resistant material. There will be two PA fans of single suction centrifugal type (each having capacity of 60% TMCR requirement) for pulverised coal transport. PA fan control will be through inlet vane to maintain a constant pressure upstream of the hot and cold air dampers of each mill.

The coal burning system will comprise of coal mills of vertical spindle type which include (a) bowl mills (XRP type), (b) roller mills (MPS type) & (c) balls and race mills (E-type) or any approved type. The number and capacities of the mills shall be so selected that while firing the worst and design coals at BMCR the following spare capacities shall be ensured.

- With 90% loading of the working mills at least one mill will be spare at 100% BMCR while firing worst coal.
- With 90% mill loading of the working mills at least two mills will be spare while firing the design coal at 100% BMCR.

3.5.7 Mill reject handling system

Dense phase pneumatic conveying system shall be employed for handling of the mill rejects. Each mill reject discharge hopper shall be fitted with a dense phase pneumatic conveying vessel which shall discharge the mill rejects through pipe lines into a storage 'silo' of adequate capacity.

3.5.8 Coal Combustion System

Pulverised coal is the main fuel and the boiler is designed to fire specified coal to achieve the BMCR generating capacity. Heavy fuel oil, pre heated and steam atomized, is fired to support combustion at low firing rates. Light diesel oil is fired for warming during start-up. The unit can be operated down to 40% BMCR without oil support.

Tangential firing system will be adopted in the boiler. In tangential firing, the fuel and air will be admitted at the four corners of the combustion chamber through fuel compartment nozzles in the wind box. Fuel compartments with coal nozzles will be located in the boiler corners and aimed tangentially to the circumference of an imaginary horizontal circle (Fireball) of which the vertical axis is the same as the furnace's centroid. Each fuel compartment has a coal nozzle and an independent stainless steel array of plates to distribute the fuel air parallel to the coal steam.

Distribution dampers proportion secondary air to the individual fuel and air compartments. Fuel and air nozzle tilt in unison to raise or lower the flame in the furnace. This provides control of heat absorption in the furnace, super heater and reheater. In operation, a cylindrical vortex is created in the furnace assuring overall fuel and thorough air mixing. The primary furnace volume effectively becomes a single burner assuring controllable heat absorption in the furnace. This thorough mixing and long residence time of the fuel and combustion air also results in low carbon loss and low NOx formation.

Proper distribution of secondary air to the furnace for combustion is ensured with each furnace corner provided with a wind box fabricated of carbon steel plate. Wind-box contains all the fuel (coal or oil) and air compartments with regulating louver dampers to proportion the secondary air in response to fuel input by elevation. The wind-boxes are provided with front plates accommodating passages and sealing for the coal pipes, oil guns, flame scanners and observation ports. At the top of each wind-box air ports with louver dampers positioned by pneumatic damper drives to control NOx production. To the side of each wind-box is a separate full height wind-box which supports the light oil igniters. The air for these igniters is supplied by axial vane fans which will take suction from either the boiler area ambient or F.D. fan discharge depending on boiler load and final design configuration.

3.5.9 Fuel Oil Support and Firing Systems

Each steam generator will be equipped with a fuel oil (LDO and HFO) start-up system to provide adequate heat to raise the furnace temperature sufficiently to start the combustion of pulverized coal. Fuel oil shall also be used during low load operation and flame stabilization. Fuel oil start-up systems will consist of start-up burners, igniters and flame scanners as per the standard practice of the manufacturer.

LDO system shall be sized to meet 7.5% BMCR requirement. HFO system shall be sized for 30% BMCR capacity.

The fuel oil firing system will primarily consist of 2x100% HFO forwarding/ pressurizing pumps, heaters and LDO forwarding/ pressurizing pumps for each unit. These pumps shall be equipped with Strainers/ filters at the suction common header of forwarding/ pressurizing pumps of each unit.

The start-up burner system is supplied as part of the steam generator burner system complete with all flame safety equipment.

3.5.10 High Pressure Steam Piping

Alloy steel piping as per specific Power Piping Code for the applicable operating parameters of pressure and temperature will be provided. The design will also meet the IBR requirements.

Main Steam Piping and valves

The Main Steam System will convey superheated steam from the steam generator superheater outlet to the main turbine stop valves.

The main steam system will consist of the following major components:

- Steam generator superheater outlet stop valves
- Main steam line to the main turbine stop valves
- Safety relief valves.
- Main steam vents and drain piping and valves.
- Hangers and Supports.

Main steam generated in the superheater section of the steam generator will flow from the superheater outlet header through the main steam line to the HP turbine stop valves.

Safety valves and power relief valve will be provided for system overpressure protection. A vent line with motor – operated isolation valves will be provided for venting the Main Steam System prior to start-up after an extended outage.

Reheat Steam Piping

The Reheat Steam System will provide a flow path for cold reheat steam from the high-pressure turbine exhaust to the steam generator reheater inlet and for hot reheat from the reheater outlet to the intermediate-pressure turbine inlet. The Reheat Steam System will consist of the following major components:

- Cold Reheat Line
- Hot Reheat Line
- Cold Reheat non return valve
- Interceptor Valves
- Drain Piping and Valves

A drain line will be provided near the high-pressure turbine exhaust (upstream of the cold reheat non-return valve) for water collection and removal from the cold reheat piping.

Hot reheat steam will be routed from the steam generator reheater outlet to the combined intermediate stop governing valves at the intermediate pressure turbine. Drain lines will be located at low points in horizontal runs of hot reheat line as near as practical to the intermediate-pressure turbine.

3.5.11 Air and Flue Gas System

A balanced draft system will be provided. There will be two Forced Draft (FD) fans of capacity two (2) x 60% TMCR, two Primary Air (PA) fans of capacity two (2) x 60% TMCR and two Induced Draft (ID) fans of capacity two (2) x 60% TMCR.

Two (2) FD fans and two (2) PA fans together supply air necessary for fuel combustion. They are sized to handle stoichometric air plus excess air needed for proper combustion for which the boiler is designed; in addition they can provide for air leakage through the air heater.

The FD fans will be provided with a Test block margin of 20% on volume and 44% on pressure at BMCR with performance coal. Each FD fan will include flexible coupling and guard, sleeve bearing, inlet vanes with actuator, discharge damper with actuator, constant speed motor and acoustic silencer with screen.

Two high pressure primary air fans supply the air needed to dry and transport coal directly from the pulverizing equipment to the furnace. Located upstream of air heaters, the cold primary air fan draws air from the atmosphere and supplies the energy required to force the air through duct, air heaters, pulverisers and fuel piping. The PA fans will be provided with a Test block margin of 20% on volume and 30% on pressure at BMCR with performance coal. Each fan will include flexible coupling and guard, sleeve bearing, inlet vane with actuator, discharge damper with actuator, constant speed motor and acoustic silencer with screen.

Two (2) ID fans remove the products of combustion from the boiler. The fans will be provided with a Test block margin of 20% on volume and 44% on pressure at BMCR with performance coal. Each fan will include hydraulic coupling, sleeve bearing, inlet vane with actuator, and discharge damper with actuator, constant speed motor and acoustic silencer with screen.

Each boiler will be provided with two tri-sector type air preheaters (RAPH). Both air heaters will be of the vertical shaft regenerative type. This design consists of a fixed housing fabricated from carbon steel plate with flanged connections to air and flue gas ducting. Concentric to the housing is a large rotor with pie shaped compartments densely packed with preformed mild steel and corten (low alloy) steel elements

(sheets). This provides a very large surface area for rapid heat transfer. The equipment will be supplied with an upper guide bearing and a Kingsbury type thrust bearing at the bottom. The lower bearing has an external lube system with pump, filter and heat exchanger. The guide bearing is designed so that ambient radiation and convection of the bearing housing maintains the proper operating oil temperature. The rotor is driven by an AC motor coupled through a low ratio gear box to a sprocket gear with a mesh to the ring gear around the rotor at mid circumference. A backup AC motor and compressed air motor provide rotation in case of the primary drive AC motor failure. The air heater will also be equipped with a fire fighting and fire detecting system.

A steam coil type air preheater (SCAPH) system will be provided at each F.D. fan discharge to preheat the secondary air so that the cold end metal temperature of the RAPH heat transfer elements (sheets) will be raised above the dew point of the flue gas and thereby diminish sulphur acid corrosion of the corten sheets located in the “cold end” of the RAPH. The system consists of a staggered tube bundle of spiral wound finned mild steel tubes. The heating medium is steam from the unit auxiliary steam header.

The air duct system will include ducts from primary air and secondary air suction side up to fan, outlet flange of fan to air heater. Secondary side air-heater outlet to furnace wind boxes and primary side air heater outlet flange to coal pulverises.

Flue gas ducts will include ducts from outlet of economizer to inlet flanges of air heater, air heater outlet to ESP and outlet of ESP to inlet flanges of ID fans.

All ducts will be equipped with necessary dampers of multi-louver type or equivalent and connected to ducts by means of flanges. They will be provided with pneumatic actuation and manual device as standby.

Expansion joints located on hot gas ducts between boiler outlet and air heaters are made of shaped (steel) plates. Expansion joints installed on cold air ducts, hot air ducts and cold gas ducts (located between air heater and stack) will be fabric joints or equivalent with inside deflectors.

Access doors are installed on all ducts on each section between two dampers. Access doors will be accessible from walk ways or from platform.

The air and flue gas ducts will be adequately supported and provided with access doors, guide vanes and expansion joints. The ducts will be of all-welded construction of steel plate and stiffened by means of angles, tees, channels or flats secured outside.

All ducts will be designed to minimize resistance to air/gas flow and to give proper distribution.

3.5.12 Soot Blowing System

The Soot Blowing System utilizes high pressure steam from the Steam Generator System to remove ash deposits from the heat transfer surfaces of the water walls, convection pass and the air heater. The soot blowers will be supplied with steam from the primary super-heater outlet header or any other suitable point to be decided by the manufacturer. Pressure control valve will be provided on this line to supply steam to the soot blowers at the required pressure.

During start-up, the air heater soot blowers receive air from the Station Air System until superheat steam is available to clean the air heater.

Automatic thermal drain valves are provided at the termination of each soot blower supply header. These valves maintain a small amount of flow of steam through the system to provide the appropriate amount of superheat required in the soot blowing steam. The thermal drain valves are provided with manual bypass valves for pipe warming.

The Soot Blowing System is controlled by programmable logic control system. The control system is provided with manufacturer supplied recommended soot blowing sequence/ program. The control system allows operation in the full automatic mode and in manual mode that allows the operation of single soot blower unit or groups of soot blowers. The control system allows selection of the recommended soot blowing program or an alternate program input by the operator.

3.5.13 Blowdown /Drain tank

One blow down tank and flash tank per unit complete with a blow down recovery system will be provided.

3.5.14 Electrostatic Precipitator

In the proposed design, flue gas from the air heater flows through the ESP before passing into the ID fans. The ID fans discharge the flue gas into the stack. The function of the electrostatic precipitator (ESP) system is to remove the particulate matter from the flue gases, so as to maintain the flue gas particulate emissions limit below the permitted level.

Adequate number of ESP units will be provided for each boiler. Each ESP unit consists of four parallel passes with requisite number of fields. High voltage power supply for each field shall be fed from a separate TR set unit. Type of emitting electrodes, collector plates and rapping mechanism shall be as per the standard proven design of the supplier.

ESP shall be designed in such a way that the dust concentration level at outlet is maintained below 50 mg/Nm^3 at TMCR with worst coal, to meet PCB norms, with one field in shutdown condition.

Fly ash collection hoppers will be located beneath each field. Fly ash will be collected by ESP hoppers of 8 hours storage capacity and removed periodically by pneumatic ash handling system.

3.5.15 Steam Turbine and Accessories

Turbine

The steam turbine will be supercritical, multi-stage, multi cylinder, tandem compound, single reheat, regenerative, condensing design directly coupled with the generator; and suitable for indoor installation.

The plant would be designed to operate as a base load station.The turbine design will cover adequate provision for quick start-up and loading of the units to full load at a fast rate. Apart from constant pressure operation, the turbine will also have the facility for sliding pressure operation.

The steam turbine will consist of three cylinders; high-pressure turbine (HP), intermediate pressure turbine (IP); and double flow low-pressure turbine (LP). The turbine will be directly coupled to the Generator. The critical parameters of the turbine are as follows:

i	Type	Impulse, tandem compound single reheat, double flow LP, condensing
ii	Turbine maximum continuous rating (Gross)	660 MW
iii	Steam condition at TMCR a. Main steam pressure at HP inlet b. Main steam temperature at HP inlet	 247 Kg/Cm2 565 deg 0C

	c. Reheat steam temperature IP inlet d. Exhaust pressure	593 deg 0C 76 mm Hg
iv	Rated speed	3000 rpm

HP turbine will be provided with steam at about 247 kg/cm^2 for 660 MW set at 537ºC from main steam piping which conveys super-heated steam from Steam Generator super-heater outlet. Main steam piping at the turbine end will be connected to separate emergency stop and control valves. Each control valve is having its own hydraulic actuator connected to Electro Hydraulic Governing System (EHG). The control valves are modulated depending on the load demand to adjust first stage pressure accordingly. The governor senses the speed and modulates the control valve position to match with the speed-load curve setting of the machine.

The droop characteristics provides 3-5% droop and is adjustable. The emergency stop valves are provided with their own actuators and control system to take care of all requirements of shutting off the steam supply instantaneously under emergency conditions and also to provide suitable control adjustments and openings based on the logics provided for shut off purpose.

The steam from exhaust of HP turbine is taken to re-heater through cold re-heat (CRH) piping. From CRH piping, steam is tapped off to meet the requirement of steam for HP heater. The balance steam after getting reheated in the boiler to a temperature of 565°C is taken back to the IP section of the steam turbine through Hot Reheat (HRH) piping. The HRH pipes at the turbine end carrying the reheated steam will be connected to IP turbine stop and intercept valves. The stop and intercept valves on IP turbine will be controlled from EHG in tandem with HP stop and control valves. The direction of steam flow in HP and IP sections is kept in opposite direction so as to balance the thrust and minimize the load on thrust bearing provided.

The MS, CRH and HRH piping will be routed and supported to take care of static and dynamic loads including thermal expansions. Routing and pipe support using constant and variable load hangers will be provided based on the pipe flexibility analysis to be carried out during detailed engineering stage. Drains will be provided to drain low points in the piping system and at strategic locations to avoid water entry into the turbine.

3.5.16 Condensing System

Condenser

Double pass Steam Surface Condenser with tubes of welded type will be provided below LP turbine exhaust. The condenser will be of divided water box construction. Condenser will be horizontal, surface type with integral air-cooling section. Condenser hot well will be sized for three (3) minutes storage capacity (between normal and low-low level) of total design flow with the turbine operating at VWO condition, 3% make-up, and design backpressure.

The condenser will be adequately sized to cater to all conditions of turbine operation including abnormal operating conditions. Tube plugging margin of 5% will be considered for sizing of the heat transfer surface of the condenser. Stainless steel / cupro-nickel / aluminium-brass tubes will be used in the condenser.

The condenser will be designed, manufactured and tested in accordance with the latest applicable requirements of the Heat Exchange Institute (HEI), USA. Provision of separate sponge rubber ball type condenser on-load tube cleaning system for each half of the condenser including ball circulation pumps, strainer, ball monitoring system etc. will be made.

Air Extraction

The unit will comprise 2x100% vacuum pumps along with all accessories and instrumentation for condenser air evacuation. The vacuum pumps and accessories will be used to create vacuum by removing air and non-condensable gases from steam condenser during plant operation. Vacuum pumps will be of two-stage liquid ring type with both stages mounted on a common shaft to reduce the noise level and improve vacuum during the summer. Vacuum pumps will be sized as per latest HEI requirements.

Condenser Extraction Pumps

Since the units are intended to operate on a base load and not on part loads at and around 50 %, it is more appropriate to consider 3 x 50% or 2 x 100 %. Condenser Extraction Pumps (CEPs) for better operation, layout, performance, efficiency and redundancy. The wetted portions of the pumps will be of stainless steel. Each pump will be provided with its own re-circulation system.

The re-circulation system will be designed to provide minimum flow protection to the pump. Each pump is sized to ensure that it is capable to handle condensate from hot well and deliver it to deaerator through Gland steam Condenser and LP heaters under VWO condition with 3 % make up. Pumps shall have adequate margins on capacity and head to cater to adverse conditions like HP heater out and unit operating at its maximum load. The condensate extraction system is designed as per HEI.

