FITZROY
ENERGY & MINERALS

DETAILED PROJECT REPORT

TABLE OF CONTENTS

CHAPTER – 1

EXECUTIVE SUMARY

1.1 INTRODUCTION

Fitzroy Energy & Minerals("Project Developer"), a registered company to conduct power generation business, proposes to set up an independent thermal power plant of 2x30 MW capacity for power generation from coal procured from local mines in Tuli area, Nagaland.

NAGALAND ENERGY SUPPLY

Nagaland gets its share of power from the Central Sector Power plants located in the Eastern/North Eastern Region. The present requirement of the State is 140MW during peak hours; whereas the availability of power from Central Sector Power plants is 92MW. This is based on data of FY 2015-16. The state has peak demand shortage which has grown at present. Presently, the state is buying power and distributing to the consumer. In turn the state faces a huge loss every year. With the various developmental plans of the Govt, the power requirement is going to increase further.

The State Government has initiated an ambitious industrial policy for the industrial development of the state. It has identified tremendous growth potential in the power sector. A number of incentives like Exemption of Stamp Duty, Contribution to Feasibility are available from the state govt. 15% Capital Investment Subsidy on Plant & Machinery subject to a maximum of Rs. 30.00 lakh, 90% Transportation Subsidy, 3% Interest Subsidy on Working Capital Loan, 10 years Tax Holiday for GST & Income Tax are available. The state is following the guidelines and policy of Government of India for power generation programs to be implemented by the Private Sector Units. In addition to the Fiscal and Promotional incentives of the Govt. of India for participation by Private Sector Institutions/ Companies in generation, the State Government is making preparation to frame a policy of its own to further facilitate private participation and investment in the field of Generation, Transmission and Distribution. Govt. of India has evolved a strong Act East Policy giving priority of attention to develop North Eastern States of India into a commercial hub for international trade through Myanmar. Setting up of a thermal power plant at Nagaland with indigenous coal and/or bamboo as fuel is a feasible and commercially sound proposition.

With due support from the govt. arrangements can be made to obtain coal as well as bamboo locally. The power generated from this plant can be supplied to the state grid and also to the adjoining states & also use the NTPC provision for export of power to Bangladesh.

Coal required for the power plant is linked to the government supplied coal from the pit head thereby reducing the cost of transportation and making power generation viable. Bamboo, which is proposed to be fired from the second year of operation onwards, will be procured locally. Initially, in the second year of operation, 10% bamboo and 90% coal (percentages based on heat input) will be fired. The percentage of bamboo firing will be progressively increased each year and 100% bamboo firing will be adopted from the eleventh year of operation onwards. Owing to lack of adequate water supply, it is proposed to adopt an air-cooled condenser (ACC) system for the steam turbine exhaust steam.

1.2 LOCATION

The proposed project is being set up within the boundary limits of the Site location near Wamaken Village, Tuli, Nagaland. The site is located at a distance of approximately 3.2 km from highway NH61.

METEOROLOGICAL DATA

Meteorological data of the site has been considered for the design of the power station and this will be later fine-tuned during detailed engineering. With an average ambient temperature not exceeding 35 degree C, the site is suitable for adoption of the ACC option.

1.3 ACCESS TO SITE

The project site, is well connected by road to the National highway No.61 which is about 3.2km from the project site. Access road leading to the site is also available and will be strengthened where required during project implementation. The nearest railway station is at 2.8 kilometres from the site.

1. LAND CO-ORDINATES:

A. 26° 44.951'N : 94° 38.378'E
B. 26° 45.202'N : 94° 38.728'E
C. 26° 44.318'N : 94° 38.730'E
D. 26° 45.416'N : 94° 38.969'E
E. 26° 45.008'N : 94° 39.314'E

Land area: approx. 400 acres

2. DISTANCE FROM NEAREST SUBSTATION:

- Hindustan Paper mill substation:
  - **i.** Distance: 2.9 km
  - **ii.** Voltage: 35 kV
- Tuli town substation:
  - **i.** Distance: 6.5 km
  - **ii.** Voltage: 66 kV

1.4 TYPE OF PLANT, CAPACITY, PLF

The proposed power plant will consist of two (2) circulating fluidized bed boilers of 150 TPH capacity with outlet steam parameters of 110 ata, 5400C connected to two steam turbine generators, each of 30 MW (Net) capacity, with inlet steam parameters of 105 ata, 5350C along with all required auxiliary equipment.

In order to conserve water, an air-cooled condenser (ACC) system, designed for 350C ambient dry bulb temperature, will be provided for each 30MW (Net) turbine generator unit. Even though the site is blessed with a major river – Milak River at a distance of 2 kilometres - still an ACC option is selected to avoid local issues arising out of river water use.

The proposed power plant will fire Nagaland coal from the coal mine and the aspect of high sulphur in coal will be taken into account in the boiler design. The coal will be conveyed to the plant site through trucks, since the coal pit point is around 11kms from the site. In addition, the boiler will also be designed to accept other Indian coal with high ash content for a back up plan during any exigencies. When bamboo firing commences, the bamboo will also be conveyed to the plant site through trucks.

Description of the proposed power plant is given in Chapter-4 (Plant Technical Features) of this report.

The power plant project is proposed to be executed on EPC (Engineering, Procurement and Construction) basis through M/s Resurgent Power Projects Limited (RPPL)(formerly Enmas GB Power Systems Projects Limited) who are well-established EPC contractors for the type and capacity of power plant envisaged herein. RPPL would be responsible for detailed design, manufacture/supply, shop inspection & testing, installation, site testing and commissioning of all mechanical, electrical and control & instrumentation systems, detailed design and drawings, supply of materials and construction of all required civil works as well as demonstrating agreed plant performance parameters through a power plant performance guarantee test.

Based on annual plant availability of 95%, an annual Plant Load Factor of 93% has been considered for the purpose of the financial projections in this report.

1.5 POWER EVACUATION

Power from the generator terminals will be connected to a 132 kV switchyard in the plant premises through step-up transformers. The power available for export to the grid will be 60 MW after accounting for power consumption for the power plant auxiliaries as well as transmission losses.

Considering an annual Plant Load Factor of 93% and net available power of 60 MW, the energy available for export at the power plant switchyard will be about 479 million units (kWh) per annum.

1.6 PROJECT COST

The estimated Project Cost inclusive of interest during construction is estimated at Rs. 410 Crores as per details indicated in Chapter – 8.

1.7 PROJECT COMPLETION SCHEDULE

It is envisaged that the Power Plant would be commissioned and synchronized with the grid within a period of 24 months for Unit-1 and 27 months for Unit-2, both reckoned from the date of issue of Notice-to-Proceed (NTP) by Owner to the EPC Contractor. It is expected that issue of NTP to the EPC Contractor would be concurrent with achievement of Financial Closure of the project (i.e. availability of first installment of debt for drawdown).

1.8 CONCLUSION

As indicated by the Project Developer, adequate land to the tune of about 400 acres is available for the proposed power plant and this land is being made available by the State Government for the purpose of the project.

Coal required for the power plant will be brought from the pit head at a distance of 11 kilometres from the project site & moved by trucks to the power plant site. The annual coal consumption for the 60 MW (Net) power plant at 93% PLF during the first year of operation (100% coal firing) is estimated at 230,000 tonnes based on the use of Nagaland coal with average GCV of 6700 Kcal/Kg. In view of the relatively small quantity of coal required and the short distance from the coal supply point, it is proposed to transport the coal from the pit head to the site through trucks.

Bamboo required for the power plant will be brought to the site by trucks. The annual bamboo consumption for the 60 MW (Net) power plant at 93% PLF during the eleventh year of operation (100% bamboo firing) is estimated at 340,000 tonnes based on the use of bamboo with average GCV of 4500 Kcal/Kg.

Since the power plant is being provided with an air-cooled condenser system, the average consumptive water requirement of the power plant is estimated at only 40 m3/hr which can be met from the ground water allocation to be obtained for the power plant.

The total annual ash generation from the power plant is estimated at 13,500 tonnes based on the use of Nagaland coal. The fly ash will be sent to cement manufacturers for use in cement manufacture and the bed ash will be disposed off as land fill.

The power plant concept and technical features of the selected plant and equipment are well proven. The EPC Contractor selected for execution of the power plant project is well experienced in the field and has a proven track record of similar projects in successful commercial operation.

The power plant will be designed such that the gaseous emissions from the power plant will meet the prescribed environmental requirements. Further, the solid and liquid wastes from the captive power plant will be disposed off in an environmentally acceptable manner.

The financial viability of the power plant, based on the financial model for the project, is summarized in Chapter-8 of this report.

CHAPTER – 2

JUSTIFICATION FOR THE PROJECT

2.1 NEED FOR THE PROJECT

Nagaland gets its share of power from the Central Sector Power plants located in the Eastern/North Eastern Region. The present requirement of the State is 140MW during peak hours; whereas the availability of power from Central Sector Power plants is 92MW. This is based on data for FY 2015-16. The state has peak demand shortage which has grown at present. The state now is buying power and distributing to the consumer. In turn the state faces a huge loss every year. With the various developmental plans of the Govt, the power requirement is going to increase further. Hence to ensure proper supply and availability of quality power, it is necessary to have the power plant closest to the load points. Reasons are provided hereunder for setting up of the power plant:

- To ensure adequate power supply to the grid at all times without being subject to power cuts in the event of a supply-demand mismatch in the state;

- To insulate from increase in input cost of power in future on account of expected increase in the industrial tariff charged for energy drawn from the state grid since coal supply is within the state and closest to the power plant without being impacted on account of transportation costs.

2.2 SUITABILITY OF PROJECT SITE

As indicated by the Project Developer, adequate land to the tune of about 400 acres is available for the proposed power plant and this land is being made available by the State Government for the purpose of the project.

Coal required for the power plant will be brought from the pit head at a distance of 11 kilometres from the project site and moved by trucks to the power plant site. The annual coal consumption for the 60 MW (Net) power plant at 91.2% PLF is estimated at 231,000 tonnes based on the use of Nagaland coal. In view of the relatively small quantity of coal required and the short distance from the coal supply point, it is proposed to transport the coal from the pit head to the site through trucks.