De-aerator and closed Heaters

The regenerative feed water heating system shall comprise staged low pressure (LP) heaters, deaerator decanting to the boiler feed pump and staged high pressure HP) heaters. The feed water heaters shall be heated from the steam extractions from the turbine as given in heat balance.

The HP and LP heaters will be horizontal shell and tube type and are designed as per HEI standards for full range of the units and transient condition.

The deaerator will be of spray and tray type and will be designed and arranged for efficient removal of non-condensable gases from feed water under all conditions. It will be provided with anti-vortex baffles and wire mesh strainers at discharge connection. SS impingement plates and dispenser shall be provided at all HP heater drain inlets and BFP re-circulation inlets. The storage tank of the deaerator will have capacity for six (6) minutes. The dissolved oxygen content at the outlet of the deaerator will be limited to about 5 ppb. The non condensable gases are vented to atmosphere.

Automatic level control system will be provided for all heaters and deaerator.

Boiler Feed Pumps

The each unit will comprise of 2 x 50% turbine driven boiler feed pumps and 1 x 50 % of motor driven boiler feed pump. The BF pumps are centrifugal, horizontal, multistage, barrel type. The barrel type design facilitates easy removal of the rotor and quick replacement of the cartridge. Each BFP is provided with booster pump on suction side to meet the NPSH requirements of main BFP. The booster pump takes the suction from deaerator. The BFP is provided with minimum re-circulation system for each pump set such that the plant operates in a smooth and satisfactory manner over the entire operating range and under conditions where the pumping duty is met by one or more pump sets in any manner permitted by overall pump control.

The BFP and its drives will have necessary lubrication, cooling and control system for safe operation under all conditions. The hydraulic coupling will be provided for speed control of MDBFP.

Condensate Polishing System

The Condensate Polishing System will be designed to remove dissolved and suspended solids, corrosion products and other impurities from condensate during start-up, normal operation and periods of condenser tube leakage to maintain the feed water and steam purity requirements of the boiler and turbine. The condensate polisher will be located in condensate feed water cycle between the condensate pump discharge and the gland steam condenser. Separate external regeneration arrangement will also be provided.

3.5.17 Instrumentation and Control System

Control Philosophy

The control and instrumentation system shall be designed to ensure safe, efficient and reliable operation of the plant under all operating regimes, namely start up, shutdown, normal operation and under emergency conditions.

The state of the art control and instrumentation system shall include but not be limited to the following:

A functionally distributed microprocessor based DCS, designed for CRT operation, control and monitoring with in-built Sequence of Events (SER) recording and Annunciation system, including control desk and system cabinets. The DCS Monitor based plant operation shall result in cost effective power generation with optimum fuel consumption and reduced emission levels. It shall relieve the operator from tedious manual operation as most operations of the plant shall be automatic with sequential start-ups of major plant equipment. The design of the control and instrumentation system would be such as to permit on line localization, isolation and rectification of fault in the minimum possible time. Ease of maintenance would be given due importance at system design stage.

The DCS shall provide a comprehensive integrated control and monitoring system to operate, control and monitor the Steam Generator and auxiliaries, Steam Turbine-Generator and Auxiliaries and Balance of Plant (BOP) systems.

Monitoring and control, data acquisition, alarm annunciation, fast response time, fail safe design, sequence of events recording, online diagnostic and online maintenance are some of the inherent features of the DCS to be designed for the proposed power plant.

Plant operation and control shall be through the Operator Work Stations (OWS) located on the Unit Control Desk (UCD) in the Central Control Room, which shall consist of colour graphic LCD (TFT) monitor, keyboard/mouse.

The main plant including Steam Generator and its auxiliaries, Steam Turbine Generator and its auxiliaries and Balance of Plant equipment and auxiliaries etc. shall be controlled and monitored through DCS. DCS shall include the modulating controls of the plant including coordinated Master Control, Steam Generator modulating controls, Turbine governing and other Turbine modulating controls, and modulating controls for Balance of Plant equipment.

All open loop control functions for the main plant including Steam Generator (e.g., FSSS) and the Steam Turbine Generator (e.g., ATRS) and their auxiliaries along with Balance of Plant (BOP) equipment and systems shall be implemented in the DCS.

DCS shall also include sequential start up, shutdown of the plant including Steam Generator, Turbine Generator and BOP Equipment and Systems.

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

Operation and Monitoring of Plant Electrical and downstream System shall be performed through DCS. Additionally, DCS shall have a Software link for monitoring of electrical system.

Sequence of Event Recording system shall be provided for recording and printing trip and causes of trip for quick diagnostic of fault and remedial action.

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

The plant offsite systems like Water treatment, Coal handling, Ash handling, Instrument and Service air system etc. shall be controlled and monitored through the respective Local Control panels and control systems. Independent and stand-alone PLCs in hot redundant configuration shall be used for control and monitoring of these offsite systems. PC based Operator Work Stations (OWS) with LCD (TFT)/ KBD/ Mouse shall be provided for these offsite systems, which shall be kept in the respective Local Control Rooms. Additionally, control and monitoring of these offsite packages shall be possible from DCS Operator Work Stations (OWS) from Central Control Room.

Redundant Software link shall be provided between the offsite package PLCs and DCS for data exchange shall.

3.5.18 Plant Operation

General

The Control System for the main equipment of the Power Generating Units and control systems for offsite packages in the Plant shall be designed such that a centralized operation monitoring and control of the process and the equipment can be carried out from a central location (Central Control Room). Separate and independent Instrumentation and Control System has been envisaged for the Power Generating Unit. This will be integrated in the Management Information Level to assist the higher management in analyzing the performance of the Plant.

The Instrumentation and Control System for the entire plant shall be designed in such a manner that normal maintenance, testing and operation of any of the other units in the plant as well as any abnormal event shall not affect the safety, availability and production capability of the proposed unit.

The entire plant control, operation and monitoring shall be performed from Operator Work Stations (OWS) consisting of colour graphic LCD (TFT) monitor/keyboard/mouse located on the Unit Control Desk (UCD) in the Central Control Room. Selected group alarms shall be provided on a hardwired Annunciation system on the Unit Control Panel. In addition, hardwired push button stations shall be provided on Unit Control Desk (UCD) to provide manual back-up of major auxiliaries as well as to ensure fast and reliable tripping of the plant and major auxiliaries in case of emergency.

Runback Capability

When a unit is on load and a trip or abnormal condition is detected, the control system shall take specific automatic run back actions in parallel to any possible trip functions, to place the unit and major components in a safe and stable operating state.

The control objective is to reach this lower energy state in a controlled manner and to remain in a controlled stable state. This requirement is necessary to enable adequate time for the operator to decide on further actions (e.g. re-start or total shutdown of the unit or the respective components of the unit).

Unit Islanding

The control system of the unit shall be capable of tripping to house load and continue stable operation under unit islanded conditions. The unit shall be islanded in all cases of network disturbances which would otherwise lead to unit shutdown.

Control and Instrumentation Systems -Components

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

- Distributed Control System (DCS) with Plant wide Data High way
- Steam Generator Control and Protection System as per manufacturer's standard design with interfacing with the Plant DCS.
- Steam Turbine Generator Control and Protection System as per STG manufacturer's standard design interfacing with the Plant DCS.
- Turbine Supervisory Instrumentation system for STG
- Vibration monitoring system for major plant auxiliaries
- Master and Slave Clock System.
- Central Control Room
- Measuring Instruments
- Steam and Water Analysis System (SWAS)
- Off site Packaged control system
- Stack Emission Monitoring
- Close Circuit Television (CCTV) System
- Uninterruptible Power Supply and Distribution
- Final Control Elements
- Instrumentation and special cables
- Maintenance and Calibration Instruments
- Erection Hardware

Distributed Control System (DCS)

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

Distributed Control System (DCS) for each unit of the plant shall consist of following basic functions / Subsystems:

- Close Loop and Open Loop Control Systems, which include Interlock and Protection systems, Sequential Controls, Plant Automation features and Measurement Systems
- Operator Work Stations (OWS)

- Data Communication System
- Historical Storage and Retrieval systems
- Plant Performance Calculations System
- Management Information System
- Sequence of Events Recording System
- Alarm Annunciation System
- Smart Transmitter Maintenance Station
- System programming and Documentation Facility

Necessary interfaces between DCS of each unit of the plant shall be provided. DCS shall be of Open Architecture Type having high system availability and reliability.

The DCS shall be of proven and latest configuration and shall be compatible with OPC, Ethernet, and TCP/IP communication for high speed LAN so that it can be connected seamlessly with other OPC compliant systems. Data transmission speed shall be sufficient to meet the response of the Distributed Control System.

Modular system design shall be adopted to facilitate easy system expansion. It should be possible to remove or replace various modules on line.

DCS shall include online self-surveillance, monitoring and diagnostic facility so that a failure or malfunction can be diagnosed automatically down to the level of individual channels of modules with display and print out.

DCS shall be fault tolerant to provide safe operation under all plant disturbances and component failure.

The control and automation system, including plant protection systems, operator interface and information system shall employ fully integrated modern distributed control system technology.

The control and automation system shall be suitably designed to achieve the plant performance and safety requirements, and shall be highly reliable, fail-safe, self-checking with comprehensive internal diagnostics. No single random fault in the entire automation and control system shall cause a load loss, forced outage or unit trip, and no two simultaneous faults shall lead to or potentially cause damage to plant. Safety-related instrumentation and control shall be designed with a fail-safe mode. Fault in any of the sub system shall be suitably alarmed in the Operator Station.

Adequate redundancy in Processor, Power Supply and communication interfaces shall be provided so that no single failure shall jeopardize the functioning of the entire system. Fault in any of the sub system shall be suitably alarmed in the Operator Station.

Measured data shall be continuously checked for validity, whether used for operator

information, for control, calculations or plant history.

Interfaces of the control and automation system to specialised equipment or stand-alone equipment shall be standardised, based on internationally accepted norms. Provision for minimum 30% reserve capacity in respect of Processor Memory and minimum 40% reserve capacity in respect of Networks shall be included in the base design of the control and automation system and the system shall be expandable for up to 20% hardware and 30% software without requiring redesign of the configuration.

The control and automation system and the field measurement and actuator systems as well and its support systems, power supplies and data networks shall be immune to electromagnetic interference, and shall conform to internationally accepted standards for power plant.
The control and automation system and the field measurement and actuator systems shall comply with Process Control Security Requirements, meeting international standard norms and requirements.

Close Loop and Open Loop Control System

The control system along with its measurement system shall perform functions of Closed Loop Control System (CLCS), Open Loop Control System (OLCS) including protection functions, measurement and monitoring of signals and alarm function.

The plant shall be functionally subdivided into groups, subgroups and drive control levels. The Close Loop Control System (CLCS), Open Loop Control System (OLCS) and protection system for different groups with its subgroups shall be implemented through separate controllers. However, CLCS and OLCS of same group/ subgroup shall be implemented through same controllers, which shall have multifunction and multitasking facilities.

The main and hot standby controllers shall be identical in hardware and software implementation and there shall be automatic and bump less switchover from main controller to hot standby controller in case of main controller failure and vice versa without resulting in any change in control status. Major protection systems of the plant including Furnace Safeguard and Supervisory System (FSSS) and Turbine Protection System (TPS) shall be implemented through triple redundant Controllers based on three (3) input signals and three (3) input / output channel.

Critical Protection Systems shall be implemented through triple redundant sensors and input/output channels. Triple redundant sensors / transmitters and input channels shall be provided for critical closed loop controls such as Furnace Pressure / Drum Level

Controls. Dual redundant sensors / transmitters and input channels shall be provided for other closed loop controls.

The control and automation system and the field measurement and actuator systems as well and its support systems, power suppliers and data networks shall be immune to electromagnetic interference, and shall conform to internationally accepted EMC standards for power plants.

The control and automation system and the field measurement and actuator systems shall comply with Process Control Security Requirements, especially the IEC 62443 «Security for Industrial Process Measurement and Control – Network and System Security» valid from 2007.

The control system along with its measurement system shall perform functions of Closed Loop Control System (CLCS), Open Loop Control System (OLCS) including protection functions, measurement and monitoring of signals and alarm function.

The following major control and monitoring systems shall be covered by the Plant DCS. These are grouped based on main plant equipment, auxiliaries and their functional distribution.

- Steam Generator (SG) Control System
- Steam Turbine Generator (STG) Control System
- BOP and Auxiliaries Control System
- Monitoring and Operation of Electrical System

The SG control system shall include the following functional blocks:

- Burner Management System (BMS)
- Furnace Safeguard, Supervisory and Control System
- Steam Temperature Control system
- Drum Level Control system
- Auxiliary pressure reducing and de superheating station (APRDS) Control System
- Coal Feeder Control System
- Steam Generator Auxiliaries Controls
- Electromagnetic Relief Valve control, Furnace Temperature Probe control and other miscellaneous control
- Air Heater Leakage Control System and Fire Detection System

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

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

The boiler protection philosophy to be implemented is based on the respective required regulations. NFPA guidelines shall be followed.

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

SG & TG control system

The Steam Turbine control and governing system is configured as a two channel redundant system, which allows for bump less control transfer from the one to the other channel in the event of a channel failure.

A turbine stress evaluator is also included, to control stress in the turbine via measurements at predetermined locations in the turbine. This function shall be continuously active under all operating conditions, but particularly during start-up.

The SG C&I system shall typically include the following functional groups:

a) Furnace Safeguard Supervisory System for Boiler
b) Auxiliary PRDS Control
c) Soot Blower Control
d) Coal Feeder Control, etc.

Turbine Supervisory Instrumentation System / Vibration Monitoring Systems

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

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

Vibration monitoring system for major plant auxiliaries

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

The vibration monitoring system shall be provided both at Driving and Non Driving ends of the fans, pumps, and their drive motors both at X-and Y-directions at each measuring points.

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

Master and Slave Clock System

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

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

In the event of non-availability of GPS Pulses, the time synchronizing pulse from the Master Clock itself shall be utilized for time synchronization of the plant DCS with other systems.

3.5.19 Central Control Room

The plant shall be controlled, by a minimum of operators during any shift, from a main operating control room, to cover all normal operations including start-up and emergency situations.

The operating control room shall be sized to accommodate additional staff and observers for commissioning, testing, start-up and emergency situations.

A communication system shall be provided for the operator to communicate verbally and in electronic form to all parties involved in normal and abnormal events.

The operating control room shall house all necessary support systems, such as documentation, references, procedures and computerised support systems necessary. Printers shall be provided for logs, reports, hard copies of displays and other documents as required by the operators.

The entire control room environment shall be designed with due consideration to human factors, safety, access, emergency evacuation, aesthetics, shift work, and interpersonal communications.

3.5.20 Measuring Instruments

Primary Sensors, transducers and transmitters shall be selected from reputed makes of proven performance. Smart transmitters having 4 -20 mA DC Signal Output with superimposed digital signal conforming to HART or any other internationally accepted protocol shall be used for measurements, having high degree of accuracy and reliability.

Signal transmission from primary sensors or converters (except temperature elements and few other field devices) to DCS, shall be 4-20 mA DC, 2 wire type.

Two numbers portable digital calibrator / HART Communicators shall be provided for on line calibration of transmitters.

In general, for temperature measurements, upto 300 Deg C, resistance temperature detectors shall be used unless the area is prone to vibration. For temperatures above 300 Deg C, Chromel -Alumel (Type-K) thermo couple shall be used. For lower temperature, vibration prone areas, iron-constantan (J) type thermocouples shall be used.

All temperature elements shall be duplex and shall be in sheath tube and thermo wells of suitable material. For high temperature applications, noble-metal thermocouple in Nicolay sheath and thermo well shall be used. Thermocouples shall be mineral insulated type. Thermo well length and material selection shall take care to avoid erosion / breakage due to high fluid velocity.

Flow nozzles shall be utilised for measurement of Steam flow, Feed water flow, SH and RH attemperator flow and BFP re-circulation flow.

For fuel oil flow measurements" Coriolis type mass flow meters with an accuracy of +/- 0.5% of FSD shall be used. For Cooling Water flow measurement, Ultrasonic / Impact Head Type flow measurement system shall be used.

Aerofoil / Ventury type sensors shall be used for Combustion Air flow measurements. Airflow measurements used in the combustion process shall be reliable and accurate. The impulse lines for air flow measurement and furnace pressure should be designed to eliminate blockages that could lead to incorrect flow or pressure measurements.

Orifice Plate shall be used for all other flow measurements.

Level switches for separator and drain pots of steam lines shall be of conductivity probe type. All other level switches shall be of external chamber Float / Displacer type as per application.

Level Transmitters for vacuum service shall-be of displacer type. All other level transmitters shall be of Differential Pressure type with pressure and temperature correction, as required.

Flue Gas oxygen measurement shall be carried out by in situ Zirconium Oxide Type Sensor which shall be provided at the Economizer Outlets and Air Heater Outlet.

The transmitters and switch devices shall be grouped together and shall be placed in different local instrument enclosures in open and dust prone areas and in local instrument racks in covered areas at suitable locations. Measurement gauges shall be provided locally.

Transmitters required to serve multiple receivers shall be arranged so that disconnecting, shorting or grounding of one receiver device shall not have any perceptible influence on any other consumer point of the same signal nor shall change the transmitter calibration.

Local Indicating Gauges shall be provided for local monitoring of process parameters.

All field mounted instrumentation items shall be of IP 65 protection class. Uniformity in Make and type of instruments shall be followed in similar applications.

Equipment for special applications such as fail safe, protection applications and hazardous locations, shall be based on the specific requirements for the application.

Where bus type communications are used for the field measuring device interface, care should be taken to ensure appropriate functional distribution to prevent load losses due to bus failures.

3.5.21 Steam and Water Analysis System (SWAS)

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

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

Sample Conditioning Panel shall contain sample filtering, secondary sample cooling and temperature control, pressure reduction and control, flow rate control, necessary instruments required for sample conditioning and monitoring.

Primary sample coolers and high-pressure reduction units shall be located in field. Provision of grab samples shall be provided in Sample Conditioning Panel.

The Analyzer Panel shall consist of process analyzers and monitors. Analyzer panel shall house alarms in local control panel with provision for repeat alarms in Central Control Room. The signal from the analyzers shall be hooked up with Plant main DCS.

Following Table provides a guideline for analysis of Samples taken from different streams:

Table - 3.2: Guideline for analysis of Samples taken from different streams

Stream / Service Application	Analyser
Make Up Water	Specific Conductivity
	Cation Conductivity
Hotwell condensate	Specific Conductivity(Both Sides)
CEP Discharge	pH
	Specific Conductivity
	Cation Conductivity
	Sodium
	Dissolved Oxygen
Condensate Polisher outlet	pH
	Specific Conductivity
	Cation Conductivity
	Sodium
Deaerator Outlet	Dissolved Oxygen
Feed water at economizer inlet	pH,
	Specific Conductivity
	Cation Conductivity
	Silica
	Hydrazine
	Turbidity
Separator outlet steam at LTSH inlet	Specific Conductivity

Stream / Service Application	Analyser
	Cation Conductivity
	Hydrazine
	Silica
Main Steam outlet	Specific Conductivity
	Cation Conductivity
	Sodium
	Silica
Reheated Steam	Cation Conductivity
Condenser cooling water	pH
	Specific Conductivity

Off Site Packaged Control System

The control, interlock, protection and start / stop operation for the Off Site package like DM Water Plant, Coal Handling Plant, Ash Handling Plant, Instrument and Service Air Compressor Plant, Fuel Oil Handling System etc. shall be carried out from the respective PLC based Local Control Systems.

Redundant Software Links shall be provided between all these PLC based Control Systems and DCS so that full operation, Monitoring and Control of the Off Site Packages are possible from the Central Control Room through DCS Operator Work Stations.

PLC based control systems with hot redundant CPU, memory, power supply and communication modules for these off site packages shall be provided. These PLCs shall be interfaced with DCS through redundant software links based on Dual Optical Fiber Communication (OFC). Necessary ports / converters shall be provided at both ends.

For redundant PLC based control system for offsite packages, alarm annunciation shall be carried out in the PLC system and to be displayed in the Operator Work Stations (OWSs) of the respective PLC based systems. Conventional Hardwired alarm system shall be provided where LCD (TFT) based OWS is not provided.

3.5.22 Stack Emission Monitoring System

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

a) Oxides of Nitrogen NOx
b) Sulphur Dioxide SO2
c) Carbon Monoxide CO
d) Stack Opacity Monitor

Opacity Monitoring shall be in situ type. The other CEMS shall be complete with flue gas sample extraction and conditioning and analysing system. PC based Emissions Monitoring System with 21" Colour Graphic LCD / TFT Monitor with Keyboard, Mouse along with Laser jet Printer. A software link shall be provided to hook up the Emission Monitoring System to the Plant DCS.

Ambient Air Quality Monitoring System (AAQMS)

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

(a) AAQMS stations -3 nos.
(b) Centralized AAQMS data acquisition system.

The complete Ambient Air quality monitoring system shall contain measurement of following parameters:

i) Sulphur Dioxide (SO_2) ii) Nitrogen Dioxide (NO_2) iii) Carbon Monoxide (CO) iv) Particulate matter PM10 (SPM) v) Particulate matter PM2.5 (RSPM) vi) Carbon Di-oxide (CO2) vii) Ozone (O_3) at one location

Local display unit (to display real time AAQ parameters) to be located at strategic location in the plant shall be provided. Local display unit shall be interfaced with Centre PC station.

Auto calibration facility shall be provided for AAQMS.

3.5.23 Public Address System (PA system)

A central exchange based Public Address (PA) system would be used to provide proper communication throughout the plant (including Balance of Plant) with the help of handset stations, loudspeakers, potable handset stations etc.

3.5.24 Closed Circuit Television System (CCTV)

Closed Circuit Television System (CCTV) with all equipment and accessories shall be provided for the purpose of surveillance of major Electrical Drive areas e.g. Boiler feed Pumps, ID, FD and PA fans, Mills, Condensate Extraction Pumps and critical areas like Turbine hall, firing floor, CW/ACW Pump House, Ash Plant areas etc. Also, cameras shall be installed at the Main Gate and other common auxiliary plants.

3.5.25 Water Systems

General

Water in the plant will be used for cooling of condenser, cooling of SG & TG auxiliaries apart from various other services including SG makeup, fire protection system, air-conditioning & ventilation system and plant potable water service.

The water system consists of various sub-systems listed below and discussed in the subsequent paragraphs of this chapter. The following systems will be part of water system.

- Raw water system
- Raw water Reservoir
- Cooling water (CW) system
- Make up water system for cooling towers
- Auxiliary cooling water (ACW) system
- Water treatment (WT) system
- Service & potable water system
- Fire protection system
- Effluent Reuse and Recycling

The total water requirement for 2x660 MW units has been summarized in blow Table:

Table - 3.3 : Total Water Requirement

S. No.	Description	DM Water	Filtered water	Clarified water	Raw Water
A DM Water Requirement					
1	Heat cycle make-up	131			
2	Make-up for DMCW	11			
3	Hydrogen Generation Plant	3			
4	Condensate polishing	4			

S. No.	Description	DM Water	Filtered water	Clarified water	Raw Water
5	Chemical feeding system	9			
	Total	**158**			
	Considering regeneration time of 4 houres; the capacity of DM plant worked out		174		
B Potable water requirement		70			
	Total filtered water requirement		244		
C Clarified water requirement					
1	Input to filtration plant			244	
2	Service water			150	
	Cooling Tower make -up			4068	
	Sludge disposal			25	
	Total clarified water requirement			**4487**	
D Raw Water requirement					
1	Input to clarifier by considering 90m^3/hr sludge disposal			4577	
2	Total raw water requirement				4577
3	RO plant recovery				-357
4	Evaporation loss				20
	Total raw water requirement for the plant				**4240**

Note: All values are in m^3/hr

Raw Water Supply & Treatment Plant

Make up water requirement for the plant shall be made available from Lower Ganga Canal which is around 22 kms from the proposed site. The quantity of makeup water requirement is near about 4240 m^3/hr. Raw Water shall be supplied through 3 x 50% pumps for each unit (2 working and 1 standby) to clarifier to remove the suspended solid. The clarified water shall be used for the cooling tower make-up, service water, potable water, DM plant, fire-fighting system etc.

Water Treatment Plant

The pre-treatment plant shall consist of two nos. (2x60%) clarifiers each has a capacity of about 2150 m^3/hr, along with mixing of lime and alum with raw water. Clarified water will be stored in a clarified water storage tank of eight hours capacity from where water will be distributed to different users by providing following pumps.

- 2x100% pumps capacity of each pump 90 m^3/hr for supplying water to DM plant.
- 2x100% pump, capacity of each pump 35 m^3/hr for supplying water to potable water tank.
- 2x100% pump, capacity of each pump 75 m^3/hr for supplying water to service water tank.

Condenser (CW) System

The plant CW system shall include the CW and auxiliary CW pumping system, natural draught cooling tower, and cooling tower make-up.

The Condenser Cooling Water shall be pumped from the CW pump house. 3x50% CW Pumps with two working and one standby shall be used for each unit. The Water requirement for Condenser Cooling of each unit shall be ~ 105083 cum/Hr. The main cooling water pump shall be vertical mixed flow type pumps coupled with vertically mounted electric motors.

3x50% auxiliary cooling water pumps will be supplied for supply of auxiliary, cooling water to 3x50% heat exchangers, which will be used for cooling of generators, air compressors, turbine oil coolers and Boiler Feed Pump lube oil coolers for both the units. The auxiliary cooling water pumps shall be mixed flow vertical pumps.

The main cooling water pumps and auxiliary cooling water pumps shall be located inside the CW pump house to be located adjacent to the cooling tower.

Two (2) no. of Natural draught cooling towers (NDCT) of RCC construction shall be provided for cooling the hot CW return from condenser and plant auxiliaries for both the units. The NDCT shall be designed considering wet bulb temperature 28°C and CW temperature range 9°C.

The clarified water will be used for cooling tower make-up. Cooling tower blow-down will be treated in the clarifier & RO system to utilize that further into the plant water system. The condenser cooling water system shall be provided with adequate chlorine dosing system.

The cooling water circuit will be designed to operate at optimum cycles of concentration

in order to limit fresh water consumption and minimize blowdown.

Auxiliary Cooling Water (ACW) System

The ACW system meets the cooling water requirements of DM water in plate heat exchangers. DM water is used for cooling of the auxiliary equipment related to TG & SG units such as turbine lube oil coolers, hydrogen coolers, seal oil coolers, stator water coolers, ID/FD/PA fans bearing oil coolers, mill lube oil coolers, BFP auxiliaries such as lube and working oil coolers, seal water coolers, drive motors, etc., condensate pump bearings, air preheater bearings, sample coolers, air compressors and ash handling system compressors.

A closed loop system using passivated DM water is proposed for the ACW system. The DM water of boilers, turbine & station auxiliary's water is circulated through all equipment coolers for cooling. The hot water from the auxiliaries is cooled in the plate type heat exchangers by the circulating water from the ACW pumps located in the C.W pump house.

The auxiliary cooling water system would be on unit basis and the equipment of the system for each unit will be as follows:

- 3 x 50 % capacity de-mineralized cooling water pumps.
- 3 x 50 % capacity ACW pumps.
- 3 x 50 % heat exchanger.
- 2 nos. DMCW tanks for makeup.

The water treatment (DM) plant will provide make up water to closed loop circuit of the primary cooling water system.

DM Plant

The 2x660 MW unit will be provided with a 2 x 100% DM plant chains (90 m^3/hr capacity for each chain) to ensure make-up requirement of heat cycle at the rate of about 3% of the BMCR steam flow. Clarified water from Pre-treatment plant shall be supplied to DM plant for the above purpose.

The Dematerialized Water shall be generated after the completion of treatment process of clarified water through set of 2 x 100% pressure filters, activated carbon fillers, Anion Exchangers, Cation Exchangers, and Mixed Bed Exchangers. Degasser towers, Degasser pumps, blowers for mixed bed exchanges, blowers for pressure filters, acid and alkali storage towers, Acid and Alkali measuring tank, pipes & valves.

DM water shall be stored in 2 x 2100 m^3 of DM water storage tank and three nos. (2W +

1S) DM water storage forwarding pumps each of capacity 90 m^3/hr shall be provided to DM water to transfer the DM Water from the DM plant storage tank to a Condensate storage tank of capacity 750m^3/hr for each unit for further heat cycle make up system. DM water storage tank capacity is adequate to meet 24 hrs make-up requirements.

Besides, there will be 2x100% boiler fill pumps for direct filling of boiler with Dematerialized Water. These pumps shall be located near Condensate storage tank.

The complete mode of operation of DM plant and filtration plant will be semi-automatic for which a PLC based control system will be provided.

Service and Potable Water Systems

The service water system covers supply of clarified water required for seal water for clinker grinders, ventilation, air conditioning system, fly ash & bottom slurry and water pumps, air washer and miscellaneous water requirements such as plant washing. Two (2) horizontal, centrifugal pumps, (1W + 1S) will pump water from the clarified water storage tank to the service water overhead tank. Water from the overhead tank to the different consumer points would be distributed by gravity.

Requirements of the plant potable water system will be met from the clarified water storage tank. Two (2) (1W + 1S) horizontal, centrifugal plant potable water pumps, will draw suction from the clarified water storage tank for further distribution of potable water to various consumption points in the plant and colony.

Effluent Recycling and Reuse System

The Plant is designed for minimum liquid effluent to be sent out of the plant. The liquid effluents will be collected and treated / recycled generally as per the following:

- Effluents from Boiler, Turbine and other areas, which may contain oil traces, will be sent to oil/water separator. The oil will be pumped out periodically and trucked offsite for disposal. The treated water of significantly low quantity will be directed to central monitoring basin.

- The clarifier sludge generated in pre-treatment and cooling tower blowdown treatment system shall be further thickened and dried in thickener and drying bed. The dry sludge from the sludge drying bed shall be manually sent through truck for offsite disposal.

- The cooling tower blowdown will be used as quench water for boiler blowdown. The quenched water shall be treated in the effluent treatment plant. A clarifier and RO

will be provided to maximize the blowdown recovery. The RO rejects will be utilized as makeup water for ash handling system, even after ash-water recirculation from ash pond. This is due to mostly evaporation losses in the pond and ground tank.

- 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 shall be used for dust suppression in the coal pile area. During excessive rain, when the runoff is not expected to contain substantial amount of suspended solids after initial hours of heavy rains, the clean runoff shall be directed to central monitoring basin for storage and further reuse. The pump, which shall be used for coal pile dust suppression, shall be used for transferring the runoff from settling basin to central monitoring basin. Provision shall also be kept for disposal of coal pile runoff to ash pond via central monitoring basin and ash slurry sump.
- Filter backwash waste, which is generated in raw water pre-treatment system and contains high-suspended solids, shall be taken back to raw water clarifier to minimize wastewater effluent.
- Wastewater generated during offload air heater wash will be taken to Settlement basin, the capacity of which shall be adequate to hold one air heater wash volume. The air heater wash water shall contain high-suspended solids. After settlement of suspended solids in settlement basin the clear water will be taken to central monitoring basin.
- The oil sumps will collect water from areas where there are possibilities of contamination by oil (for transformer yard, fuel oil storage area) and the drains from such areas will be connected to an oil separator. From the oil separator the clear water will be discharged to the guard pond, while the oily waste sludge will be collected separately and disposed. Water collected in the guard pond will be subjected to treatment (if necessary) and then discharged to storm water drains.
- Fly ash will be disposed in dry form. During retrieval of dry fly ash from silos, adequate water injection into the ash-conditioner will be made to avoid dust nuisance. During exigencies, it may be necessary to dispose both bottom and fly ash in wet form to ash pond. Wastewater generated in fly ash handling system will contain some suspended solids. This wastewater will be taken to small collection sump. This collection sump will be provided with weir chamber, where suspended solids will be settled. The overflow clear water will be pumped to ash slurry sump. From the ash slurry sump, the content shall be disposed to Ash pond. During "emergency excess water or unacceptable quality water in central monitoring basin

shall be taken to ash slurry sump for final disposal to ash pond.

- All the plant liquid effluents will be mixed in the central monitoring basin. However there may be some occasional variations in suspended solids and pH. A provision for chemical dosing is kept to adjust suspended solids and pH. If the treated water quality in central monitoring basin is inacceptable limit, the water shall be used either for plant green belt development or for miscellaneous plant uses. Excess water or unacceptable quality water in central monitoring basin shall be taken to ash slurry sump for final disposal to ash pond and finally utilized for ash water system and green belt development.