Since the power plant is being provided with an air-cooled condenser system, the average consumptive water requirement of the power plant is estimated at only 40 m3/hr which can be met from the ground water allocation to be obtained for the power plant. Evacuation facilities are also available at a nearby distance. Hence the selection of the site for the 60MW (Net) power plant is adequately addressed since it qualifies as a pit head power plant.

2.3 JUSTIFICATION FOR THE PROJECT

Based on the above, installation of the 2x30 MW power plant is justified considering the following factors:

- Need to ensure adequate power supply to the grid at all times.
- Need to reduce the input cost of energy to the grid over time.
- Utilize the advantages of coal availability in Nagaland employ a technology to utilize high sulphur coal & existing infrastructure for setting up the greenfield power plant.
- As a result of utilizing local coal, revenue to the state also increases significantly and future expansion becomes feasible based on proven development of this power plant.

CHAPTER – 3
BASIC POWER PLANT REQUIREMENTS

3.1 POWER PLANT REQUIREMENT

The basic requirements for setting up and operating a power plant are availability of land, fuel, water, transmission system for power evacuation, other facilities like road, etc and suitability of the site for complying with environmental requirements.

The Project will be implemented within 24 months for Unit-1 and 27 months for Unit-2 from the date of financial closure (which will also be the NTP date for the EPC contract).

Total area required for the power plant including coal & bamboo storage area is estimated as 50 acres. In order to reduce the water requirement for the power plant, the plant is being designed with an Air Cooled condensing system. An auxiliary cooling tower will be provided for the power plant auxiliary coolers. Based on the above, the plant water requirement for make-up to the plant auxiliary cooling water system, for feed cycle make-up and other plant water requirements is estimated at 40 m3/hour. This water requirement is proposed to be obtained from the ground water allocation.

The proposed power plant will use Nagaland coal from the coal mine and the aspect of sulphur in coal will be taken into account in the boiler design. The coal will be conveyed to the plant site through trucks. In addition, the boiler will also be designed to accept other Indian coal with high ash content as a back-up plan during any exigencies. In addition, the proposed power plant will also be designed for 100% bamboo firing.

3.2 LAND

The project site, is well connected by road to the National highway No.61 which is 3.2km from the project site. Access road leading to the site is also available and will be strengthened where required during project implementation. The nearest railway station is at 2.8 kilometres from the site.

The site is ideal for the proposed 2x30 MW (Net) power project due to the following reasons:
The total land required for captive power plant is around 50 acres while the availability is 400 acres and the same is available at the project site. The required land details and its coordinates are available for the power plant.

LAND REQUIREMENT

Total land required for the proposed power plant project will be approximately 50 acres.

The following systems/areas have been taken into account while preparing the plant layout:

- Main Power Block & associated area
- Coal Handling system & storage area
- Water storage and treatment facility
- Switchyard for power evacuation
- Space for construction (to be converted to green belt later as required).
- Air cooled condensers
- Auxiliary cooling water system
- Ash Silos
- Roads and drains

It is envisaged that the infrastructural facilities such as Administrative Building, Stores, warehouses, open storage area, parking, canteen and first aid center will be made located within the available space.

3.3 WATER

3.3.1 WATER REQUIREMENT

In view of the limited availability of water, an air cooled condensing (ACC) system design has been adopted so that a major source of water consumption is avoided. Based on the water balance diagram for the project, the water requirement of the power plant is estimated to be 960 m^3/day which works out to 40 m^3/hour on the average.

The break-up of the total water requirement of 960 m^3/day is given below:

- Auxiliary Cooling tower make up water: 390m^3/day (degassed water quality)
- Boiler make-up water: 200 m^3/day (DM water quality)
- Service water: 20 m^3/day (clarified water quality)
- Waste water generated (reused): 350 m^3/day

Further, it is proposed to use the boiler blow down water as make-up to the auxiliary cooling water system. Depending on the quantum of boiler blow down, there will be a corresponding reduction in the make-up water requirement to the auxiliary cooling water system.

3.3.2 WATER SOURCE

The water requirement indicated above is proposed to be obtained from ground water sources for which the necessary water allocation shall be obtained.

3.4 FUEL & ASH

3.4.1 MAIN FUEL- COAL

Coal for the proposed power plant is proposed to be obtained from the captive mines for the project which is being set up as a pit head power plant using Nagaland coal with high calorific value. At the same time with higher sulphur, lime stone mixing into the firing of coal is envisaged to ensure SOx emissions are well within the environmental norms of the country. Coal will be transported by trucks since the captive mines are within a distance of 11 kilometres from the site.
Bamboo required for the project will be sourced locally and transported to the site by trucks.

3.4.2 COAL ANALYSIS:

The boiler will be designed for 100% Nagaland & 100% other Indian coal as per coal analysis provided below as well as for 100% Bamboo firing.

NAGALAND COAL

TM % - ARB - 6.24 to 11.57
Ash %- ADB - 4.98 to 5.72
FC % - ADB - 50.43 to 48.69
C % - 71.3 to 69.50
P % - 0.006 to 0.004

TM % - ADB - 5.93 to 6.78
VM % - ADB - 38.66 to 38.69
S % - ADB - 3.58 to 5.26
HYD % - 5.32 to 5.49
GCV - KCAL/KG 6896 to 6345 (avg 6700)

BAMBOO AVERAGE GCV – 4500 KCAL/KG

OTHER INDIAN COALS (BOILER DESIGN IS FEASIBLE)

COMPOSITION	%WT	INDIAN COAL 1
Proximate Analysis		
Fixed Carbon (By Difference)	%	21.0
Volatile Matter	%	26.0
Moisture	%	5.0
Ash	%	48.0
Moisture		
Carbon	%	36.43
Hydrogen	%	2.49
Nitrogen	%	0.74
Sulphur	%	0.78
Oxygen	%	6.56
Moisture	%	5.00
Ash	%	48.00
Total	%	100
GCV	kcal/kg	**3500**

3.4.3 FUEL REQUIREMENT:

Considering Nagaland coal with an average gross calorific value of 6700 kcal/kg, bamboo with an average gross calorific value of 4500 kcal/kg, plant gross heat rate of 2850 Kcal/kWh, auxiliary power consumption of 9% and transmission loss of 2%, the coal and bamboo requirement for the 2x30 MW (Net) power plant with air cooled condenser is as given below:

TOTAL COAL REQUIREMENT

Per day requirement 675 (Tonnes/day)
Per annum requirement 230,000 Tonnes/annum at 93% PLF

TOTAL BAMBOO REQUIREMENT

Per day requirement 1000 (Tonnes/day)
Per annum requirement 340,000 Tonnes/annum at 93% PLF

3.4.4 ASH GENERATION

Per day generation - 40 Tonnes/day (Tonnes /day)
Per annum requirement - 13,500 Tonnes/annum at 93% PLF (Tonnes /annum)

3.4.5 START-UP FUEL - LDO:

Light Diesel Oil (LDO) will be used only for start up. A storage facility of 25 KL is envisaged which is sufficient to cater to the start-up fuel requirement of the captive power plant.

3.5 POWER GENERATION AND EVACUATION

The power plant generation level will be at 11kV which, after catering to the in-house loads, will be stepped up to 132 kV for interconnection to the nearest substation. Interconnection of the power plant to the existing substation will facilitate (a) feeding power to the existing loads of the state, (b) drawl of power from the grid for power plant start-up and (c) export of surplus power, to the other consumers as envisaged elsewhere. The net energy available for export from this power plant is 479 million units (kWh) per annum.

3.6 INFRASTRUCTURAL FACILITIES

In addition to land, fuel, water, etc. listed above, availability of a few other infrastructural facilities is essential for successful implementation of the power plant project. The facilities which are considered essential during the early stage of construction of the project are: -

- Access road - & interfacing to the NH 61
- Construction power and water
- A housing facility (temporary) for the construction staff
- Skilled and unskilled manpower.

Since the site is located near NH 61, only a relatively small access road of 3.2km length is required for movement of trailers for haulage of heavy equipment to the plant site.

Construction power will be drawn from the electrical power distribution network. Alternatively, use of DG sets for construction purposes can be considered to provide flexibility for the project.

Construction water is proposed to be supplied from the ground water sources & bore wells will be dug as part of the preliminary site formation process.

During the period of operations, it is considered a better option to locate all operation & maintenance personnel at Tuli (nearest town) in view of better access to water, electricity, schools, community facilities etc at Tuli.

CHAPTER – 4

PLANT TECHNICAL FEATURES

4.1 THE POWER PLANT WILL BE DESIGNED FOR A CAPACITY OF 2 X30 MW UNITS.

LAYOUT OF FACILITIES

The power plant equipment viz., boiler unit, turbine generator, electrical equipment and all associated auxiliaries will be located optimally in the power plant layout. The main plant building will house the turbine generator(s) and auxiliaries as well as the electrical and control & instrumentation systems. The Air-cooled Condensers (ACC) shall be located adjacent to the main plant building. The 11 / 132 kV step up transformers as well as the 11 / 0.433kV transformers will also be located adjacent to the main plant building. One (1) EOT operated crane will be installed in the main plant building for maintenance purposes. The turbine building will be provided with a maintenance bay for the steam turbine generating unit. The Boiler units along with its auxiliaries like fuel feeding system, draft fans, electrostatic precipitator etc. will be located outdoor.

An open coal-cum-bamboo storage yard designed for 30 days coal storage will be located within the power plant boundary for receiving the coal and bamboo brought to the plant site by trucks. Coal, after crushing to the required size, and bamboo will be fed by means of conveyors to the boiler bunkers. The ash will be collected directly from the bottom of the furnace, economizer, air preheater and electrostatic precipitator hoppers and conveyed to the ash storage silos. Ash collected in dry form shall then be disposed off for commercial use.

The 132 kV switchyard will be located within the power plant complex with gantry for interfacing with the transmission line being provided as part of the switchyard design.

The auxiliary cooling tower and re-circulating water pumps will be located close to the steam turbine building in such a way to ensure free flow of air. The demineralized water tanks will be located adjacent to the water treatment plant.

Facilities such as security office, time office, administrative building, car park, canteen etc., will be built along with other civil works.