3.5.26 Coal Handling System

General

The Coal Handling System for the proposed 2x660 MW units will receive coal by Railways open top wagons (BOXN). Railways will be undertaking the operation for transporting the coal from the coal mine to the project site. All transporting facilities including wagons and locomotives to transport the coal from the mine to the plant will not form part of the project site. In Plant coal handling system will consist of:

- Wagon tipplers (3 nos.)
- Track Hopper (1 no.)
- Locomotives (2 nos.)
- Dumpers (2 nos.)
- Side Arm Chargers
- Belt Conveyors
- Belt Scales
- In line Magnetic separators
- Metal detectors
- Coal Sampling Unit
- Stacker cum reclaimers (2 nos.)
- Dust suppression system
- Dust extraction system in enclosed areas like transfer point, bunkers
- Hoists/ Equipment handling facilities
- Control and instrumentation
- Electrical System
- Ventilation System in Conveyor Tunnels and Bunker floor
- In-motion weigh bridge
- Safety and protective instrumentation

Design Criteria and Assumptions

Domestic coal for the proposed plant will be sourced from the Rajmahal group of

coalfields in Sahpur – Jamarpani Sector, Brahmani Basin, Dumka District of Jharkhand. The useful heat value (UHV) of the coal in these coal fields will be in the range from 1392 kcal / kg to 5988 kcal / kg. For calculation purposes an average GCV of 4000 kcal / kg has been assumed.

The coal will be unloaded at project site by wagon tipplers. The Coal Handling Plant (CHP) will be designed to operate throughout the year with worst Indian coal.

Considering a gross plant heat rate of 2247 kCal / kWh, the coal consumption for the plant at full load with GCV of 4000 kCal / kg will be:

S. No.	Coal Consumption at full load	2x660 MW Capacity
1	Tonnes per hour	740 T/hr
2	Tonnes per day	17800 T/day
3	Tonnes per year (at 85% PLF)	5.52 million TPA

Coal handling plant capacity is worked out at 1800 TPH considering adequate margin. Coal will be unloaded by wagon tipplers into a common hopper. CHP shall be suitable for operation 24 hours/day. However, plant will operate in two shifts for 6 hours in each shift.

CHP system will consist of two (2) streams of conveyors (1 operating + 1 standby) and each stream will have guaranteed capacity of 1800 TPH. The complete CHP equipment and systems will, however, be designed for simultaneous operation of both the streams in exigency.

The CHP system envisaged shall have one (1) crusher house having four crushers (2 working + 2 standby) each of capacity 900 TPH capacity, one (2) stacker-reclaimer machines, of adequate capacity with reversible yard conveyors, one (1) crushed coal storage yard. Coal bunkers will be filled by two (2) trippers. Normally one tripper conveyor will be operated although provision will be kept for both conveyors' simultaneous operation. Other facilities such as safety guards, safety switches and hoists for maintenance will be provided. The conveyor galleries with walk way on either side will be of covered type having corrugated GI sheets as roofing and side cladding. Galleries will be naturally ventilated. FRP sheet side panels will be provided in a staggered manner for natural lighting.

The CHP system anticipated will be complete with dust suppression / dust extraction system etc. to make the CHP system operation eco-friendly.

All chutes will be provided with stainless steel lining to ensure smooth flow & discharge of coal as well as to ensure longer operating life of chutes. All Junction Towers (JT's) and crusher house will be provided with floor cleaning chutes.

Three Wagons Tipplers and 1 track hopper shall be provided; the wagon tipplers shall be so spaced that one Engine Escape Line (EEL) can be accommodated in between. Separate hoppers shall also be provided for each wagon tippler. The side arm charge should be capable of dragging full rake including locomotive, 59 wagons and one break van. There should be scope of expansion of the range of the side arm charge to 60m each side of the Wagon Tippler. Three additional tracks shall be provided, one track shall be for Petroleum Oil and Lubricants (POL) second track shall be for Engine Escape and third track shall be spare for material handling etc. Space shall also be kept for future provision of additional wagon tipplers.

However detailed system of coal transportation will be decided at detailed engineering stage.

Coal Unloading Facilities

The ROM coal of (-) 50 mm or smaller size will be transported (from coal mines) in BOXN wagons. The CHP layout will be developed for unloading coal through Wagon tippler and track hopper. The design capacity of Wagon Tipplers shall be 25 TPH.

There will be four (4) vibrating feeders (2 operating + 2 stand by). From vibrating feeders coal will be fed to each of the two (2) belt conveyors each of 3000 TPH designed capacity. From the belt conveyors coal will be delivered to crusher house.

Required number rail tracks appropriately interconnected with each other will be laid ahead & prior to the wagon tippler for handling / shunting / bunching / return of empty rakes. Necessary line side equipment and signalling arrangement for rake movement will be provided.

Crushing & Screening Facilities for Coal

a) Coal will be delivered to crusher house for crushing & screening via belt conveyors. Tramp will be separated from uncrushed coal by in-line magnetic separators mounted at head end of conveyor before feeding coal to crushers.

b) The Crusher House envisaged will have following features:

i) Four (4) screens will be provided for pre-screening of coal to screen out (-) 20 mm lumps prior to feeding it to four (4) crushers. Two (2) screens will be

operating while the other two (2) will act as standby. Similarly two (2) crushers will operating and the other two (2) crushers will be standby.

ii) Pre-screened feed to crusher will prevent-crusher choking due to wet fines during monsoon as well as prevents generation of excessive amount of fines to avoid dust nuisance.

iii) Anti vibration pads for crushers will be provided to optimize civil / structural design of each crusher house.

Crushed Coal Storage / Reclaiming / Coal Bunker Feeding Facilities

When coal bunkers are full, crushed coal from crusher house will be transported to crushed coal storage yard by stacker / reclaimers with reversible yard conveyors. The stockyard will have capacity to hold 30 days coal requirement.

In the event of non-availability of coal at wagon tippler, crushed coal from stockpile will be reclaimed by bucket wheel stacker / reclaimer and transported by conveyors for filling boiler coal bunkers.

Coal Handling Plant Auxiliaries

1. Auxiliary systems such as dust extraction / dust suppression system for dust emission control, ventilation system in tunnels etc. and air conditioning system in control room and ventilation system in MCC room will be provided.
2. Weighing system will be provided on belt conveyors to weigh the coal feed rates to coal bunkers.
3. For removing iron piece, in-line magnetic separator will be provided at discharge end of belt conveyor feeding crushers and discharge end of conveyors feeding bunker floor conveyors.
4. 3-stage sampling system will be provided after crusher house at suitable place.
5. High/ high & low-level indicators will be provided for coal bunkers to show the measurement assessment of coal in the bunkers.
6. Electric / Manual hoists will be provided for maintenance of drive units / pulleys / crusher & screen components etc. Hoisting system will be capable to remove of material to the ground level for transportation to repair shop.
7. Sump pumps will be provided in conveyor tunnels, transfer lowers and stockpiles area etc. for rain-water drainage.
8. Suitable belt vulcanizing machine will be provided for belt repairs & replacement.
9. Belt sealing arrangement will be provided for coal bunkers.
10. Control system will be provided on tripper conveyor floor, wagon tippler control room and CHP main control room etc. to operate the entire CHP facility safely and

efficiently.

11. Dust suppression system will be provided in stack yard area.

3.5.27 Ash Handling System

General

The ash handling system will be designed to collect, transport and dispose bottom ash, coarse ash and fly ash from ESP hoppers. Fly Ash from ESP hoppers and Air preheater hoppers shall have dry ash as well as wet ash handling and transportation system. The ash will be transported to Ash utilization project and / or ash dump area in wet form. The ash handling system will consist of two major systems, namely bottom ash and Fly ash system.

The System proposed is for wet disposal of the Bottom Ash, dry extraction of the Fly Ash. HCSD system shall also be provided for fly ash disposal in case of emergencies.

The quantum of ash generation would depend on the plant load factor and the quality of coal being fed. Considering worst coal with ash content of 45% in domestic coal about 335 T per hour of ash will be generated from the proposed station.

The ash handling plant will be designed to meet the following requirements”

i) Bottom Ash per hour (20%) : 67 Tons
ii) Fly Ash per hour (70%) : 235 Tons
iii) Coarse Ash per hour (10%) : 33 Tons

An additional margin of ten (10) percent will be considered for designing the Ash handling plant over and above the anticipated ash generation rates. Fly ash generation of 90% will be considered for designing the Fly ash handling plant with additional 10% margin.

Bottom Ash System

Bottom ash is extracted either by using a continuously operating submerged scraper chain conveyor system or by using intermittently operating jet pumps in conjunction with a water impounded hopper. Dry type bottom ash hoppers shall be used in case of the submerged scraper chain conveyor system. In case of continuous bottom ash extraction system involving submerged scrapper conveyors, the bottom ash will be led to a common Bottom ash slurry disposal pump house.

In case of the intermittently operating jet pump system, the jet pumps would convey the

bottom ash slurry from water impounded bottom ash hoppers to the slurry sump of the common Bottom ash slurry disposal pump house of the proposed plant.

Economiser and airpreheater ash shall be handled in wet form. Coarse ash slurry from economizer and air preheater hoppers shall also be led to the slurry sump of the common Bottom ash slurry disposal pump house.

The bottom ash of each unit collected in bottom ash hopper will be removed in 90 minutes once in a shift of 8 hours.

From the Bottom ash slurry disposal pump house, bottom ash and coarse ash slurry shall be pumped to the ash dyke by bottom ash slurry duty pumps. No pits will be permitted in the boiler area to accommodate the water impound hoppers.

Coarse Ash System

Coarse ash collected in Economiser & Air Pre-heater hoppers, will be extracted by the flushing apparatus located below each hopper. Coarse ash slurry will be routed to the surge tank. Ash slurry from the surge tank will be pumped to the slurry sump with 2 x 100 % capacity horizontal centrifugal slurry pumps through adequately sized carbon steel pipes. The contents of coarse ash from various hoppers will be evacuated out in the 45 minutes in a shift of 8 hours.

Water requirements for flushing will be tapped from LP ash water pumps discharge header.

Dry Fly Ash System

Fly ash collected in ESP hoppers will be extracted in dry form and conveyed to transfer tanks automatically by means of vacuum generated by mechanical exhauster and will be transported to fly ash silos by means of pressure conveying system. Adequately rated oil free rotary screen type conveying air compressors will be provided to supply compressed air required for conveying fly ash from transfer tanks to fly ash silos. One transfer tank will be provided for each vacuum stream. Bag filters of adequate size will be mounted on buffer hopper. Six streams will be provided for evacuating the fly ash from hoppers to fly ash silos. Three fly ash silos shall be provided for both the units, each having effective storage capacity of storing fly ash for 12 hours.

Ash collected in ESP hoppers in a shift of eight (8) hours will be evacuated within 270 minutes through six streams operating simultaneously. The capacity of the individual lines and grouping of various ash hoppers will be based on the standard compressor capacity.

Fly Ash Slurry Disposal (HCSD System)

The ash from fly ash silos will be fed by rotary feeders and ash conditioners into the slurry mixing tank. The conditioned dry fly ash will be made in the mixing tank wet by water and the entire ash will blended to a uniform consistency by mixer. One mixing tank and one ash slurry pump will be provided for each fly ash silo. Each slurry pump discharge piping will be provided up to the disposal area with all necessary isolation valves etc. Necessary booster pumps shall also be provided for flushing the chocked disposal line.

The density of the ash slurry will be continuously monitored and maintained (±) 1% CW of set point. Ash disposal pipelines will be installed above ground with flange joints wherever necessary and it will suit the maximum pressure encountered in the pipeline or otherwise pipelines will be welded.

Ash Disposal System

The dry fly ash collected in the storage silos will be unloaded into closed type trucks through motorized telescope chute for further transportation to the FA utilisation place. Adequate number of silos will be provided. There will be two outlets for dry disposal. The BA slurry will be pumped from the ash slurry sump to the ash pond in each shift. Horizontal centrifugal pumps will be provided for this purpose.

The major quantity of ash in the ash slurry discharged into the ash pond settles in the settling pond and relatively clear water flows to the stilling pond through the collecting well. The secondary settlement of the ash takes place in the stilling pond. The water from the stilling pond flows to the recovered ash water sump through the collecting well, from where it will be pumped through 2 nos. (1 W + 1 S) vertical turbine type pumps to the clarifier. This ash water is treated in the clarifier to reduce the suspended solids below 100-PPM level and clarified water is collected in the clarified water sump. The clarified water is pumped to the ash water tank in the plant area for further utilisation in the ash handling plant.

Compressed air required for conveying fly ash from intermediate hoppers to fly ash storage silos would be met by compressors of suitable capacity with adequately sized air receivers. For fly ash hopper fluidising air requirement two (2) nos. of blowers (1 working + 1standby) for each unit with Air heaters, piping, valves, etc. shall be provided. For fluidising of silos, 3 nos. (2 working + 1 standby) blower with air heaters, piping, valves, etc shall be provided.

The piping for conveying mixture of fly ash and air from fly ash hoppers to the intermediate hoppers, piping for conveying air from intermediate hoppers to vacuum pump, piping for conveying air ash mixture from intermediate hopper to silo, storage silos would be of ERW mild steel pipes. The ash hopper isolation valves would be of knife gate type.

Three (3) low pressure (LP) water pumps would be provided, out of which one (1) pump would operate to meet the water requirement of the refractory cooling, seal trough makeup, bottom ash hopper filling and makeup, fly ash slurry formation one pump will be common standby. The pumps would be of horizontal centrifugal type.

Three (3) high pressure (HP) water pumps would be provided to supply HP water to respective jet pumps, bottom ash hopper flushing, quick filling of bottom ash hopper, seal trough flushing, of require water for making slurry of ash from silo etc., with one pump as common standby. The pumps would be of horizontal centrifugal type.

To meet the high-pressure filtered water requirement, two (2) Seal water horizontal pumps would be provided. One (1) Pump would operate to meet the seal water requirement of slurry pumps, sump pumps, clinker grinders, vacuum pumps, etc., and one pump as standby. These seal water pumps would take suction from the service water system.

For automatic control of all the compressors, pumps, valves, etc., in the handling system, a centralised control panel with microprocessor based PLC would be provided in the ash handling system control room. The PLC system would provide for continuous cyclic operation of fly ash evacuation system. The opening and closing of the valves below fly ash hoppers would be controlled with the help of level switches provided on the fly ash hoppers. The hopper from which fly ash is being removed would be indicated on the monitor or mimic panel. The equipment and valves in the bottom ash handling system would be controlled automatically through a separate PLC system provided near each bottom ash hopper. The status of operation of bottom ash handling system will be available on the monitor or mimic panel in ash handling system control room.

Ash slurry sump would have an optimum capacity to hold the ash slurry prior to disposal. The sump would be provided with suitable alloy cast iron liners, agitating nozzles, overflow connections, etc. Ash slurry pump house would be located adjoining this sump. The pump house will be complete with EOT crane, drainage facilities, sump pumps, etc. Operation of ash slurry disposal pumps and pneumatic valves will be

controlled from main PLC in centralized Ash Handling control room.

Ash water tank would be located above ground. The HP & LP water pumps would take suction from this tank. Tank would have a capacity of about 20 minute's water requirement of the ash handling system.

Ash Water Re-Circulation System

Ash water system consisting of required water pumps, piping and valve etc., to cater to LP and HP water requirement shall be provided. It is also proposed to re-circulate the ash water from the ash dyke area to plant area for its re-use in ash handling system. The make to ash handling system during recirculation shall be provided from CT blowdown, plant make-up system & recovered water from WTP.

Ash Dyke Area

The ash dyke area shall be constructed in stages; each stage shall have an incremental height of 3 to 5 m. The entire ash dyke area shall be properly lined and roads of adequate size shall be provided all around the ash dyke area for monitoring of ash dyke.

The earthen dyke wall shall be constructed strong enough to withstand the loads from the future ultimate ash filling. Along the dyke wall RCC curb wall with drainage shall be provided for collection of rainwater.

To prevent erosion of dyke and finished ash filled area, proper arrangement of erosion protection shall be provided. Trees shall be planted all around the identified ash dump area initially to form green belt. The ash disposal area shall have a liner system to prevent any migration of ash and / or water out of the land fill to the adjacent surface soil or ground water or surface water at any time and shall be meet the guidelines of MoEF/ State Pollution Control Board.