Adequate green belt will be developed inside the plant premises taking into consideration the guide-lines of environmental authorities.

PLANT FACILITIES

1. LAND CO-ORDINATES:

Nagaland & other Indian coal sources are the major fuels being considered as the fuel for the boiler which shall be of circulating fluidized bed combustion type. The important components of the boiler include superheater, economizer, drum, and air preheater. The steam generated from the boiler shall drive a steam turbine coupled to an electric generator. The power generated, after catering to the power plant in-house requirements, will be exported to the state grid.

Steam from the turbine will be condensed in an air-cooled condenser and the condensate will be supplied to the deaerator through a LP heater by means of 2x100% capacity condensate extraction pumps. The deaerator will remove oxygen and non-condensable(s) from the condensate. The condensate is heated by the steam supplied from turbine bleed. The preheated condensate will be stored in the feed water tank, which is an integral unit of the deaerator. The feed water will be pumped back to the boiler through a HP heater by means of 2x100% capacity boiler feed pumps. The deaerator will be supplied with Demineralised make-up water to make-up the feed water loss from the system due to boiler blow down and leakage. A suitable capacity Demineralised water plant will be provided for the supply of make-up water.

The turbine generator unit feed water cycle will be complete with condensate pump, ejectors, gland steam condenser, ejector condenser, HP & LP Heater, etc.

A pressure reducing and de-superheating station (PRDS) will be provided to supply steam to the de-aerator and to the turbine generator ejectors and gland sealing during start-up.

Salient features of the major equipment and systems of the proposed power plant are given below:

The major equipment in the power plant are:

- Circulating fluidized bed combustion boiler (CFBC).
- Steam turbine generator (STG)
- Air cooled condenser (ACC)

In addition to these main equipment, the plant will have all necessary auxiliary systems such as fuel storage and handling system, ash handling system, auxiliary cooling water system, water treatment plant, fire fighting system, compressed air system, electrical system including power distribution equipment, instrumentation and controls, ventilation, air conditioning system and all other utilities required for the power plant.

A brief description of each of the systems / equipment is given below.

4.2 STEAM GENERATOR & ITS AUXILARIES:

4.2.1 BASIC DESIGN PARAMETERS

The power plant shall be provided with two (2) coal-fired circulating fluidized bed combustion (CFBC) boilers rated at 135 TPH (Boiler Maximum Continuous Rating – BMCR) with steam parameters of 110 ata & 540 ± 5°C at superheater outlet based on feed water temperature of 2100C at economizer inlet (HP heater in service). Further, the boiler shall also be capable of meeting the steam flow requirement of the turbine generator unit at 100% MCR even with a lower feed water temperature at economizer inlet in case the HP heater is out-of-service.

The Boiler shall be of radiant two pass type, single drum, natural circulation, all welded type pressure part design, top supported, balanced draft, semi-outdoor type unit.

The Boiler shall be designed to fire the design fuels specified elsewhere; Nagaland coal is considered as the load carrying fuel. Light Diesel Oil (LDO) shall be used as start-up fuel. The coal analysis provided in Chapter – 3 above shall be considered for the design of the boiler and its auxiliaries.

Superheater steam temperature control range shall be between 60% BMCR - 100% BMCR.

4.2.2 BOILER FURNACE, FUEL FIRING, STEAM & WATER SYSTEMS

The Boiler shall be of circulating fluidized bed combustion (CFBC) type suitable for firing the design fuels indicated in Clause 3.4 of Chapter - 3.

The furnace shall be a gas tight enclosure of fully water-cooled membrane construction. The lower combustion chamber shall be a refractory-lined water-cooled enclosure. Stainless steel nozzles shall be provided between the water-cooled tubes. Primary air from the wind box shall flow through these nozzles to provide combustion air as well as fluidization of the bed. Air-cooled bed ash coolers shall be provided in order to cool the bed ash to 2500C before disposal through the pneumatic bed ash handling system.

Plate type hot cyclones shall be provided to separate the circulating bed material from the flue gas stream leaving the furnace. The solid particles separated from the flue gas shall be re-circulated back to the furnace through the loop seal. The loop seal shall provide a pressure seal between the cyclone and the furnace as well as a flow path for the solids from the cyclone to the furnace. Vortex finder shall be provided to enhance the separation efficiency of the hot cyclone.

A steam soot blowing system shall be provided to maintain clean surfaces throughout the convective pass of the boiler. Steam for soot blowing shall be tapped-off from a suitable intermediate stage of the superheated steam system.

The Boiler shall be provided with rectangular coal bunkers of mild steel construction with conical hoppers with sufficient number of openings for feeding coal to the coal feeders. The coal bunkers shall be designed for a capacity corresponding to 16 hours coal consumption at BMCR operation. In addition, the boiler shall also be provided with bamboo storage bunkers of 2 hours storage capacity.

The required number of volumetric drag chain type fuel feeders shall feed fuel from the bunker hoppers to the furnace. The drag chain feeders shall be of variable speed type (controlled through variable frequency drive) to enable regulation of fuel feed based on the fuel requirement indicated by the combustion control system.

The boiler shall also be equipped with a light diesel oil (LDO) system for start-up and low load operation. The system shall comprise 2x100% capacity unloading-cum-firing pumps, scanner, oil burner, etc. and shall be designed to cater to up to 30% BMCR load. A 25 KL LDO tank shall also be provided.

The feed control station shall comprise one 100% capacity pneumatic control valve, one 30% capacity pneumatic control valve for use during start-up and one 100% capacity motor-operated globe type inching bypass valve. Feed water shall be fed through the feed control station to the economizer where heat is recovered from the boiler exit flue gas. Feed water from the economizer shall be fed to the boiler drum through the furnace water walls for circulation through down comers. Saturated steam from the drum shall be sent through the various super-heater stages to achieve the required degree of super-heat at the boiler main steam stop valve. Steam temperature control shall be achieved through de-superheaters installed between the various super-heater stages. Spray water for de-superheating shall be drawn from the discharge of the boiler feed pumps.

4.2.3 BOILER AIR & FLUE GAS SYSTEMS

As the last stage of heat recovery, air heater system shall be provided in the boiler rear pass (after economizer). Corten steel tubes as required shall be provided in the air heater to avoid cold end corrosion. In the air heater, the flue gas shall heat both the primary air and secondary air on the air side.

The boiler shall be provided with 2x50% capacity primary air (PA) fans and 2x50% capacity secondary air (SA) fans for providing combustion air to the boiler. The PA fans shall also provide the air for fluidization of the bed.

The boiler shall also be provided with 2x50% capacity induced draft (ID) fans for evacuation of flue gas from the boiler to the stack.

One RCC stack of 105 meters height, common to both boilers, which is well above the stack height computed in accordance with the current environmental guidelines shall be provided for effective dispersal of pollutants in the exit flue gas.

4.2.4 POLLUTION CONTROL SYSTEMS

Flue gas from the outlet of the air heater shall be passed through a single pass electrostatic precipitator (ESP) so as to control the particulate matter emission to within permissible limits when firing 100% Nagaland or other Indian Coal or bamboo at BMCR. The ESP shall be fitted with fly ash hoppers of 8 hours storage capacity.

Space provision will be made to incorporate, in future, a suitable Selective Non-Catalytic Reduction (SNCR) system with ammonia/urea injection downstream of the economizer for reducing the NOx content in the exit flue gas to within permissible limits if required by the environmental clearance obtained for the project.

Limestone dosing system will be provided in the boiler to reduce the SO2 content in the exit flue gas. However, space provision will be made to incorporate, in future, a flue gas desulphurization (scrubber) system downstream of the air heater to reduce the SO2 content in the exit flue gas to within permissible limits if required by the environmental clearance obtained for the project.

4.3 STEAM TURBINE GENERATOR (STG) SYSTEM

4.3.1 STEAM TURBINE & AUXILARIES

Each steam turbine will be of 30MW capacity and would be a high speed, regenerative, condensing, horizontally split, single cylinder machine with three (3) uncontrolled extractions for regenerative feed heating.
The turbine would be fitted with a gear box to reduce the shaft speed to 3000 rpm for coupling with the generator unit. The turbine would be designed for main steam parameters of 105 ata at 535°C at inlet to the turbine. The turbine will exhaust against a condenser (air-cooled) pressure of 0.18 ata.

A fully automatic gland sealing system shall be provided for the turbine which will receive steam from the auxiliary steam header. The turbine-generator shall also be equipped with an electric motor driven turning gear. If required, jacking oil pump shall be provided to facilitate turning gear operation.

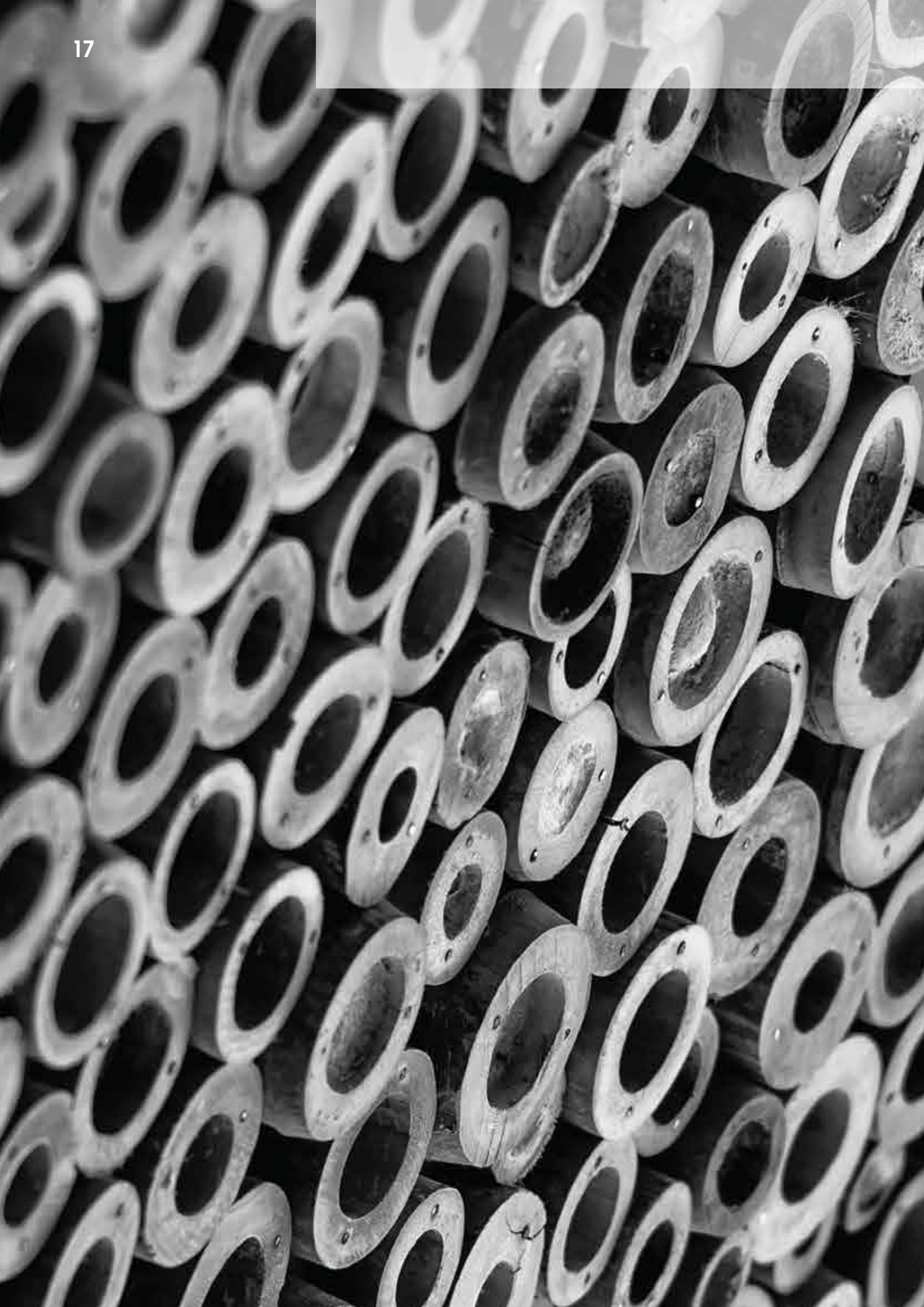
The turbine-generator shall be equipped with a hydraulically operated emergency stop valve and an electro -hydraulic governing system ensuring stable operation under any grid fluctuation and load throw off condition. Control oil for operation of the above shall be derived from the control oil system comprising control oil tank, high pressure pumps, oil accumulator and filters. The same oil specification shall apply for both lube oil and control oil.

The turbine-generator unit will also be provided with a self contained lubricating oil system for supplying oil to turbine, gear box and generator bearings. The lubricating oil system shall comprise lube oil tank (with 2x100% oil vapor fans), main oil pump (shaft or AC motor driven), AC motor driven auxiliary oil pump, DC motor driven emergency oil pump, 2x100% capacity oil coolers and filters. The oil coolers shall be cooled by the auxiliary cooling water system.

4.3.2 GENERATOR & ITS AUXILARIES

The generator(s) shall be a 2-pole, air-cooled 3000 rpm generator driven by the steam turbine through a gear box. 4x33% capacity generator air coolers shall be provided so that 100% output is available even with one cooler out-of-service for maintenance or repair. The generator air coolers shall be cooled by the auxiliary cooling water system.

The generator excitation system shall be of brushless or static excitation type and shall be capable of maintaining steady generator terminal voltage under varying load conditions. The excitation system shall be complete with automatic voltage regulator and all necessary metering and supervision equipment.



4.3.3 DEAERATOR (COMMON FOR BOTH BOILERS) AND CLOSED FEED WATER

This turbine feed cycle shall be provided with a variable pressure type deaerating heater with a feed water tank of 10 minutes storage capacity (normal level to trip level). Vent condenser shall be provided with the deaerator to minimise wastage of steam. The deaerator shall be of spray-cum-tray type and shall be designed to de-aerate all the incoming condensate and drain flow to keep the oxygen content of the condensate below the permissible limit.

The deaerator will normally operate by taking extraction steam from the turbine casing. However, during low load operation and start-up, the deaerator will be pegged with steam drawn from the auxiliary steam header. The deaerator will be placed at a suitable higher elevation (above the control room roof in the electrical bay of the Main Plant Building) so as to provide sufficient NPSH for the boiler feed pumps.

In addition to the deaerator, the feed cycle system for each turbine generator shall comprise one low pressure (LP) heater and one high pressure (HP) heater. Condensate will be heated in the LP heater by low pressure extraction steam from the turbine. The condensed steam (drain) from the LP heater will be led to the ACC condensate storage tank. Feed water will be heated in the HP heater by high pressure extraction steam from the turbine. The condensed steam (drain) from the HP heater will be led to the deaerator feed water tank at higher loads and to the ACC condensate storage tank at lower loads.

4.3.4 BOILER FEED PUMPS

A common system of 3x100% capacity (2 W + 1 S) boiler feed pumps shall be provided for the two boilers. The boiler feed pumps shall be of horizontal, single suction, multistage, ring section casing, centrifugal type motor driven type and shall supply feed water to the boilers. The boiler feed pumps shall take suction from the common deaerator feed water storage tank and supply feed water to the boiler through the high pressure heaters and feed control station. The boiler feed pumps shall be located in the turbine hall portion of the Main Plant Building. A variable speed hydraulic coupling drive with scoop tube control shall be provided between the drive motor and the boiler feed pump to regulate feed water flow to the boiler. Each boiler feed pump shall be provided with minimum flow recirculation control arrangement to protect the pump under low load operation.

Each pump will be provided with auto recirculation valve (to ensure minimum recirculation flow for pump protection under low load operation), balance leak-off, mechanical seals, suction strainer, self-contained forced lubricating oil system for supplying oil to the bearings, couplings etc., cooling water piping and valves, and all required pressure and temperature gauges.

4.4 AIR COOLED CONDENSER

Each steam turbine unit (STG) shall have one set of Air Cooled Condensing Plant (ACC), which condenses the exhaust steam from turbine exhaust to water and then delivers the water back to the heat cycle. The ACC shall be designed for turbine exhaust pressure of 0.18 ata at 110 TPH flow with ambient temperature of 350C. The ACC shall be of finned type design capable of condensing all the steam exhausting from the STG at full load operation of the STG with HP heater out-of-service.

Air cooled condenser with eight modules (two rows of four modules each, with one forced draft fan for each module), 2 x 100% condensate extraction pump sets, finned tube ACC heat exchanger bundles, headers, frames and nozzles, condensate storage tank of 10 minutes storage capacity, exhaust duct from STG exhaust flange to ACC inlet, semi-automatic fin cleaning system, structures & associated equipment shall be provided.

For removal of non-condensable gases, steam jet air ejector system comprising one starting ejector and 2x100% capacity holding ejectors with inter and after condensers shall be provided.

The condensate extraction pumps shall be of horizontal centrifugal motor-driven type taking suction from the ACC condensate storage tank and pumping the condensate to the deaerator through ejector condensers, gland steam condenser and LP heater.

4.5 PLANT WATER SYSTEM

4.5.1 RAW WATER SYSTEM

Raw water for the power plant will be sourced from the ground water and led to the power plant raw water tank which would have a useful capacity of 4000 m3 which would cater to about four days consumptive water requirement of the power plant.

Water required for the water treatment system would be drawn from the raw water tank through appropriate pumping systems.

The raw water analysis will be tested during the site investigation period and the water treatment plant will be designed accordingly.

4.5.2 AUXILIARY COOLING WATER SYSTEM

Auxiliary cooling water for the power plant auxiliaries (turbine oil coolers, generator air coolers, boiler feed pumps, ash handling system and steam & water analysis system) shall be cooled in an Auxiliary cooling tower. The inlet water temperature to the Auxiliary cooling tower shall be 42°C and the outlet water temperature from the Auxiliary cooling tower shall be 34°C. The Auxiliary cooling tower shall be designed based on an ambient wet bulb temperature of 28.5°C. An operating capacity of 800 m3/hr (2 working + 1 standby) is envisaged for the Auxiliary cooling tower.

Make-up water to the auxiliary cooling water system to compensate for losses on account of evaporation and blow down would be degassed water. However, the boiler blow down water would also be led to the auxiliary cooling tower basin as make-up water and hence, depending on the quantum of boiler blow down water, the degassed water make-up quantity would be reduced accordingly.

4.6 WATER TREATMENT SYSTEM

The water treatment system for the power plant shall comprise (a) Pre-treatment System, (b) Reverse Osmosis (RO) and Degasser System for meeting the requirement of the Demineralization (DM) plant and the Auxiliary Cooling Water System, and (c) DM Plant for catering to the make-up water requirements of the thermal cycle (boiler blow down and steam cycle condensate loss make-up. The water treatment plant scheme indicated herein is based on typical ground water quality data. The scheme may require modifications once actual ground water analysis data becomes available.

4.6.1 PRE-TREATMENT SYSTEM

Raw Water (bore well water) will be received at the raw water storage tank of the power plant. 2x100% capacity Raw water pumps shall pump raw water from the raw water storage tank to a common High Rate Solids Contact Clarifier (HRSCC). The HRSCC system consisting of flash mixer, solids contact clarifier, coagulant and flocculent dosing system will reduce the suspended solids, silica & colloids in the raw water.

Clarified water from the HRSCC will flow by gravity to the fire water storage tank (550 m3 capacity) and the clarified water storage tank (300 m3 capacity). Clarified water from the clarified water storage tank will be pumped by Multi Grade Filter (MGF) feed pumps (2W + 1S) through two streams of MGF units followed by two streams of Ultra Filtration (UF) units to the UF product water storage tank.

4.6.2 RO AND DEGASSER SYSTEM

The treated water collected in the UF product water storage tank will be pumped by means of Reverse Osmosis (RO) feed pumps (2W + 1S) to the Cartridge Micron Filters. High pressure pumps (2W + 1S) will be provided downstream of the Cartridge Micron Filters for feeding high pressure water to the RO permeators.