3.5.28 Miscellaneous Systems

i). Fuel Oil System

a. System requirement

Light Diesel Oil (LDO) will be used for start-up and HFO for firing support during low

load operation and for stabilizing of flames. The HFO/LDO will be brought to the plant fuel oil handling area by railway wagons. The fuel oil handling system will include receipt, unloading, storing and subsequent pressurization and pumping to boiler burners at the desired flow rate, temperature and pressure.

a) LDO system shall be sized to meet 7.5% BMCR requirement.
b) HFO system shall be sized for 30% BMCR capacity.

b. LDO System

LDO will be brought to the plant by railway wagons. A suction header will be provided for unloading of LDO. Flexible hoses with quick disconnector couplers will be provided to connect LDO road tankers to the suction header. For unloading two numbers of LDO unloading pump shall be provided. One tank of capacity 1000 m^3 each will be provided to store LDO. The oil pressurization system will be provided to supply oil to burners. This pressuring system will contain suction header, pressurization pumps, filters, strainer piping with fittings and supports, valves etc.

c. HFO System

HFO will be brought to the plant by railway wagons and unloaded to the storage tanks by means of 3x50% unloading pumps. Necessary strainers and tanker heating arrangement will be provided. The storage tanks will be provided with floor coil heaters and outflow heaters. The pressurizing and heating (P&H) system 3x50% will feed the boiler burners at the required pressure and temperature. The fuel oil heaters will be of steam heating type and all HFO lines will be steam traced.

The fuel oil storage facility will consist of 2 nos. HFO tank of capacity 1500 m^3 each. The system will be designed in accordance with the existing rules of the inspectorate of Explosives, Government of India. All the fuel oil storage tanks will be steel fabricated vertical, cylinder outdoor type to conform to Indian Petroleum Code or API – 650. The HFO tanks will be equipped with fuel oil suction heater and floor coil heater and will be fully insulated.

The oil pressurization system will have oil suction header connected from the tanks, pressurizing, pump, heaters, filters, strainers, pressure accumulators and piping up to burners and the return / re-circulation arrangement. The re-circulation system to the tank will maintain oil pressure and temperature in the system and the return oil is connected back to the oil tank.

ii). Compressed Air System

Compressed air system would cater to the requirements of instrument and service air of the 2x660 MW unit. Instrument air is required for operating control valves, pneumatic tools, various control system bag filters purging. Service air is required for cleaning purposes during regular and shut down maintenance. Instrument air is also dehumidified and dried to requisite level before it is admitted to the instrument air system. Oil free air is required from the compressors especially for instrument air. Four (4) nos. (3 working + 1 standby) screw type air compressors along with driers, one for each compressor, would be provided for instrument air.

The instrument air distribution will be through main header and it will be ensured that sudden leakage in any part of the instrument air lines will not affect air to any of the supply points. The service air line is also connected to the main header of instrument air to meet the redundancy. The plant air system will be designed and provided suitable manifolds to allow adequate discharge points in all operation and maintenance areas. Three (3) nos. (2 working + 1 standby) screw type air compressors along with driers, one for each compressor, would be provided for plant service air. These compressors will be same as instrument air compressors.

Air Conditioning System

Various control rooms of the plant units having a group of sophisticated and precision control and protection devices as well as computer rooms will be air-conditioned to have controlled environment for proper functioning and operating personnel. Various types of air-conditioning systems as required will be provided (viz.) centralized chilled water, DX type AC system; package air-conditioning plants & split window AC. The following areas will be air-conditioned:

- Central Control Room consisting of Controls, Control Equipment rooms, Telecommunication Rooms, Microprocessor based DCS, Computer and Programmers Rooms, Data Storage Rooms, UPS Rooms, Instrumentation Laboratory and Steam & Water Analysis Rooms, Conference Room, Shift Charge Engineer's Room (If applicable), Relay Rooms.
- 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 Water Treatment Plant Control Rooms, Water and Fuel Analysis Room, Instruments Room.

- Any other area, which contains control and instrumentation equipment requiring air conditioning or otherwise requires being air-conditioned.

A central water cooled chilled water type air conditioning plant will be provided for air conditioning of central Control Room and its associated area as well as administration building and related facilities. Chilled water from the central plant will be pumped to various air-handling units catering each area or groups of areas.

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

iii). Ventilation System

Adequate ventilation system is considered as detailed below for the power plant machine room building, ESP control building; and other areas such as DG set room, air compressor room, A/C plant room, DM plant building, Battery rooms and various pump houses such as fuel oil pump house, DM water pump house etc. to achieve:

i) Dust free comfortable working environment.
ii) Scavenging out structural heat gain and heat load from various equipment, hot pipes, lighting etc.

a) Turbine and Generator building

Supply air system will be provided with evaporative cooling plant by a set of air washers with cooling water coils. The system will include supply air fans, inlet louvers, bird screens, viscous filters, cooling coils, re-circulating water system with circulating water pump sets, bank spray nozzles & flooding nozzles, eliminator plates and sump tank etc for supply and distribution of cooled air at various locations. The exhaust system will consist of roof extractors (for machine room). The system will be designed to maintain close to ambient dry bulb temperature inside the building.

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

b) ESP control building

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

c) Other building

Other areas such as DG set room, air compressor room A/C plant room etc will be ventilated by means of dry system comprising axial flow fan, dry filter wherever required, cowls, ducting etc. Fire dampers will be provided on ductwork routed through electrical installation areas. Ventilation system of respective areas will be suitably interlocked with fire detection system to minimize spreading of fire.

The normal design criteria for ventilation system shall consider:

- For number of Air changes in TG – 6 Air changes per hour.
- For various Auxiliary plant building – 20 Air changes per hour.
- For building like battery room, Chlorination plant – 30 Air changes per hour.

3.5.29 Chemical Dozing System

Boiler water chemical dozing system will be provided for chemical conditioning of the boiler water, condensate and feed water.

The boiler chemical dozing system will be designed to introduce chemicals into the steam, feed water and condensate cycles to control corrosion and deposition. The chemical dozing system is composed of the following major components.

- Phosphate dozing system
- Ammonia dozing system
- Hydrazine dozing system

The phosphate dozing systems will be designed to inject di-or trisodium phosphate solution directly into the boiler drum. The phosphate dozing system will consist of solution tank, agitator, chemical metering pumps, piping, valves, instrumentation and controls.

The ammonia dozing system will be designed to inject ammonia solution into the condensate. The ammonia dozing system will consists of solution tank, agitator, measuring tank, chemical metering pumps, piping, valves, instrumentation and controls. A tank and transfer pumps will be provided for bulk storage and transfer of ammonia to the dozing system.

The Hydrazine dozing system will be designed to inject a hydrazine solution into the boiler feed pump suction piping. The Hydrazine dozing system will consist of solution tank, agitator, measuring tank, chemical metering pumps, piping, valves, instrumentation and controls

Automatic dozing system shall also be considered.

Chlorination Plant

Chlorination plant shall be provided for chlorine dosing in the water pre-treatment plant and CW system to avoid the growth of algae and bacteria. Separate chlorination plant shall be provided for water PT plant and CW system. CW chlorination system would consist of Two (2) numbers of chlorinator-evaporator sets of adequate capacity and PT chlorination system shall consist of three (2) numbers of chlorinator sets of adequate capacity with associated pumps etc.

Each chlorination system shall be provided with required chlorine tonne containers, instrumentation, panels, chlorine leak detectors etc. Complete chlorination plant shall be located indoor. Chlorine leak absorption system as plant emergency measure shall be provided for each of the chlorination plants to neutralize chlorine leakage from the plant.

Along Chlorination plant, ozone plant shall also be considered.

Hydrogen Gas System

- Hydrogen gas with a purity of 99.9% is needed to cool the turbo-generators. A hydrogen generation plant has been envisaged in order to fill up high pressure hydrogen cylinders which are required for generator initial fill up and regular makeup required for generator rotor cooling.
- Hydrogen generation is accomplished by water electrolysis process. It is proposed to provide a hydrogen generation plant of 8 Nm^3/hr for the project with two streams of electrolysers each of capacity 4 Nm^3/hr with two hydrogen compressors each of capacity 6 Nm^3/hr along with auxiliaries.
- The plant shall be designed as per the regulations of the Explosives Authority with all the required safety aspects, instrumentation control, including On-line hydrogen purity analyzer system and control panel.

Cranes, Hoists and Elevators

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

One (1) electrically operated travelling type (EOT) crane of adequate capacity shall be provided for handling heavy equipment in the machine room/turbine building during erection & maintenance.

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

Conventional and special type of cranes for maintenance of a few important equipment in SG and TG packaged plants such as FD/PA/ID fans, pulverizes, air heaters, condenser water box, ESP transformer rectifier sets etc. will be provided. For various pump houses, clarification plant; Filtration plant; Demineralising plant; Fuel oil pump house; Intake pump house; Under slung cranes of adequate capacity, pendant operated, with electrical hoists will be provided. For circulating water pump house, a pendant operated 40/5 tonne capacity electric overhead travelling crane will be provided.

Maintenance cranes/handling devices of suitable capacities will be considered for all other areas such as compressor house; hydrogen generating plant; coal handling plant transfer points etc. Monorails for lifting heavy motors and other equipment within the power house not covered by EOT crane such as miscellaneous pumps, heat exchangers etc will also be provided. Suitable rails embedded on floor for dragging the horizontal feed water heaters to have the approach under EOT cranes will also be provided.

Elevators

One (1) 2000 kg capacity goods elevators will be provided for boiler area. One (1) 500 kg capacity elevator will be provided for stack. Further, one (1) passenger elevator of 1000 kg capacity will be installed in the service building annexed to power plant building. Two-passenger elevator of 544 kg for office & TG building will also be provided. Elevators envisaged for the power plant will conform to IS: 3534 and IS: 4666.

Workshop and General Stores Equipment

Workshop

Plant maintenance/ repair workshop equipped with all necessary equipment and facilities for the best up-keep of the entire plant will be provided. The equipment and facilities will include lathe machines, milling machines, boring machines, motor rewinding machines, wending equipment and flame cutting machine, etc. required for handling also will be installed in the workshop.

General Stores

General stores will be a combination of open storage areas and enclosed buildings required for the proper up-keep of spare parts. The stores will be equipped with suitable parts handling system. Air-conditioned rooms will be provided for storage of electronic equipment. Hazardous chemicals will be stored in a separate confined area. Computerized spares management system also will be adopted in the stores for spares accounting and control.

3.5.30 Chemical Laboratory Equipment

A fully equipped chemical laboratory capable of carrying out analysis of boiler water, flue gas, turbine oil, transformer oil, ash coal, ambient air quality, stack emission and other effluents, etc. will be available in the plant. The laboratory will be organized with all testing equipment, instruments, glass wares, laboratory supplies, chemicals etc.

3.5.31 Auxiliary Steam System and Auxiliary Boiler

Auxiliary Steam System

The auxiliary steam system would be designed to provide steam for turbine auxiliaries and the fuel oil heating system. For the auxiliary steam, steam would be tapped off the main stream-line and pressure reduced and de-superheated. The system would normally operate on the unit system basis.

Auxiliary steam header will be approximately sized for 60 Kg/cm^2 pressure and for a quantity of about 30 T / hr to take care of heating requirement of FO tanks and oil lines and other auxiliary steam service requirements of the running unit and to meet start up requirements. Both the Boilers will have identical facilities.

Auxiliary Boiler

A package type, oil fired auxiliary boiler of adequate capacity is proposed to be installed to meet the auxiliary steam requirement of one unit during start-up

3.5.32 Fire Protection System

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

(a) In view of vulnerability to fire and its importance in the running of the power station, effective measures will be taken to tackle fire in the susceptible areas such as cable galleries; fuel oil handling areas; coal handling plant areas including transfer points, crusher houses and tunnels, etc.

(b) For containment of fire and preventing it from spreading in cable galleries, unit wise fire barriers with self-closing fire doors will be provided. In addition, all cable entries / openings in the cable galleries, tunnels, and floors will be sealed with non-inflammable / fire resistant sealing materials to prevent fire propagation for at least three (3) hour. Fire protection cable coating compound over cables at switchgear entry points, power station building entry points and trays shall be provided to prevent damage from fire for at least thirty (30) minutes.

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

Fire water pumps are installed in the raw water pump house. Water will be stored as dedicated dead storage for meeting firewater requirement in exigencies. The details of system are as follows:

(a) Two (2) electric motor driven fire water pump sets of adequate capacity having adequate head along with two (2) identical capacity & head diesel engine driven backup fire water pumps of identical capacity will provided for hydrant and sprinkler system in addition to two (2) Jockey pump sets having adequate capacity which would be brought to operation automatically when hydrant pressure drops indications are received. In addition to these pump sets, other auxiliaries for the fire protection system such as hydro-pneumatic tanks, compressors, pipe work, valves etc will be provided as required.

The hydrant system will feed pressurized water to hydrant valves located throughout the plant and also at strategic locations within the powerhouse.
(b) Automatic high velocity sprinkler spray protection system will be provided for Generator transformers; Unit auxiliary transformers; Station service transformers; and Turbine oil storage tanks.

(c) Automatic medium velocity sprinkler protection system actuated by heat detectors strategically located will be provided for cable galleries and coal handling areas such as coal conveyors, transfer points, crusher houses etc.

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

- Automatic medium velocity sprinklers will be used for protection of burner zone of each of the boilers.

(d) Fuel oil tanks in the fuel oil farm area will be provided with spray water system as well as fixed foam mechanical system to extinguish accidental fires in tanks as well as outside in the dyke. Water for foam system will be drawn from the plant hydrant system. Adequate numbers of hydrant points will be distributed near the oil tank farm area. Fire hoses fitted with couplings and nozzles will be located suitably at the oil station and kept in hose boxes.

(e) Automatic inert gas based flooding type-extinguishing system will be provided for unit control room, areas independently apart from the provision of detection and fire alarm system in that area.

(f) Suitable fire detection system will also be provided at cable vault rooms, unit control rooms and other MCC rooms etc to detect outbreak of fire at an early stage.

(g) Adequate number of fire hydrant points will be distributed throughout the plant building, service building, coal handling plant ash handling plant and other areas along with fire hoses fitted with couplings and nozzles and kept in the hose boxes.

In addition to the above facilities, adequate number of manual call points; as well as portable and mobile (wheel mounted) fire extinguishers of soda acid type foam type; chemical type; and carbon-dioxide type will be provided at suitable locations throughout the plant area to meet NFPA code as well as Tariff Advisory Committee stipulations. These extinguishers may be used during the early stages of fire to prevent from spreading.

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

3.5.33 Electrical Systems

General Description

The system consists of two unit STG of 660 MW rating, the generation voltage being 27 kV (or any other voltage as per as Manufacturer's standard). The 2x660 MW generator output will be connected to the proposed 765 kV switchyard of Jawaharpur Thermal power plant, through step-up Generator Transformers. The 765 kV switchyard will be connected to the 400 kV switchyard through two nos. ICTs and 400 kV switchyard shall be connected to the 220 kV switchyard though one no. ICT. The power will be evacuated through three voltage levels. i.e. 765 kV, 400 kV and 220 kV. Start up power will be taken from station transformers at 400 kV from 400 kV switchyard.

Three voltage levels i.e. 11 kV, 3.3 kV and 415V are adopted for feeding the plant auxiliaries.

General Principles of Design Concept

The design concept of the electrical system as a whole is based on the requirements for the safe and reliable performance of steam turbine generator set and the interconnected electrical system with provision for easy maintenance and overhauling.

The design principles and standards delineated herein is generally in compliance with latest IEC/IS Standards and the Code of Practice already established in the country and also CEA notification dated 21/2/2007 (Technical standards for connectivity to the grid).

Indian Electricity Rules wherever applicable have also been complied with.

Electrical System Arrangement

Isolated Phase Bus Duct will be provided for connection of each Generator with its respective generator transformer set & neutral earthing equipment and tap off connections to respective Unit Auxiliary transformers, Voltage Transformers and Surge Protection Cubicles.

Two (2) nos. 40 MVA, 27 kV/11.5 kV, three-phase Unit Auxiliary Transformers (UAT) for each unit have been envisaged to cater total unit auxiliary loads of each 660 MW Unit. The transformers will be rated to meet the auxiliary loads required to run the Unit at MCR. Further, two nos. 80/40/40 MVA, three phase, three windings 420/11.5/11.5 kV Station Transformers (ST) have been envisaged for both the units. The Station

transformers will be rated to meet the total station auxiliary loads required to run the Plant at MCR. The Station Transformers will be supplied power from 400kV switchyard of the Jawaharpur Thermal power plant.

For supply of unit and station auxiliary loads of the proposed power plant, following voltage levels have been envisaged:

i) 11 kV level through 27 kV/ 11.5 kV Unit Auxiliary Transformers and 420/11.5/11.5 kV Station Transformers.
ii) 3.3 kV level through 11/3.45 kV Auxiliary/Service transformers

Following fault levels will be considered for design of all electrical equipment at various voltage levels. Fault levels shall be restricted to the same.

System	Fault Level	Duration
765 kV	40 kA	1 second
400 kV	40 kA	1 second
220 kV	40 kA	1 second
11 kV	40 kA	1 second
3.3 kV	40 kA	1 second
415 V	50 kA	1 second
220 V DC	10 kA	1 second
48 V DC	10 kA	1 second

The Creepage distance for exposed bushing/insulators will be minimum 25 mm/kV.

The 765 kV, 400kV and 220 kV system will be solidly earthed. The neutral point of each generator will be earthed through single-phase dry-type earthing transformer with a loading resistor, connected at its secondary side, to limit the earth fault current. 11 kV systems will be low resistance earthed to limit the earth fault current to about 300 Amps. 415 V systems will be solidly earthed. The DC systems will be unearthed.

Generator

The turbo-generators will be of 3 phase, 50 Hz, horizontal mounted, two poles, and cylindrical rotor type directly driven by the turbine and rated for 660 MW at 0.85 lagging to 0.95 leading power factors. It will generally comply with the requirements specified in IEC-34.

The generation voltage is envisaged as 27 kV (or any other voltage as per manufacturer's standard design).

The Generator will be designed with adequate margin for operation with 47.5Hz.

The Short Circuit Ratio (SCR) will be 0.49 (minimum). The class of insulation for stator and rotor will be class F. However as per normal practice the temperature rise of various parts during operation will be limited to class B limits as per IEC 34. The generator will be Wye connected and the star point will be connected to earth through neutral grounding transformer, the earth fault current to a safe value of less than 10 A.

Accuracy at which generator terminal better than voltage to be held	0.5%
Range of transformer drop compensation	0 to 15%
Maximum change in generator voltage when AVR is under all conditions of excitation	less than 0.5%
Manual control range	70% of no load to 110% full load excitation
The AVR will be provided with following built-in facilities.	

- Voltage transformer fuse failure circuit with changeover to manual.
- Volt/Frequency (V/F) limiter circuit.
- Rotor earth fault detector.
- Rotor angle limiter -Stator current limiter
- Rotor current limiter
- Power System Stabiliser (PSS) suitable for damping various modes of electromechanical oscillations.

The generator will have adequate number of temperature detectors provided for measurement of temperature of core, winding, bearings etc. It will also be equipped with following monitoring devices.

- Generator core monitor
- Generator winding temperature monitor

Online temperature monitoring for water in stator conductor

Transformers

a) Generator Transformer

The generated voltage of 27 kV will be stepped-up to 765 kV and fed to 765 kV switchyard by step-up transformers connected to generator through isolated phase bus duct. Connection between Generator Transformer high voltage terminal and 765 kV switchyard equipment will be made by overhead conductor.

Each 660 MW unit shall have a bank of three (3) single phase transformers each of rating 275 MVA, 27/800/√3 kV.

However, the final value of the Generator transformers impedance at the principal tap will be selected so as to compatible with the 765 kV and bus duct fault level and full load regulation.

To protect the Transformer against lightening, lightening arresters will be provided with the standard protection devices and accessories.

Transformer will be designed in conformance with the following requirements.

Temperature rise over 50℃ ambient temperature: Winding (by resistance): 55℃ Top Oil (by thermometer): 50℃

Parameter	Requirement
Degree of Protection for all Outdoor Kiosks like cooler control cabinet, marshalling box etc:	IPW 55

b) 11/3.45 kV Unit Auxiliary Transformers/ Service Transformers for CHP & AHP

For power supply to all 3.3 kV unit and station auxiliary motors and loads, 2x100 % 11/3.45 kV transformers have been envisaged for the following systems:

3.3 kV system for each unit
3.3 kV system for Coal Handling plant
3.3 kV system for Ash Handling Plant
3.3 kV system for raw water intake pump house

Each transformer will be rated for 11/3.45 kV, three phase, Dyn1, 50 Hz, ONAN cooled, outdoor type and provided with OFF circuit tap changer (OCTC) having range of ±5% of nominal voltage @ 2.5% tap. The rating for these transformers will be finalized during detail engineering stage.

c) Interconnecting transformers (ICTs)

Two (2) nos. 765 / 400 kV ICTs of suitable capacity shall be provided for enabling power evacuation at 400 kV voltage level. Further, 400 kV voltage shall be further stepped down to 220 kV voltage level by one (1) no. 400 / 220 kV ICT.

Bus Duct

a) Generator Bus duct

Each generator will be connected to its respective Generator Transformer Set & Neutral earthling equipment through main bus duct and respective unit Auxiliary transformers, Voltage Transformers and Surge Protection Cubicles through tap off-bus duct. The bus duct will be of isolated phase, continuous type with aluminium conductor in aluminium enclosure. Lightning arresters and surge capacitors of proper rating will be located within Surge Protection Cubicles. The current Transformers for measuring and protection purposes will be provided inside the enclosure of the bus duct both at line side, neutral side and Unit Auxiliary transformer side. The maximum temperature of the bus conductors & connections and enclosure will be limited to 105^0 C and 80^0 C respectively. A generator neutral earthling cubicle housing the dry type neutral earthling Transformer and secondary loading resistor will be located near the neutral star point of the generator.

The bus duct enclosure will be of welded construction. The bus ducts will be naturally cooled, dust tight and weather proof in construction. Bus duct pressurization arrangement using clean dry air will be provided.

b) 11 kV and 3.3 kV Bus Ducts (Phase-segregated)

11kV and 3.3 kV bus ducts will be metal enclosed, phase segregated type and natural air-cooled. Bus conductor shall be of aluminium alloy, adequately sized for continuous rated current and short circuit current for duration of minimum one (1) second.

Neutral Grounding Equipment

The function of neutral grounding equipment is to connect neutral of each system to ground while limiting the fault current to reasonable values and providing detection for ground faults.

Illumination System

Suitable illumination is necessary to facilitate normal operation and maintenance activities and to ensure safety of working personnel. This will be achieved by artificial lighting.

For outdoor yard illumination, floodlights will be installed at suitable locations to provide requisite level of illumination. Pole mounted high-pressure sodium vapour lamp fixtures will be used for approach and work roads.

The station emergency DC lighting will be fed from station 220 Volt DC distribution system during extreme emergencies. On failure of the AC supply, these lights will glow from DC system.

3.5.34 Power & Control Cables

Main factors which are considered for selection of sizes for power cables are as follows:

a) System short circuit current
b) Deaerating factors due to higher ambient temperature and grouping of cables.
c) Continuous current rating.
d) Voltage drop during starting and under continuous operation.
e) Standardisation of the cable sizes to avoid too many sizes of cables.

11 kV and 3.3 kV power cables will be 11 (UE) and 3.3 (UE) volt grade, single/ multi core, 90 Deg C rating under normal running condition and 250 Deg C under short circuit condition, heavy duty with stranded annealed copper/ aluminium conductor, extruded semi-conducting conductor screen, XLPE insulation, extruded semi conducting insulation screen, extruded PVC inner sheath, round wire armour and extruded FRLS PVC overall sheath. These cables shall have phase identification colour coding.

LT power cables will be 1,100 V grade with stranded aluminium conductor. XLPE insulated, extruded PVC inner sheathed, galvanized steel strip/ wire armoured (for multi-core cables only) and with FRLS PVC outer sheath. The cables would be suitable for effectively earthed system.

Control cables will be multi-core 650/1100 V grade PVC insulated, PVC sheathed, round steel wire armoured and with FRLS PVC outer sheath having 4 sq.mm stranded copper conductors for C.T. and control circuits and 2.5 sq.mm conductors for P.T. circuits.

Fire survival cables (FS) will be used for system, which are necessary for protection and safe shutdown of plant in case of fire.

3.5.34 Switchyard

A 400 kV switchyard has been envisaged for import of power for start up/shut down/ station service power through Station Transformers for the proposed power plant and evacuation of power available from the proposed power plant. 765/400/220 kV switchyard will be located in an area separate from the main powerhouse building and will be surrounded by a fence.

765/400kV switchyard for power evacuation with one and half breaker switching scheme which provide high degree of reliability will be provided. 220 kV switchyard will have 2 main bus and 1 transfer bus scheme. The switchyard will have suitable numbers of SF6 circuit breakers, air break isolators, current transformers, capacitive voltage transformers, lightning arrestors, earthing switches etc.

The switchyard will be designed for suitable lightning impulse, switching impulse and power frequency withstand voltage as per relevant Indian Standards. Following fault levels will be considered for design of all electrical equipment at various voltage levels. Fault levels shall be restricted to the same.

The continuous current rating of all switchyard equipment will be about 2000 A. Additional creepage distance will also be provided for the outdoor insulators / bushings as per IS/IEC. The minimum creepage distance envisaged is 25 mm / kV for switchyard and 20 mm / kV for indoor.

Design Parameters for 765 kV Switchyard

Highest System Voltage	800 kV.
Power Frequency Withstand Voltage for one (1) minute	880 kV rms.
Full wave Impulse Withstand Voltage	2100 kV peak
Switching Impulse Withstand Voltage	1550 kV peak
Creepage distance	24000 mm
Minimum Phase to Earth Clearance	4900 mm
Minimum Phase to Phase clearance	15000 mm
Minimum Ground Clearance	14000 mm

3.6 Raw Material / Inputs Required for Proposed Project

Besides the infrastructure logistics, the basic input requirements for the proposed project include:

i) Land
ii) Access
iii) Water
iv) Fuel
v) Construction power
vi) Power evacuation
vii) In plant facilities

A. Land

The table below gives the actual land requirement in acres for the proposed 2x660 MW power plant.

Table - 3.4: Land Requirement

System description	Land required (acres)
Switchyard	34
Ash Dyke Area	172
Coal Handlng Area	220
WTP & Cooling Tower	40
Reservoir	78
Msc (Road, Drain & Bldgs. etc).	64
Green Belt	221
Total	**865**

The above land requirement does not include the land required for colony, transmission tower corridor to connect to the grid and railway line from Etah to project siding. The above table gives the land requirement specific to this site considering domestic coal of GCV 4000 kCal/kg and 85% PLF. A station heat rate of 2247 kCal/kWh has been takenas per CERC regulations. Area of reservoir has been considered to store around 20 day's water with depth of 6m. Four (4) nos. coal stock piles of 600 m X 45 m X 10 m have been considered to cater coal requirements of around 30 days.

B. Water availability and conveyance

The water requirement for the project shall be met from the Lower Ganga canal. Estimated total consumptive water requirement for the project is about 4240 m^3/hr, considering recirculating closed cooling water system with cooling tower, using clarified water for turbine condenser cooling. The major quantity of this water will be essentially

makeup water for the cooling towers, lost on account of evaporation, drift and blowdown.

The blowdown water will be utilized as makeup water for ash handling system, in addition to ash-water re-circulation from ash pond.

The Lower Ganga Canal is around 22 kms from the proposed site. The pump house will be constructed at suitable location. In principle approval has been given by the Irrigation Department of U.P. for drawal of 53 cusecs of water for the project from Lower Ganga Canal.

C. Fuel availability and Transportation

The requirement of coal for the proposed project is estimated at 5.52 million tonnes per annum (MTA) @ 85% PLF considering domestic coal. The gross calorific value (GCV) of domestic coal has been considered 4000 kCal / kg for calculation purposes. Station heat rate has been assumed 2247 kCal / kWh as per latest CERC regulations. Domestic coal for the proposed plant will be sourced from the Rajmahal group of coalfields in Sahapur - Jamarpani Sector, Brahmani Basin, Dumka District of Jharkhand.

Transportation of Coal to Plant Site

Coal will be transported from coal fields to site by Indian Railways. The coal will be transported to site by BOXN wagons.

D. Construction Power

Construction power at 33 kV for the proposed plant can be drawn from either Malawan substation which is around 2.5 kms from the proposed site or from Etah substation which is around 20 kms from the site. The contactors will be required to arrange their own diesel generating sets also.

E. Power Evacuation

Evacuation of power from the proposed plant will be done at 765 kV, 400 kV and 220 kV level; the generation voltage is envisaged as 27 kV. For evacuation of power, three nos. single phase 275 MVA, 27/800/√3 kV generator transformers for each unit will be connected to the 765 kV switchyard of the proposed power plant. For power evacuation following outgoing bays shall be provided.

- 2 nos. 765 kV bays
- 2 nos. 400 kV bays
- 4 nos. 220 kV bays.

F. In-Plant Facilities

Apart from the main power house building housing the power generating equipment, buildings for the auxiliary plants / systems and other buildings required for running and maintaining the power plant, the following facilities shall be provided inside the power station premises for the operation, maintenance and administration personnel.

a) Administrative building
b) Technical office
c) Canteen
d) First-aid Centre
e) Car parks and cycle sheds

Toilets, wash-rooms, change-rooms and drinking water facilities etc, would be provided in main buildings and in auxiliary building to meet requirements of the Factories Act. Some of the above buildings / facilities shall be required during the construction stage.

A well thought-out investment plan for these facilities shall expedite construction and provide permanent facilities at a later date. Administrative building shall be constructed to meet the space requirement for the manpower needed in the construction and later into operation phase. This building would be located adjacent to the plant entry gate. The plant entry gate would be flanked with security office on one side and time office on the other. The time keeping would be done by means of punch clock operation. A service building located adjacent to the main power house building would serve as technical office and first-aid centre for the proposed station. The canteen would locate at a suitable space and food / snacks would normally be carried in trolleys to the work areas to minimize wastage of time. Car parks, cycle sheds shall be provided adjacent to the main plant. The toilets, wash rooms and change rooms, etc, would be provided as required.

Township

Separate land for constructing township near the project site to accommodate plant personnel.

Approx.100 acres of non-agricultural / unused land will be acquired or purchased directly from land owners for development of township

3.7 Environmental Management

3.7.1 Air Pollution Control System

High efficiency ESPs (99.9%) as provided will limit the outlet emission to 50 mg/Nm3. Besides, the CFBC boilers as used will be responsible for lower emission as per process requirement. The fugitive emissions from ash handling, coal stock yard, loading & unloading points and transfer points will be controlled by using RO reject water in a dust suppression system.

3.7.2 Water Pollution Control System

Effluent management scheme will be prepared for implementation with the objective of optimization of various water systems so as to reduce intake water requirement which will ultimately result in lesser waste water discharge. Adequate treatment facilities will be provided to all the waste streams emanating from the power plant to control water pollution. For this, adequately sized settling sump, oil-water separator, settling pond, waste treatment sumps will be provided. Besides, the effluents collected in guard pond will be treated in ETP using UF & RO modules. The RO reject waste will be utilized in dust suppression.

3.7.3 Solid Waste Management

The ash management scheme for the ash generated from power plant will involve dry collection of fly ash, supply of ash to entrepreneurs for utilization, promoting ash utilization and disposal of unused ash.

As per the MoEF notifications, a new coal based power station should make plans for 100% fly ash utilisation in a phased manner, within 4 years of commissioning. Hence, it is proposed to provide dry fly ash extraction and storage system to provide for fly ash utilisation and all possible measures will be undertaken to maximize utilization of ash produced. Supply of ash to cement plants in the region, for manufacture of cement shall be taken up on a priority basis. Use of fly ash in road construction will be explored.

3.7.4 Environment Clearance Requirements

According to the EIA Notification of September 14, 2006 the proposed coal-based thermal power project falls in category „A" and therefore the project proponent will

require prior environmental clearance from the MoEF&CC before commencement of any construction activity.

In order to obtain environmental clearance for the project, an Environmental Impact Assessment (EIA) study has to be carried out. The steps broadly involved are indicated below Figure – 3.2.