The RO product water will be further passed through a degasser tower where the weak acids and other corrosive gases will be released. Degassed water from the degasser tower will flow down into a degassed water storage tank of one hour holding capacity. Degassed water for make-up to the Auxiliary Cooling Water system and as feed to the Demineralization (DM) plant will be drawn from the degassed water storage tank through suitable pumps.

4.6.3 DM PLANT SYSTEM

The treated water collected in the degassed water storage tank will be pumped to two DM plant streams, each stream with a final product water capacity of 100 m3/day. Each stream shall comprise Strong Acid Cation (SAC) unit, Strong Base Anion (SBA) unit and Mixed Bed (MB) unit.

The final product water from the MB units will be stored in two DM water tanks, each of 150 m3 capacity.

4.7 FUEL HANDLING SYSTEM (COAL)

The Coal Handling Plant shall be designed for 40 TPH capacity which is adequate to fulfill the fuel demand of 24 hrs in about 15 hrs of operation based on the performance coal analysis for Nagaland Coal presented in Clause 3.4.2 of Chapter - 3. The Bamboo Handling Plant shall be designed for 40 TPH capacity which is adequate to fulfill the fuel demand of 24 hrs in about 23 hrs of operation.

Nagaland coal of maximum 150mm size received at the ground hopper shall be fed to a belt conveyor through vibrating feeders. The belt conveyor shall carry the fuel to the crusher house where it will drop the material on to a vibrating screen. The vibrating screen will screen the fuel, drop the filtered material on to a belt conveyor and drop the rejects in the Crusher. The material crushed in the Crusher will be conveyed back to the belt conveyor feeding the crusher house. The belt conveyor receiving the filtered material from the screen will convey the coal to the boiler bunkers. The belt conveyors will have a belt width of 800 mm and will be covered with removable hoods. Walkway will be provided on one side of the conveyor. Belt conveyor inclination will be limited to 160.

In view of the coal size of (-) 150 mm, high speed impactor type is considered for reducing the size from 150mm to 6mm. Magnetic separators shall be provided before the crusher to ensure maximum removal of iron tramps.

A traveling tripper shall be provided above the boiler bunkers to ensure the uniform distribution of coal inside the bunkers.

4.8 ASH HANDLING SYSTEM

Ash generated in the boiler shall be evacuated through the ash handling system. The ash handling system shall comprise the following:

a. Bed ash handling system - To evacuate the ash generated in the boiler furnace.
b. Fly ash handling system - To evacuate the ash generated in the other zones of the boiler (economizer, air pre-heater & ESP).

BED ASH HANDLING SYSTEM

The bed ash handling system will evacuate the ash generated in the furnace through a pneumatic dense phase dry ash conveying system after cooling the ash to less than 250°C by means of air-cooled bed ash coolers. The ash from the furnace will be conveyed to a bed ash silo through the pneumatic dense phase conveying pipes.

FLY ASH HANDLING SYSTEM

The fly ash handling system will evacuate the ash collected in the economizer, air pre-heater and electro-static precipitator (ESP) through a pneumatic dense phase dry ash conveying system. The ash from the above locations will be conveyed to a fly ash silo through the pneumatic dense phase conveying pipes.

PNEUMATIC DENSE PHASE ASH HANDLING SYSTEM

Surge hoppers will be installed below each opening of the ash hoppers of the boiler. An ash vessel will be provided below each surge hopper. The surge hopper and ash vessel shall be connected via an expansion joint. Cooling water supply shall be provided for the ash vessels of the bed ash handling system and the ash vessel below the economizer in view of the relatively higher ash temperature in these areas. The pneumatic transporter shall convey the bed ash and fly ash at specified rate through MS conveying pipeline to the bed ash and fly ash silos respectively. The conveyed ash shall be discharged into the silo through a terminal box with vent filter, provided at silo top.

2 x 100% (1W+1S) oil injected screw compressors, common for both the bed ash and fly ash handling systems, will be installed for providing the air required for conveying the ash from the vessels to the silos. The compressed air system will also be provided with suitable capacity air receivers along with conveying air pipelines, valves, instruments etc.

One (1) number MS bed ash silo of 40m3 capacity and one (1) number MS fly ash silo of 150m3 capacity along with its supports of RCC construction shall be provided. This will provide over three days storage when using 100% Nagaland Coal.

4.9 COMPRESSED AIR SYSTEM

The power plant will be provided with an instrument air system as well as a service air system. Instrument air is required for operation of various pneumatically operated valves as well as other services requiring dried air while service air is required for the boiler (atomizing air for LDO firing during start-up, flame scanner cooling, etc) as well as for general use for cleaning purposes.

The compressed air system shall comprise three (3) nos. of oil flooded, twin rotary, positive displacement, energy efficient, screw type air compressors each of capacity 500 Nm3/hr (2W+ 1S) with delivery pressure of 7.5 Kg/ cm2g.

2x100% capacity air-drying units of heatless dessicant type, each of capacity 500 Nm3/hr (inlet air flow) will be provided.

One(1) no. service air receiver of 5 m3 capacity & One(1) no. instrument air receiver of 2 m3 capacity shall be provided for each 30 MW unit for plant service & instrument air requirement. A separate instrument air receiver of 1 m3 capacity shall be provided at a suitable location in the coal handling area (for dust extraction system). The service air will be tapped off prior to the air-drying unit. A pneumatically operated block valve will be provided at the inlet of the service air receiver to maintain the instrument air pressure.

4.10 AIR CONDITIONING & VENTILATION SYSTEM

4.10.1 GENERAL

Packaged type air conditioning units are proposed to be provided for the air conditioning of the control room. For the TG Hall, Cable Gallery and Battery Room, wall mounted exhaust fans are proposed. The Switchgear/MCC, VFD, UPS, battery charger rooms will have fresh air supply with 2 x 50% supply air fans and exhaust fans.

4.10.2 BASIS OF DESIGN FOR AIR CONDITIONING:

COMPOSITION	DESIGN DATA
Outside design conditions (0 C)	40 DB/ 28.5 WB.
Inside conditions to be maintained	22 +/- 1 0 C DB RH not exceeding 60%.
Area to be air conditioned	300 m2.
Occupancy rate for design	10.
Lighting load	10 watts per m2.

Based on the above design basis, it is proposed to provide an air conditioning system with packaged air conditioning units. The units will be of air-cooled type, and the air cooled condenser will be located outdoor. The cooled air from the AC units will be distributed into the control room by means of galvanized sheet steel ducting, located over the false ceiling. The air will be distributed through Aluminum air diffusers. The return air will be collected over the false ceiling and led back to the AC plant room.

The other smaller control rooms will be provided with required numbers of Hi Wall split units of 2 TR capacity.

4.10.3 BASIS OF DESIGN FOR VENTILATION:

SL. NO	AREA	NO OF AIR CHANGES PER HOUR	SUPPLY AIR FANS	EXHAUST FANS
1.	T G Hall	6	Nil	To be provided
2.	Switchgear/ MCC/VFD/ UPS rooms etc	10	To be provided	To be provided
3.	Cable Gallery	10	Nil	To be provided
4.	Battery Room	6	Nil	To be provided

4.11 FIRE PROTECTION SYSTEM

4.11.1 GENERAL

- The Fire protection system generally shall be designed based on erstwhile Tariff Advisory Committee (TAC) guidelines and NFPA standards.
- For the purpose of system design, the power plant is considered as ORDINARY HAZARD risk as per the classification of the erstwhile TAC.
- All required areas / buildings shall be covered under the fire protection system.

4.11.2 FIRE HYDRANT SYSTEM:

- The hydrant system shall cover both outdoor areas and plant buildings.
- The hydrant system shall comprise of network with under ground and above ground piping provided throughout the power plant with hydrants/water monitors. The hydrant piping shall be laid out in rings so that leakage/breakage at one location would not render the system non-operational in other parts. Suitable isolation valves shall be provided at appropriate points for proper isolation of any portion of the piping for maintenance. The valves shall be properly enclosed in under ground RCC valve chambers.

- Fire hose, branch pipe and nozzle shall be provided for individual hydrant points. These shall be housed in hose boxes.

- The water storage required for the exclusive purpose of fire protection system shall be provided in the raw water tank (refer Clause 4.5.1 above).

- One electric motor driven fire pump of 273 m3/hr capacity, one diesel engine driven fire pump of identical capacity and one jockey pump of 10.8 m3/hr capacity will be provided. This fire water system shall cater to both the hydrant and high velocity water spray systems.

4.11.3 HIGH VELOCITY WATER SPRAY (HVWS) SYSTEM:

- HVWS system shall be provided for all transformers above 10MVA rating and for the STG lube oil tank.
- The required water will be trapped from the nearest Hydrant main.
- The system shall be designed and installed as per NFPA rules.

4.11.4 FIRE DETECTION AND ALARM SYSTEM:

- A fire alarm system will be provided for the Control room, Cable Gallery, Switchgear and MCC Rooms in the TG Hall.
- The system will have suitably located smoke detectors, photo electric detectors, heat detectors,

4.11.5 PORTABLE FIRE EXTINGUISHERS:

Suitable capacity dry chemical powder extinguishers and CO2 extinguishers will be provided as required.

4.12 CIVIL & STRUCTURAL WORKS

4.12.1 GENERAL

The power plant civil and structural works shall cover all buildings, structures, equipment & structure foundations required for installation of the power plant.

4.12.2 DESIGN BASIS

The design of all civil and structural works shall be based on the following parameters:

- Soil bearing capacity shall be as per the recommendations of the geotechnical investigation report. For the purpose of the cost estimate for civil works indicated in this report, a soil bearing capacity of 20 t/m2 is considered.

- Static and dynamic load of equipment shall be as per the respective vendor data.

- Live loads shall be as per IS 875.

- Wind loads shall be as per IS 875 Part 3.

- Seismic loads shall be as per IS 1893 Part – 1 – 2002.

- Design of concrete members shall be based on IS 456.

- Design of Steel structures shall be based on IS 800.

4.12.3 MAIN PLANT BUILDING

The Main Plant Building including the adjacent control room shall be a concrete framed structure (with a common column for power house building and control room building) supported over isolated/ combined foundations based on soil test data and loads.