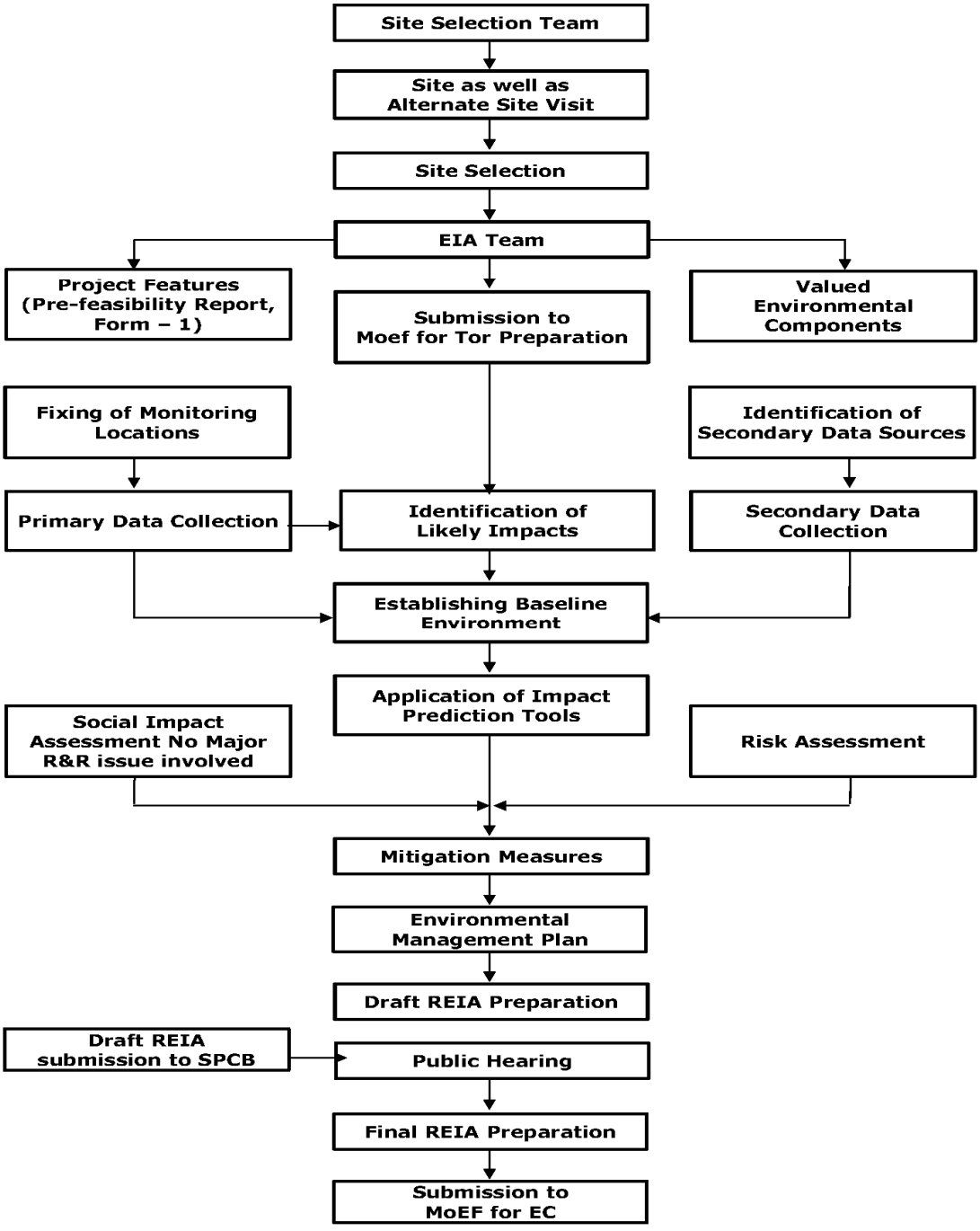


Figure - 3.2 : A schematic representation of the EIA process

An application seeking prior environmental clearance is made in the prescribed Form- I along with a copy of the pre-feasibility project report for initial clearance of the scope of work and terms of reference.

Based on the application submitted, the Expert Appraisal Committee (EAC) determines detailed and comprehensive Terms of Reference (ToR) addressing all relevant environmental concerns for preparation of EIA report.

The EIA report thus prepared will be appraised by the EAC before considering issue of Environmental Clearance.

Appraisal is made by Expert Appraisal Committee (EAC) in a transparent manner in a proceeding to which the promoter can furnish necessary clarifications in person or through an authorised representative. The committee makes categorical recommendations to the regulatory authority for grant of prior environmental clearance on stipulated terms and conditions or rejection of the application along with reasons for the same.

The regulatory authority considers the recommendations of the EAC and conveys its decision to the applicant within forty five days of the receipt of the recommendations. Normally, regulatory authority accept the recommendations of the Expert Appraisal Committee.

4.0 SITE ANALYSIS

4.1 Site Accessibility

The National Highway NH-91 passing through Etah town is close to project site. The broad gauge railway line of Northern Railway is only about 18 km away from the site.

Construction of Road

The site lies close to the Delhi – Kanpur National highway (NH-91) and therefore no separate road access outside the plot is required to be built except the approach road connecting site to NH-91. Around 5 km. approach road shall need to be widened and strengthened upto N.H-91 for movement of heavy equipment. Further internal roads with appropriate approach to different work centres would have to be constructed.

Construction of Railway Access

The nearest railway station from the site is Etah Station on broad gauge line of Northern Railway at a distance of 18 Km from the site. A separate rail line from Etah Station is proposed to be laid to the power plant site, which would enable easy access to the main rail network of the Northern Railway.

4.2 Land Ownership & Use

About 865 acres of land will be utilized for main plant construction. There are both private and government land, mostly uncultivated and barren. Only a part of the land is cultivated. The land for the project has already been acquired and mutated in the name of UPRVUL for nom-agricultural use. Approx.100 acres of non-agricultural / unused land will be acquired or purchased directly from land owners for development of township.

The following major villages falling within the project area:

i). Malawan ii). Nigoh Hassanpur,
iii). Babrauthi Nasirpur, iv). Ayyar v). Brisinghpur

4.3 Topography

The land proposed for the project is fairly level without much shrubs and bushes making it relatively easy and economical to level the land. The elevation of site varies from160 to163 M above mean sea level.

4.4 Existing Land Use Pattern

The proposed thermal power plant is to be established near Malawan village of Etah district. There will not be any adverse impact on land use. Land for the proposed activity is in green field area, thus, there will be no change in the present land use. Entire land of the proposed site is barren & only use for industrial purpose. Hence, there are no R & R issues involved in the proposed site. The site is plain levelled land.

4.5 Soil Classification

The soil at the project site predominantly consists of Clay in nature and area varies from gray to brown in colour. It can be concluded that the soil has moderate fertility and will not hinder the growth of certain crops in the area. No blasting is envisaged for their leveling or during the foundation work. The site is plain and needs very little grading, there is no requirement for any filling material from the outside. However, leveling activity will take place at the project site.

4.6 Climatic data from secondary sources

Meteorology determines the general weather patterns and thus identifies the probable pollution patterns. Meteorological aspects consist of the climatic factors, which are prevailing in the area. The secondary data (Annexure - 4.1) collected from nearest climatological observatory which is available at Aligarh at a distance of about 70 km.

5.0 PLANNING BRIEF

5.1 Planning Concept

Jawaharpur Vidyut Utpadan Nigam Limited (100% subsidiary of UPRVUNL) - (A U.P. Govt. undertaking) has planned to develop a coal based 2x660 MW Thermal Power Plant near village Malawan in District Etah in Uttar Pradesh.

Permission for selling surplus power to State Utility / PTC and other industries in line with open access policy of government through UPPCL or Power Grid Corporation Transmission Network will be obtained.

The major phases of the project planning are classified as under:-

- Design and Engineering Phase
- Tendering and Award Phase
- Manufacturing
- Inspection and Expediting
- Construction / Erection Phase

M/s JVUNL will mobilize to execute the project through a well-defined turnkey EPC contract. The EPC Contract will be finalized through competitive bidding. The contract will be a fixed price EPC contract with an entity with substantial financial backing and significant experience in the engineering, procurement and construction of similar plants.

The Engineering-Procurement-Construction (EPC) contract will include provisions necessary to attract project financing and ensure the prescribed cost and performance for the term of the contract. This contract will incorporate completion guarantees, performance guarantees and liquidated damage provisions sufficient to preserve the project's ability to service its debt and meet its obligations to its customers if the facility does not achieve commercial operation in time or does not meet expected performance levels.

The construction workforce and all sub-contractors will be hired by the EPC contractor. The construction workforce will be sourced from the nearby areas. M/s JVUNL will take all the necessary measures to meet the commissioning schedule for the boiler, steam turbine generator and the unit as a whole.

M/s JVUNL will engage an experienced engineering consultant for consultancy and for project management activities. In order to execute the project effectively, adequate staff of M/s JVUNL will be stationed at project site.

The project engineering activities will be planned within the time frame specified for the engineering milestones in the master network schedule. The EPC Contractor will obtain the approval of the Owner / Owner"s Engineer regarding compliance criteria for selection, sizing of all equipment, system, design margins, design calculations, control philosophy etc before proceeding with detailed engineering design and manufacture. This will ensure a good design and installation ensuring high efficiency, operability, availability, reliability, maintainability etc. Periodic reviews will be conducted to evaluate progress and take corrective actions to meet said targets and quality. For any delays, which may occur, corrective action will be identified and advance action taken to meet the project schedule.

5.2 Population Projection

Unskilled people and semi-skilled people (depending on availability) will be hired from the local population. Specially-skilled people who would work in the study area from outside, are expected to be educated. In addition, some secondary development like opening of new schools may take place in view of the increased family population due to proposed employment. These factors will be beneficial to locals residing in the study area.

5.3 Land Use Planning

The total land requirement is estimated as 865 acres which include area for main power plant & their facilities and green belt. Land use break-up is given in Table 5.1.

Table - 5.1 : Land Use Break-up Details

S. No.	Details	Area in acres
1	Main Plant	36
2	Switchyard	34
3	Ash Dyke Area	172
4	Coal Handling Area	220
5	WTP & Cooling Tower	40

S. No.	Details	Area in acres
6	Reservoir	78
7	Misc. (Road, Drain & Buildings etc.)	64
8	Green Belt	221
	Total	**865**

5.4 Assessment of Infrastructure Demand

Once the stage is set for implementation M/s JVUN will mobilize the team to set up offices and other facilities to start work at site. Power & water supply required for construction will be arranged including construction of temporary offices. In addition, JVUNL will develop necessary infrastructure like medical facility, sewerage etc., for catering to the needs of the project personnel and their families, which will also benefit the locals residing in the area.

5.5 Amenities / Facilities

JVVUNL will develop the project site with following facilities:-

a) Internal roads and drains.
b) Approach road to the plant (if required).
c) Landscaping and greenbelt.
d) Rain water harvesting.
e) Workshop and laboratories.
f) Canteens
g) Open and covered parking.
h) Medical help and first aid facilities.

6.0 PROPOSED INFRASTRUCTURE

6.1 Industrial Area (Processing Area)

The plant layout will be developed taking into account various aspects such as shape and size of the available land, ground features, and corridor for intake water line, outgoing power evacuation corridor, and railway line corridor for bringing coal as well as existing approach and planned roads.

Rural Welfare and Community Development activity of the proponent will include vocational guidance and supporting employment oriented and income generation projects like cottage industries by developing local skills, using local raw materials and help creating marketing outlets.

JVUNL will help to the eligible local people for attaining skills in construction field. JVUNL share the amenities and facilities with members of the local community. This includes sharing education and medical facilities, sports and recreation. Where ever possible, JVUNL shall provide infrastructure to help setup local schools, centres for primary learning and education, repair/construction of primary schools in neighbouring villages.

It is usually envisaged that setting up of a plant helps in developing the infrastructure of the locality.

6.2 Residential Area (Non Processing Area)

Landscaping will be done for the entire plant and township area. Residential area will be developed in the area adjoining to the project site to accommodate plant personnel.

Approx. 100 acres of non-agricultural/unused land will be acquired or purchased directly from land owners for development of township.

6.3 Green Belt

Green Belt will be developed as per MoEF norms i.e. 33% of main plant area. Green belt with minimum 10m buffer from the main plant will be provided with tall trees along the plant boundary.

The objective is to dissipate the impact of emissions, heat, noise etc. generated in the plant, improve the aesthetics in general and maintain a green environment. The green belt will form an effective barrier between the plant and surrounding settlements.

Open spaces, where tree plantation is not possible will be covered with shrubs and grass to prevent erosion of topsoil.

This will be done in a phased manner.

6.4 Social Infrastructure

The proposed project is expected to contribute towards improvement in quality of life of local people and it will generate inputs for industrial / economic development in the region:

- For social welfare activities to be undertaken by the project authorities, collaboration may be sought with local administration, Gram Panchayat, Block Development Office etc. for better co-ordination and effective results.
- Essential facilities like electricity, drinking water, toilets, and bathrooms, proper fencing, and leveled ground with proper drainage, sanitation arrangements, and adequate illumination arrangements will be provided. PCO, canteen and grocery shop are also envisaged near residential colony.
- Provision of ambulance with doctor and First Aid will be kept.
- Designated officials will ensure proper maintenance of infrastructure created for contract labours and to take immediate corrective actions whenever required after regular inspection.

6.5 Connectivity

The proposed site is located towards the north of village Malawan, on Delhi - Kanpur National Highway (NH - 91) and is about 18 kms. from Etah town, which is about 70 kms. from Aligarh on NH - 91. Etah railway station is on broad gauge railway line of Northern Railway.

Construction of Road

The site lies close to the Delhi - Kanpur National highway (NH - 91) and therefore no separate road access is required to be built except the approach road connecting site to NH - 91, About 5 km. approach road will need to be widened and strengthened up to NH - 91 for movement of heavy equipment. Further internal roads with appropriate approach to different work centres would have to be constructed.

Construction of Railway Access

Etah Railway Station on broad gauge line is at a distance of about 18 Km from the site. A separate rail line from Etah Station is proposed to be laid to the power plant site, for coal transportation.

6.6 Drinking Water

The proposed power plant will receive water supply from the Lower Ganga canal which be also used to fulfil the requirement of drinking water in the plant and the residential (township) area. Workers will not be allowed to wash their cloths or take bath adjacent to drinking water sources.

6.7 Sewerage System

The domestic effluent will be treated in Sewage Treatment Plant (STP) . The treated water will be used for green belt development and dust suppression system, while sludge will be used as manure.

6.8 Industrial Waste Management

The major effluent generated from the plant i.e. DM Plant discharge will be treated in an effluent treatment plant and recycled. No discharge of effluent outside the plant boundary is envisaged.

An effluent management, treatment and reuse scheme will be implemented with the objective of optimization of various water systems so as to reduce intake water requirement and achieve Zero Discharge Condition for the plant. The proposed plant will be provided with necessary equipment and systems to meet all applicable environmental regulations.

All the plant liquid effluents will be mixed in the central monitoring basin. However there may be some occasional variations in suspended solids and pH. A provision for chemical dosing is kept to adjust suspended solids and pH. If the treated water quality in central monitoring basin is unacceptable, the water shall be used either for plant green belt development or for miscellaneous plant uses. Excess water or unacceptable quality water in central monitoring basin shall be taken to ash slurry sump for final disposal to ash pond and finally utilized for ash water system and green belt development.

6.9 Solid Waste Management

The power plant, being Coal-fired power station, 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. An ash pond would anyhow be provided to cater to exigency conditions when for some reason ash cannot be disposed off.

6.10 Power Requirement & Supply/ source

The construction power at 33 kV for the proposed plant can be drawn from either Malawan substation which is around 2.5 km from the proposed site or Etah substation which is around 20 km from the site. Since this is a green-field site, a reliable source of construction power will need to be provided.

The power generated from the plant will be evacuated at 765 kV, 400 kV and 220 kV. However the scheme will be decided based on the Load flow study and other parameters. The permissible line loading limit depends on many factors such as voltage regulation, stability, thermal capacity of conductor etc. The surge impedance loading (SIL) capacity for a line gives a general idea of the load, which can be carried by a line. However, it is usual to load the short lines appreciably above SIL and longer lines below their SIL capacity to maintain the stability considerations of the grid.

The total power generated from the proposed power plant will be 1320 MW. After meeting the power requirement of the station auxiliaries, about 1250 MW will be available for evacuation.

The generation voltage is envisaged as 27 kV. For evacuation of power,three single phase 275 MVA, 27/800/√3 kV generator transformers will be connected to the 765 kV swithchyard of the proposed Jawaharpur thermal power plant.

7.0 REHABILITATION AND RESETTLEMENT (R&R) PLAN

The project site has been so chosen that no house or structure is affected. There are both private and government land, mostly uncultivated and barren. Only a part of the land is cultivated. The land for the project has already been acquired and mutated in the name of UPRVUL for nom-agricultural use.

Impact of Built-up Properties

As there are no homestead oustees due to the project, no built-up properties are getting affected by the project.

Impact on Community Structures

No community structures such as religious buildings or schools are getting affected by the project.