The roof over the power house building housing the turbine generator unit shall be of GI sheeting supported on structural steel arrangement. The crane girder shall be plate formed type considering all loads due to wheel loads and surge loads.

All floors shall be of cast in–-situ RCC slabs supported over RCC beams and RCC columns.

Side cladding in the control building portion of the Main Plant Building shall be of brick masonry supported over beams for the entire height. For all other portions of the Main Plant Building, side cladding shall be brick masonry up to 1000mm height and GI sheeting above 1000mm height.

The Main Plant building shall be provided with windows and doors as required. Doors in the control room shall be made of extruded aluminum box frames fully or partly glazed. Partition walls in control rooms shall be of glass panels. Rolling shutters shall be provided for large openings meant for equipment entry. Large entry points shall be provided with electrically/gear operated shutters. Main doors in the electrical and control rooms shall be sized considering the maximum size of panels.

The control room shall be air conditioned and provided with false ceiling and false floor. False floor shall be 600 mm deep with 35mm thick particle board with PVC tile finish.

Toilet blocks shall be provided at suitable locations.

4.12.4 STEAM TURBINE GENERATOR AND OTHER EQUIPMENT FOUNDATIONS

The Steam Turbine Generator shall be provided with conventional RCC framed foundation over RCC base mat. Dynamic analysis shall be carried out for the foundation.

4.12.5 BOILER FOUNDATIONS AND OTHER EQUIPMENT FOUNDATIONS

Foundations for major equipment such as boiler, ESP, boiler feed pump, fans, compressors etc shall be supported on isolated or combined or strip footing depending on loads and the final soil investigation report.

Dynamic analysis shall be carried out for fan foundations. Suitable platforms, approaches, staircases shall be provided in major equipment foundations wherever required. Boiler and ESP areas shall be paved.

4.13 ELECTRICAL

4.13.1 GENERAL

All electrical equipment and materials shall conform to latest applicable standards published by the Bureau of Indian standards (IS), International Electro technical Commission (IEC) and Central Electricity Authority (CEA) and guidelines issued by the Central Board of Irrigation & Power (CBIP), whichever is most appropriate.

All electrical installation work shall comply with the provisions of the Indian Electricity Act, Indian Electricity Rules, Code of practices by IS and any other rules and regulations applicable to the work.

All live parts and connections shall be enclosed and access to such live parts shall not be possible normally. Equipment such as switchgear, control panels shall be provided with a main earth bus, and the complete plant shall be provided with safety earthing network so as to limit the step and touch voltage within the permissible limit.

4.13.2 SYSTEM DESCRIPTION

The power plant comprises 2 x 30 MW (Net) generating units. The generated power at 11 kV will be fed to the 11kV Switchgear panel to enable further distribution of power for plant auxiliary loads and for power evacuation to the grid.

Main and Auxiliary distribution voltage for the power plant auxiliaries will be 11kV and 415V. HT Motors will be fed from the 11kV Switchgear panel and LT power supply required for power plant LT auxiliary loads will be derived from the 11kV Supply by six (6) numbers of 11kV/0.433kV 2MVA Auxiliary Transformers (2 Nos. for Unit-1, 2 Nos. for Unit-2 and 2 Nos. for common systems) and distributed through LT Switchgear panels.

The power available after in-house consumption shall be stepped up to 132 kV level by a two winding bi-directional 132kV/11kV, 35MVA Power Transformer and evacuated to the state grid through a 132kV switchyard and transmission lines to the nearest existing sub-station in the state grid. Start-up power for the power plant will be drawn from the Grid, by back charging the Power Transformer. Start-up power will be made available at the 11kV Switchgear panel.

After plant start up, during the process of power generation, the generator will be brought to the rated voltage and frequency and synchronized at 11kV Switchgear bus.

During normal operation, the steam turbine generator (STG) will run in parallel with the Grid. In case of Grid failure, the STG will be operated in Island mode to feed power to the power plant auxiliaries. A 240V AC uninterruptible power supply (UPS) system will be installed to feed essential supply to AVR, TSP, DCS, control & instruments and other essential circuits.

On resumption of Grid supply, the generator will be re-synchronized at 11kV Switchgear panel. 415V Emergency DG Set of 500kVA rating will be provided in order to meet the emergency requirement of the STG unit for safe shut down purpose. This DG set will be connected to 415V TG cum Emergency MCC to feed various essential auxiliaries such as auxiliary oil pump, oil vapour extractor, Barring Gear Motor, Battery Chargers, UPS, Emergency Lighting, etc.

A 110V DC System will be provided to feed critical & essential loads in the power plant & switchyard, control/protection/ annunciation system and critical lighting.

4.13.3 DESIGN BASIS

Design ambient temperature will be considered as 50°C for all indoor and outdoor electrical and its' associated electronic equipment. The design basis for the various electrical equipment and systems is indicated below.

SL NO	EQUIPMENT / SYSTEM	DESIGN BASIS
1.	System Voltage	
1.1	Generating Voltage	11kV, 50Hz, 3 phase
1.2	Start up Power	132kV, 50Hz, 3 phase
1.3	Power Evacuation	132kV, 50Hz, 3 phase
2.	Auxiliary & Control Voltage:	
2.1	Motor rating above 200 KW	11KV, 50 Hz, 3 phase
2.2	Motors rated up to & including 200kW	415V, 50 Hz, 3 phase
2.3	Lighting	240V, 50 Hz, 1 phase
2.4	Control & Relay panels	110V DC
2.5	DC motors for essential STG auxiliaries	110V DC
2.6	Breaker Control supply for HV Panels & LV PCC Incomers	240V
2.7	415V breaker control supply for PCC outgoing and MCC Incomers	240V AC
2.8	Control Supply for LV Starters	240V, 50 Hz, 1 Phase
2.9	AC UPS System Output Voltage	240V, 50 Hz, 1 Phase
2.10	Panel lighting & space heater	**3500**
3.	Supply Variations for Auxiliaries	
3.1	For AC	11KV, 50 Hz, 3 phase
	3.1.1 Motor rating above 200 KW	11KV, 50 Hz, 3 phase
	3.1.2 Motor rating above 200 KW	11KV, 50 Hz, 3 phase

SL NO	EQUIPMENT / SYSTEM		DESIGN BASIS
3.	Supply Variations for Auxiliaries		
3.2	For DC – Voltage Variation		11kV, 50Hz, 3 phase
4.	Insulation Level		
4.1	132 KV System		
	4.1.1	One minute power frequency withstand voltage	275kV (rms)
	4.1.2	1.2/50 Micro sec. impulse withstand voltage	550kV (peak)
4.2	11 KV Systems		
	4.2.1	One minute power frequency withstand voltage	For generator 23kV and for other equipment 28kV (rms)
	4.2.2	1.2/50 Micro sec. impulse withstand voltage	For generator 49kVp and for other equipment 75kVp
5.	System Short Circuit Current		
5.1	132kV System		31.5kA rms for 1 second
5.2	11KV System		40kA rms for 3 seconds
5.3	415V LV System		50kA rms for 1 second
5.4	110V DC system		10kA for 1 second
6.	System Grounding:		
6.1	Generator		Non-Effective Grounding through NGR
6.2	132kV System		Effectively grounded
6.3	LT System		Solidly grounded
6.4	240V UPS System		Solidly grounded
6.5	110V DC System		Not grounded
7.	Design Margin		
7.1	Motors	10% margin above the power and torque requirement of driven equipment at design point	
7.2	Auxiliary Service Transformers	10% margin over the operating load rating	
7.3	MCC Incomers	20% margin over the operating load current rating	

SL NO	EQUIPMENT / SYSTEM	DESIGN BASIS
7.	Design Margin	
7.4	Chargers & inverters	10% design margin
7.5	Battery bank	10% design margin and ageing factor of 1.25
8.	Spare Feeders	
8.1	415V PMCC, 415V MCC& DB	10% fully equipped spare feeders, at least one spare feeder of each type or rating
8.2	Spare Cores	10% of spare cores over the required cores
8.3	Terminal blocks for control circuits	10% spare terminals

4.13.4 TECHNICAL DESCRIPTION / DETAILS FOR MAJOR EQUIPMENT

A. 132KV SWITCHYARD

The power generated at 11 kV from each unit will be stepped up to 132kV level by the Power Transformer for that unit and evacuated to the Grid through the switchyard.

The switchyard will comprise two(2) Power Transformer bays and one (1) Line bay with the following bus configuration & conductor details:

- Bus Configuration : Single Bus
- Bus Conductor : ZEBRA
- Equipment Connection : Zebra conductor/ 75mm dia Aluminum tubes

The salient technical details of main switchyard equipment will be as follows:

- Circuit Breaker

  The circuit breaker will be outdoor, spring operated SF6 type provided with two trip coils for greater reliability. Breaker will be operated through motor operating spring charged stored energy operating mechanism. The circuit breaker will be controlled electrically from local as well as from the control room. The rated breaking capacity of the 132kV circuit breaker will be 31.5 kA for 1 second.

Isolator

The rating of disconnecting switch will be 1250A. Disconnecting switch will be two column horizontal centre break motor operated type.

Current Transformers

The current transformers will be suitable for the fault 31.5kA for 1 sec. These will be hermetically sealed, oil immersed type meant for separate mounting.

Electromagnetic Voltage Transformers

The Voltage Transformers will be of oil immersed electromagnetic type.

Lightning Arrestors (LAs)

LAs will be gap less metal oxide type and rated for 10 kA, 120kV nominal discharge current & discharge Class-3. Surge monitor, leakage current detector and discharge counter with bypass arrangement will be provided for each phase unit.

Protection Relay Panels

All panels will be free standing, floor mounted and sheet steel enclosed with a degree of protection not less than IP 31. The panels will be located in Main Plant Control Room.

Main protective relays will be of numerical type having integral protective functions and capable of measuring all electrical parameters like voltage, current, power, power factor, frequency etc. Supervision relays will also be provided to monitor DC supply for each trip relay.

Power Transformer Bay Protection

Following typical protections will be provided for each power transformer bay:

- Differential protection (87T) for transformer
- HV side backup over current protection (51)
- HV side restricted earth fault protection (64R)
- HV side standby earth fault protection (51N)
- LV side standby earth fault protection (51N)
- Over fluxing protection on HV side (99)
- Breaker failure protection (50LBB)
- Auxiliary Relays will be provided for transformer internal protections (26,49, 63, 71)

110V DC System

DC Supply required for the switchyard protection relay panel, control relay panels and breakers will be fed from the switchyard 110V DC system.

B. POWER PLANT EQUIPMENT

- Generator Protection, Grounding, Bus Duct and Synchronizing

A Generator Protection Relay Panel with IP42 degree of protection shall be provided. Two (2) numbers of numerical type Generator Protection relays and Electromagnetic relays for the protective functions not covered in the main relay will be provided in the Panel.

The generator neutral will be grounded through a neutral grounding resistor (NGR) to limit the earth fault current. The NGR rating will be 11kV/√3, 63.5Ω, 100A for 30 Sec. The NGR will be provided with motorized Isolator of 400A rating. The NGR panel will have IP 31 degree of protection.

The Generator Main Terminals will be connected to the 11kV Switchgear Panel by Segregated Phase Bus Duct (SPBD). Protection and Metering CTs pertaining to generator line side will be mounted in the bus duct. Generator Neutral side terminals will be connected to the NGR through bus duct. Protection CTs for neutral side will be mounted in the adopter box mounted on the generator neutral terminal box.

The LASCPT Panel, of phase segregated type will be connected to the generator line side SPBD through tap-off SPBD.

The control and synchronizing of the generator shall be carried out from a free standing floor mounted vertical panel / desk type Synchronizing Control Panel. The control panel shall incorporate generator control, metering annunciation and synchronization complete with mimic. Also, facility for switchyard synchronization and operation shall be provided in the control desk. An auto synchronizer with speed raise / lower and voltage increase / decrease facility as well as manual check synchronizing relay will be provided for generator synchronization.

Separate check synchronizing relay and guard relay will be provided for other feeder synchronization. Auto/Manual selector switch will be provided for operating mode selection. The system shall be complete with synchroscope, cut-off switch, synchronizing selector switch, double voltmeter, double frequency meter and bright lamps.

- Power Transformer

The Power transformer will be a three phase, two winding, bi-directional and oil immersed core type transformer having the following salient design specifications:

SL. NO.	PARAMETER	DESIGN SPECIFICATION
1.	Rating	35MVA, ONAN, bi-directional
2.	Voltage ratio	132kV / 11kV
3.	Vector group	YNd1
4.	Impedance	12% (Approx.)
5.	Flux Densitys	10% design margin
6.	Temperature Rise	Winding :55deg.C | Oil : 50deg.c
7.	Flux Densitys	10% design margin
8.	Type of tap changer	OLTC
9.	Range of taps	±10% in steps of 1.25%
10.	Terminal Arrangement	HV – Bushing terminals for ACSR connection LV - Cable Box

- 11kV Switchgear Panel

The 11kV Switchgear panel shall be totally enclosed, metal clad, dead front cubicles of fully interlocked and compartmentalized design. Incomers and all outgoing feeders shall be VCB based.

All main protective relays shall be of numerical type. Master Trip relay shall be of hand reset type. All auxiliary relays shall be of electromagnetic type.

Incomer and Transformer feeders shall be provided with Feeder Protection Relay. Motor Feeders shall be provided with Motor Protection relay. In addition to this, motor feeders rated above 1200kW shall be provided with differential protection. Overvoltage protection device and analog ammeter having suppressed scale to read the starting current of the motor shall be provided for motor feeders.

Auxiliary Service Transformer

The Auxiliary Service Transformers shall be outdoor, oil immersed, core type, three phase, two winding step down transformer having the following salient design specifications:

SL. NO.	PARAMETER	DESIGN SPECIFICATION
1.	Rating	2 MVA :ONAN
2.	Voltage ratio	11kV / 0.433 kV
3.	Vector group	Dyn11
4.	Impedance	6.5 %
5.	Flux Densitys	≤1.8tesla
6.	Temperature Rise	Winding : 55deg.C | Oil : 50deg.C
7.	Type of tap changer	Off Circuit
8.	Range of taps	± 5% insteps of 2.5%
9.	Terminal arrangement	HV : Cable Box LV : Bushing with bus duct flange

LT Switchgear Panel and Bus Duct

The LT PCC / MCC panel shall be free standing, floor mounted, single/double front, semi-draw out type i.e ACB will be draw-out type and other feeders will be fixed type, made out of CRCA steel sheet enclosure, fully compartmentalized, modular construction, dust & vermin proof, conforming to degree of protection IP 52 for rating up to 1600A and IP42 for rating above 1600A. The bus bars shall be of Aluminum for power and Copper for control circuits. The PCC shall be provided with 4-wire bus and MCC shall be provided with 3-wire bus. The MCC shall be provided with two incomers and a bus coupler.

Intelligent MCC shall be provided for STG, Boiler, ACC&ACT, and CHS loads and conventional MCC shall be provided for ESP, AHS, WTP and AC & Ventilation loads.

The secondary of each Auxiliary Service Transformer shall be connected to the respective 415V Power Control Centre through bus duct. The bus duct shall be 3 phase, 4 wire non-segregated type having aluminum conductor and sheet steel enclosure.

- 110V DC System (One for Each Unit)

  The power plant DC system shall provide a reliable source of DC power for critical applications such as emergency oil pump, jacking oil pump (where provided), control supply for switchyard equipment, HT switchgear and PCC & MCC Incomers, Control & Relay Panel, critical lighting, etc. DC starter panels will be provided for critical STG services such as emergency oil pump and jacking oil pump (where provided). The battery bank will supply these loads during complete blackout condition till diesel generator supply is established. The diesel generator is expected to start and feed the battery charger unit within a few seconds.

  The DC system configuration shall be 2 x 100% Float Cum Boost Battery Chargers + 2x100% SMF Battery Bank. The Battery Charger shall be designed to charge the fully drained batteries in 10 hours.

  One number 110V DC Distribution Board shall be provided to cater to the DC loads.

- Uninterruptible Power Supply (UPS) System

  To ensure essential power supply to AVR, governor, instruments, DCS loads & other critical loads, 240V AC Uninterruptible Power Supply (UPS) System shall be provided. 2x100% capacity UPS systems with individual SMF battery bank (rated to provide back-up supply for one hour), static transfer switch and a common bypass servo controlled voltage stabilizer and manual bypass switch shall be provided. Normally, both the UPS shall be operating in parallel redundant mode, sharing the load equally. In case of any problem with one of the UPS, the entire load will be catered to by the healthy UPS. If both the UPS fail, the loads shall be transferred to the bypass stabilizer without any interruption.

  A 240V 1Ph, AC Distribution Board shall be provided for UPS power distribution.

- Emergency Diesel Generator (DG) Set

  A 500kVA DG set shall be provided for safe shut down of the unit in the event of total black out and also to feed various essential auxiliaries such as AOP, oil vapour extractor, barring gear motor, battery chargers, UPS, emergency lighting, etc.

  The generator shall be rated for 415V, 3 phase, 50 Hz supply and 0.8 power factor.

  AMF panel complete with local breaker, generator protection and metering shall also be provided.

Motors

AC motors shall be of squirrel cage induction type, designed for continuous duty (S1) & ambient of 50°C. HT motors shall be designed for non-effectively grounded system. LT motors will be energy efficient type (IE2).

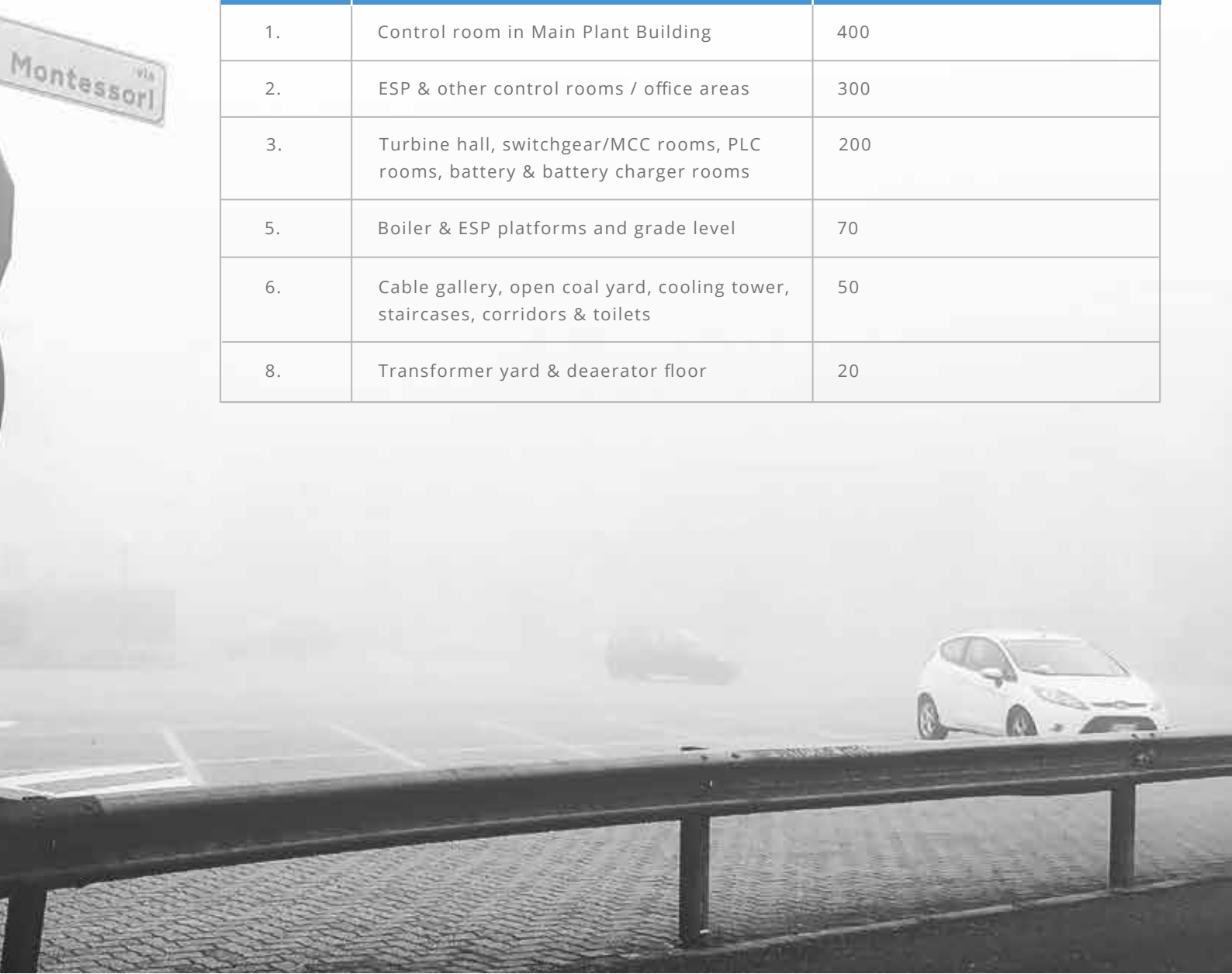
Crane motors and valve/damper actuator motors shall be designed for short time/intermittent duty.