RESETTLEMENT

Resettlement and rehabilitation in this project consists of the following broad entitlements of the entitled person/family/group:

- Compensation for the loss of property (in case of titleholders and person occupying land for period more than 3 years);
- Additional relocation support for the displaced titleholder families; R&R assistance to the non-titleholder affected/displaced families;
- Livelihood and income restoration support and assistance to the project affected and displaced families/persons.

8.0 PROJECT SCHEDULE & COST ESTIMATE

8.1 Project Schedule

The project will be scheduled for the first unit to go into commercial operation in 50 months after the „zero date" & subsequent units at four (4) months interval thereafter.

Zero date is considered as the date on which the turnkey EPC contract is awarded.

8.2 Cost Estimate

The estimated Capital Cost, Capitalised Project Cost (including IDC) has been taken as Rs. 807856 lacs and Cost of Generation at 85% PLF for the saleable energy with various other considerations.

9.0 ANALYSIS OF PROPOSAL

The gap between demand and availability of power is not likely to be closed in the foreseeable future either in Northern India or in Uttar Pradesh and all out effort is called for to add capacity for power generation and evacuation system.

In this context, the proposal of Jawaharpur Vidyut Utpadan Nigam Limited (100% subsidiary of UPRVUNL – A U.P. Govt. undertaking), for setting up of the 2x660 MW Coal based Jawaharpur Thermal Power Station is timely. The generating capacity of the proposed power plant will be helpful in narrowing down the shortfall in generating capacity in the state.

On analysis of all aspects of the project, it is concluded that:

- It is technically feasible to establish 2x660 MW units based on CFBC Technology at the site identified for the project considering the availability of infrastructural facilities subject to obtaining the statutory & non statutory clearances.

- The project will not cause any population displacement, will generate local level employment and will improve power availability in the region.

- Economic activities will receive impacts and overall quality of life will improve with improved health and education facilities and expanding economic opportunities.

जलवायवी सारणी
CLIMATOLOGICAL TABLE

BACK

स्टेशन : **अलीगढ**
STATION : Aligarh

अक्षांश LAT. 27°53' देशांतर LONG. 78°04'

समुद्री तल माध्य से ऊंचाई *HEIGHT ABOVE M.S.L.* 187 मीटर *METRES*

प्रक्षणों पर आधारित **BASED ON OBSERVATIONS** **1971-2000**

माह / MONTH		स्टेशन का सतह दाब / STATION LEVEL PRESSURE	वायु तापमान / AIR TEMPERATURE — माध्य / MEAN — शुष्क बल्ब / DRY BULB	नम बल्ब / WET BULB	दैनिक अधिकतम / DAILY MAX	दैनिक न्यूनतम / DAILY MIN	माह में उच्चतम / HIGHEST IN THE MONTH	माह में निम्नतम / LOWEST IN THE MONTH	चरम / EXTREMES — उच्चतम / HIGHEST	दिनांक और वर्ष / DATE AND YEAR	निम्नतम / LOWEST	दिनांक और वर्ष / DATE AND YEAR	आर्द्रता / HUMIDITY — सापेक्ष आर्द्रता / RELATIVE HUMIDITY	वाष्प दाब / VAPOUR PRESSURE	मेघ की मात्रा / CLOUD AMOUNTS — समस्त मेघ / ALL CLOUDS	निम्न मेघ / LOW CLOUDS	मासिक योग / MONTHLY TOTAL	वर्षा के दिनोंकी संख्या / NO. OF RAINY DAYS	वर्षा / RAINFALL — वर्षसहित सबसे नम महीने का योग / TOTAL IN WETTEST MONTH WITH YEAR	वर्षसहित शुष्कतम महीने का योग / TOTAL IN DRIEST MONTH WITH YEAR	24 घंटोकी सबसे भारी वर्षा / HEAVIEST FALL IN 24 HOURS	दिनांक और वर्ष / DATE AND YEAR	माध्य पवन गति / MEAN WIND SPEED
		एच.पी.ए hPa	डि. सें °C	डि. सें °C	डि. सें °C	डि. सें °C	डि. सें °C	डि. सें °C	डि. सें °C		डि. सें °C		प्रतिशत %	एच.पी.ए hPa	आकाश के अष्ठमाश Oktas of sky		मि.मि. mm		मि.मि. mm	मि.मि. mm	मि.मि. mm		कि.मी. प्र. घं. Kmph
जनवरी / JAN	I	996.0	10.8	9.2	20.6	7.4	25.1	3.8	30.7	28	0.6	16	80	10.5	2.5	2.3	15.2	1.5	71.9	0.0	53.8	12	3.1
	II	993.3	18.2	13.8						1991		1935	60	12.4	2.3	2.0			1883			1994	
फरवरी / FEB	I	993.7	13.3	11.1	23.6	9.5	28.8	5.0	33.3	26	1.7	11	75	11.6	2.5	2.2	13.9	1.4	141.0	0.0	71.1	2	3.5
	II	991.0	21.2	15.4						1989		1950	52	13.0	2.3	2.1			1928			1928	
मार्च / MAR	I	990.9	19.3	15.2	30.0	14.1	35.5	8.9	41.7	31	3.9	6	63	14.1	2.3	1.9	8.5	1.0	106.7	0.0	63.5	18	4.2
	II	988.1	27.2	18.7						1945		1945	41	14.8	2.6	2.1			1870			1870	
अप्रैल / APR	I	986.6	26.8	18.9	36.8	20.1	41.5	14.3	44.5	29	10.9	9	45	15.5	1.5	1.2	8.8	0.9	68.1	0.0	30.6	29	4.8
	II	982.9	34.3	21.3						1999		1957	28	14.7	2.0	1.6			1909			1997	
मई / MAY	I	982.5	30.6	21.9	40.1	24.5	43.9	19.9	47.2	28	15.5	3	45	19.2	1.5	1.3	21.0	2.2	75.7	0.0	41.1	20	4.9
	II	979.1	37.6	24.0						1988		1987	30	18.8	1.6	1.4			1913			1913	
जून / JUN	I	978.7	31.2	24.8	39.3	26.6	44.4	22.3	46.7	7	18.6	2	59	26.1	2.8	2.6	68.5	4.1	544.8	0.0	327.2	30	5.6
	II	975.3	36.5	26.0						1995		1957	44	25.1	3.0	2.8			1933			1981	
जुलाई / JUL	I	978.4	29.2	26.3	34.6	26.0	39.4	23.0	44.5	2	19.9	12	79	31.9	6.1	5.9	217.7	10.2	576.1	1.5	164.6	3	4.7
	II	975.4	32.2	27.3						1987		1988	69	32.0	6.1	5.8			1958	1941		1942	
अगस्त / AUG	I	980.0	28.3	26.1	33.2	25.4	36.9	22.9	42.1	11	20.1	13	84	32.1	6.1	5.7	247.4	11.6	529.8	0.0	183.6	15	4.3
	II	977.3	30.7	27.0						1987		1957	75	32.7	6.1	5.9			1940			1964	
सितम्बर / SEP	I	984.6	27.4	24.5	33.8	23.8	36.9	20.7	40.2	1	14.8	16	78	28.6	3.2	2.9	104.1	5.2	590.5	0.0	220.6	26	3.7
	II	981.5	31.0	25.6						1979		1994	65	28.6	3.2	3.0			1884			1964	
अक्तूबर / OCT	I	990.4	23.5	19.8	33.0	18.8	36.2	14.4	41.7	4	11.0	9	69	20.2	1.0	0.9	31.4	1.4	231.1	0.0	138.7	13	2.2
	II	987.2	29.1	21.8						1952		1983	51	20.4	1.0	0.8			1955			1955	
नवम्बर / NOV	I	994.5	17.5	14.4	28.3	12.9	32.1	9.4	36.1	3	5.0	30	69	14.0	0.8	0.7	4.2	0.5	34.8	0.0	26.2	14	2.1
	II	991.5	24.0	18.2						1944		1937	55	16.4	0.9	0.8			1904			1966	
दिसम्बर / DEC	I	996.7	12.3	10.4	22.5	8.5	26.7	5.3	32.8	2	1.2	30	77	11.2	1.7	1.4	11.0	0.8	87.6	0.0	56.2	28	2.7
	II	993.6	19.5	15.0						1948		1973	59	13.5	1.8	1.5			1909			1977	
वार्षिक योग या माध्य ANNUAL	I	987.7	22.5	18.6	31.3	18.1	44.1	3.4	47.2	28	0.6	16	69	19.6	2.6	2.4	751.8	40.7	1342.9	204.5	327.2	30	3.8
TOTAL OR MEAN	II	984.7	28.5	21.2					5	1988	1	1935	52	20.2	2.7	2.4			1933	1918	6	1981	
वर्षोंकी सं NUMBER OF YEARS	I	29	29	29	29	29	29	29	68		68		29	29	29	29	28	28	64	64	66		15
	II																						

जलवायवी सारणी
CLIMATOLOGICAL TABLE

स्टेशन : अलीगढ

STAION : Aligarh

		मौसम परिघटना						पवन													मेघ										दृश्यता				
		के साथ दिनों की संख्या						पवन की गती के साथ दिनों की संख्या (कि. मी. प्र. घं.)				पवन की दिशा के दिनों की संख्या का प्रतिशत										मेघ मात्रा (सभी मेघ) सहित दिनों की संख्या - अष्ठमांश					निम्न स्तरी मेघ मात्रा सहित दिनों की संख्या - अष्ठमांश						दृश्यता सहित दिनों की संख्या				
माह		वर्षण 0.3 मि.मि.या अधिक	ओले	गर्जन	कुहरा	धूल भरी आंधी	चंड वात	62 या अधिक	20-61	1-19	0	उ	उपू	पू	दपू	द	दप	प	उप	शांत	0	ले-2	3-5	6-7	8	0	ले-2	3-5	6-7	8	कुहरा 8	1 कि.मी. तक	1-4 कि.मी.	4-10 कि.मी.	10-20 कि.मी.	20 कि.मी. से अधिक
		WEATHER PHENOMENA						WIND													CLOUD										VISIBILITY				
		No. OF DAYS WITH						No. OF DAYS WITH WIND SPEED (Km. p. h.)				PERCENTAGE No. OF DAYS WIND FROM									No. OF DAYS WITH CLOUD AMOUNT (ALL CLOUDS) O K T A S					No. OF DAYS WITH LOW CLOUD AMOUNT O K T A S						No. OF DAYS WITH VISIBILITY				
MONTH		PPT 0.3 mm Or more	HAIL	THUN DER	FOG	DUST STORM	SQU ALL	62 Or more	20-61	1-19	0	N	NE	E	SE	S	SW	W	NW	CALM	0	T-2	3-5	6-7	8	0	T-2	3-5	6-7	8	FOG 8	UP TO 1 Km.	1-4 Kms.	4-10 Kms.	10-20 Kms.	OVER 20 Kms.
जनवरी	I	2.1	0.1	0.2	3.0	0.0	0.0	0	0	25	6	2	14	10	16	2	11	15	9	21	20	1	2	3	5	20	1	2	3	5	0	3.3	6.2	16.9	4.6	0.0
JAN	II							0	0	23	8	4	9	6	13	4	5	19	13	27	19	2	2	4	4	20	2	2	3	4	0	1.1	11.5	6.3	12.1	0.0
फरवरी	I	2.4	0.1	0.5	1.2	0.0	0.0	0	0	23	5	3	14	8	14	2	12	15	14	18	16	2	3	3	4	18	1	2	3	4	0	1.9	4.8	14.5	6.8	0.0
FEB	II							0	0	23	5	5	8	5	13	1	9	24	15	20	17	2	3	3	3	18	2	2	3	3	0	0.0	8.4	4.8	14.8	0.0
मार्च	I	2.2	0.3	0.7	0.0	0.1	0.0	0	0	27	4	2	13	8	19	2	12	16	14	14	20	1	3	4	3	22	0	3	3	3	0	0.4	4.7	13.4	12.5	0.0
MAR	II							0	0	26	5	6	8	6	11	2	10	20	22	15	17	2	4	5	3	19	2	3	4	3	0	0.1	6.3	6.6	18.1	0.0
अप्रैल	I	1.9	0.1	0.9	0.0	0.8	0.0	0	0	26	4	3	15	9	18	2	12	13	15	13	21	1	3	3	2	24	0	2	2	2	0	0.0	3.6	14.0	12.4	0.0
APR	II							0	0	27	3	8	7	6	12	4	9	13	30	11	19	2	3	4	2	20	2	3	3	2	0	0.0	5.5	7.0	17.4	0.0
मई	I	3.2	0.1	0.9	0.0	2.3	0.0	0	0	27	4	3	12	11	13	3	12	15	16	15	23	1	2	2	3	25	0	2	1	3	0	0.0	5.6	15.4	9.9	0.0
MAY	II							0	0	27	4	7	9	8	12	3	9	16	25	11	22	3	2	2	2	23	2	2	2	2	0	0.0	5.9	9.2	15.9	0.0
जून	I	5.2	0.0	0.5	0.0	1.0	0.0	0	0	26	4	2	12	13	15	4	14	11	15	14	17	1	3	4	5	17	1	3	4	5	0	0.0	5.4	13.0	11.6	0.0
JUN	II							0	0	27	3	5	14	11	15	4	13	11	18	9	15	3	3	4	5	16	3	3	3	5	0	0.0	5.8	8.9	15.3	0.0
जुलाई	I	13.2	0.0	0.6	0.0	0.1	0.0	0	0	26	5	2	13	11	11	3	18	12	15	15	4	1	2	6	18	5	1	2	6	17	0	0.0	4.6	12.2	14.2	0.0
JUL	II							0	0	26	5	5	14	14	12	4	14	10	12	15	2	2	3	8	16	3	2	3	7	16	0	0.0	5.3	7.7	18.0	0.0
अगस्त	I	14.4	0.0	0.8	0.0	0.0	0.0	0	0	25	6	2	11	12	12	3	15	13	14	18	4	0	3	5	19	5	1	2	4	19	0	0.0	3.3	11.4	16.2	0.0
AUG	II							0	0	26	5	5	14	13	10	5	14	13	9	17	2	3	3	6	17	2	3	3	6	17	0	0.0	5.4	7.6	18.0	0.0
सितम्बर	I	7.4	0.0	0.4	0.0	0.0	0.0	0	0	24	6	2	11	13	15	3	14	13	11	18	16	1	4	3	6	17	1	3	3	6	0	0.0	1.4	10.2	18.4	0.0
SEP	II							0	0	23	7	7	12	10	11	2	11	13	12	22	13	5	3	4	5	15	4	3	3	5	0	0.0	4.6	6.7	18.7	0.0
अक्तूबर	I	1.9	0.0	0.5	0.1	0.1	0.0	0	0	20	11	4	8	10	11	3	5	11	10	38	26	1	1	1	2	27	0	1	1	2	0	0.1	1.6	11.7	17.7	0.0
OCT	II							0	0	17	14	8	6	8	9	2	5	8	10	44	25	2	1	1	2	26	1	1	1	2	0	0.0	7.5	6.1	17.4	0.0
नवम्बर	I	0.7	0.0	0.1	0.1	0.0	0.0	0	0	18	12	3	7	7	11	2	8	14	6	42	25	1	2	1	1	27	0	1	1	1	0	0.1	3.6	16.3	10.0	0.0
NOV	II							0	0	12	18	6	2	4	5	1	4	11	7	60	25	1	2	1	1	26	1	1	1	1	0	0.0	12.2	6.6	11.2	0.0
दिसम्बर	I	1.2	0.0	0.1	2.2	0.0	0.0	0	0	21	10	1	9	7	15	1	9	14	10	34	22	1	2	3	3	25	0	1	2	3	0	1.5	7.7	16.0	5.7	0.0
DEC	II							0	0	17	14	3	4	3	8	1	4	20	10	47	21	2	2	3	3	23	1	2	3	2	0	0.1	14.6	5.9	10.4	0.0
वार्षिक योग या माध्य	I	55.8	0.8	6.1	6.7	4.3	0.0	0	0	287	78	2	12	10	14	2	12	13	12	23	224	11	29	38	63	240	7	24	32	62	0	7.3	52.6	166.8	138.4	0.0
ANNUAL TOTAL OR MEAN	II							0	0	276	89	6	9	8	11	3	9	15	15	24	202	28	33	46	56	220	24	27	39	55	0	1.2	91.3	83.3	189.1	0.0
वर्षोंकी सं NUMBER OF YEARS	I II	29						30				30									30					30						30				