Motors with rating up to & including 200kW shall be LT motors, suitable for 415V, 3ph, 50Hz power supply and motors with rating above 200kW shall be HT motors, suitable for 11kV, 3ph, 50Hz power supply.

Plant Lighting

The power plant lighting system shall be designed based on the following illumination levels in various areas of the plant:

SL. NO.	AREA	ILLUMINATION LEVEL (LUX)
1.	Control room in Main Plant Building	400
2.	ESP & other control rooms / office areas	300
3.	Turbine hall, switchgear/MCC rooms, PLC rooms, battery & battery charger rooms	200
5.	Boiler & ESP platforms and grade level	70
6.	Cable gallery, open coal yard, cooling tower, staircases, corridors & toilets	50
8.	Transformer yard & deaerator floor	20



Cabling

Medium Voltage (11kV) Cable shall be 11kV[UE] grade, stranded Aluminum conductor, semiconductor compound over conductor, extruded cross-linked polyethylene (XLPE) insulated; semiconductor compound & Copper tape to carry E/F current forming screen over the cores, extruded PVC sheathed, GI strip armoured (for multi core) / Aluminum strip armoured (for single core), overall PVC outer sheathed.

Low Voltage Power (1100V) Cable shall be stranded Copper (up to 2.5sq.mm)/ Aluminum (above 2.5sq.mm), XLPE insulated, extruded PVC ST2 inner sheathed, GI wire/flat armoured, PVC ST2 outer sheathed.

Control Cable (600/1100V) shall be of multi-core as required, stranded 1.5sq.mm copper conductor, PVC insulated, GI wire/flat armoured, extruded PVC ST1 inner sheathed, PVC ST1 outer sheathed.

Signal Cable (600V) shall be of multi-pair as required, 1 sq.mm stranded annealed tinned copper(ATC); PVC insulated, twisted 2 cores shall for a pair, aluminum screened, ATC drain wire, extruded PVC inner sheathed, GI wire/flat armoured, PVC outer sheathed.

Earthing & Lightning Protection

The power plant earthing system shall be designed as per the requirement of IEEE-80, IEEE -142, IEEE-665, IEEE-1050, IS-3043, Indian Electricity Rules and CBIP.

The power plant earth mat shall be designed to ensure that the earth resistance of the interconnected power plant grid is less than 1 ohm.

Power plant earthing shall consist of earth pits for system neutral earthing and enclosure earthing, equipment earth conductors and a buried earth grid of galvanized steel flat.

Earth mat / grid shall be buried in the ground at a minimum depth of about 600 mm in a mesh form. Equipment earthing conductor shall be of galvanised steel.

For generator neutral earthing, transformer neutral earthing, 2 Nos. treated earth pits will be provided as per IS. From buried earth mat / grid, risers will be welded and brought above ground level for connecting equipment earthing conductors.

Protection against lightning shall be provided for all unshielded buildings, outdoor structures. The buildings shall be provided with horizontal air terminations on roof top, down conductors, test links and earth connections as per IS 2309. Lightning protection conductors located on the top of the buildings/structures shall be connected to the plant ground grid with galvanized mild steel down conductors.

- Plant Communication System

  An EPBAX telecommunication system with one digital and twenty (20) analog instruments will be provided for the power plant.

4.14 CONTROL & INSTRUMENTATION

4.14.1 GENERAL

The power plant shall be provided with all required instruments and controls for efficient and safe operation of all equipment. The instrumentation and control system provided shall control and monitor all significant process requirements, provide data on all operational variables necessary for safe, easy and efficient operation of the plant and provide safety controls and interlocking including alarms and abnormal conditions.

The control and instrumentation (C&I) systems are broadly classified into the following categories:-

- Field Instruments
- Alarm annunciation system(Done at DCS)
- Protection and interlocking system (Done at DCS)
- Control Valves and On/Off Valves
- Distributed Control System (DCS).

14.4.2 C&I SYSTEM DESIGN PHILOSOPHY

The boiler and associated equipment shall be monitored and operated by the DCS. Boiler protection, sequential start - stop interlocking shall also be carried out by the DCS.

Separate microprocessor based system shall be provided for the steam turbine generator (STG) electro hydraulic governor control, vibration monitoring system along with over speed monitoring system in one panel of the Turbine Supervisory Panel (TSP). The STG DCS shall interact with the Electro-hydraulic Governor and Turbine Supervisory Instruments (TSI) of the STG supplier through hardwired and RS-485 serial link over MODBUS protocol. The primary objective of the interface shall be centralized monitoring and presentation of data. Minimum number of graphics for convenient monitoring & control of the STG shall be generated in the STG DCS.

With regard to balance of plant systems, the coal and ash handling systems shall be monitored and controlled from the DCS. Independent stand-alone PLC-based control system shall be provided for the UF units of the water treatment plant (if provided) and independent stand-alone microprocessor based control system shall be provided for the compressed air plant.

With regard to field instruments, RTDs shall be provided for temperature measurement up to 400 deg. C and thermocouples for temperature measurements above 400 deg C. For main steam flow measurement, flow nozzle shall be used. For feed water, condensate, spray water, soot blowing steam and other low pressure steam flow measurement, orifice plate shall be used. For air flow measurement, venturi shall be used.

14.4.3 DCS ARCHITECTURE

Distributed Control System (DCS) shall be provided for the Boiler, Steam Turbine Generator (STG), Coal and Ash Handling systems. The DCS configuration is presented in Drg. No. FTZ-DPR-102-6 (DCS Configuration Drawing).

The DCS shall cater to the following functions:

- Data acquisition
- Signal conditioning
- Analog process parameter display in bar graph as well as in digital format
- Controller face plate display
- Online and historical trending
- On/Off status display for drives and valves
- Regulatory (closed loop) controls
- Alarm monitoring and reporting
- Protection and Interlocking for auxiliaries
- Data logging, report generation

Salient features of the DCS shall be as follows:

- The system shall be microprocessor based having functional/geographical distribution and data base distribution sub-system wise.
- The system shall have self-surveillance, monitoring and diagnostic facility so that failure/malfunction can be diagnosed automatically up to individual modules.
- Redundancy shall be provided at all levels except for input/output modules to improve the system availability and reliability.
- 1:1 Redundancy shall be provided for the data acquisition and control processors, communication processors and power supply modules to maintain system integrity. In case failure is detected in the main processor all the functions of the failed processor shall be automatically transferred to the back-up processor without any disturbance to the process or any loss of data.
- The system loading shall not exceed 60%.
  The system shall have a digital communication bus that provides a high speed data transfer rapidly and reliably between the operator stations, engineering station, controllers, process I/O and other devices connected to it.
- In case of main bus failure or any communication device failure, the transfer to the back-up device or bus shall be automatic without interrupting the system operation and without any operator's inter vention.
- It shall also be possible to switch over the communication from main bus to the redundant bus manually without disturbing the system operation.
- The operator interface to the system shall be through operator's consoles.

The operator console shall cater to the following requirements:

- Indication of all analog and digital process variables of control loops, open loops and all loop related parameters
- Manipulation of control loops including changing set point, mode, output, configuration, tuning and computational constants
- Graphic displays and status indication
- Alarm displays and annunciation
- Logging and trending including historical trend recording
- Self diagnostic messages.

The Engineer's console shall cater to the following requirements:

- Configuring, tuning and maintenance of the system
- Data base configuration including overview, group, loop, multi-loop and multi-variable control configuration
- Configuration or re-configuration of alarm settings, their values, addition or deletion of any control block or component in loop
- Tuning of control loops like changing PID dead time values etc.
- Compilation of graphic displays.
- Compilation of logs/reports/historical trend points.
- To call detailed self diagnostic displays for maintenance aid.

14.4.4 CONTROL LOOPS

The following major DCS based control loops are envisaged for the Boiler unit:

- Drum Level Control (3 element)
- Combustion Control
  - Air flow control
  - Fuel flow control
- Furnace Draft Control
- Main Steam Temperature Control
- Startup Fuel oil header pressure control
- Boiler Blow down Tank Level Control.

The following major DCS based control loops are envisaged for the STG unit and feed water cycle including air-cooled condenser (ACC):

- Deaerator and Closed Feed Water heater Level Controls
- ACC Condensate Storage Tank Level Control
- Condensate and boiler feed pump minimum recirculation flow controls
- DCS interaction with the turbine governing and supervisory systems to facilitate centralized monitoring and presentation of data.

Apart from the above, the protection and sequential logics for the coal and ash handling systems shall also be catered to by the DCS.

14.4.5 ANALYZERS AND STACK EMISSION MONITORING SYSTEM

Oxygen Analyzer shall be provided for measurement and monitoring of Oxygen content (%) in flue gas at Air-heater inlet and to use the measured oxygen signal in combustion control for trimming the air flow demand to restrict excess air.

Steam and Water Analysis System (SWAS) shall be provided for measurement of the parameters indicated below at the points indicated.

- Make-up DM water to Deaerator - Conductivity, pH
- Feed water at Economiser inlet - Conductivity, pH, Dissolved Oxygen
- Condensate at condensate pump discharge - Conductivity, pH
- Boiler Drum water - Conductivity, pH
- Saturated steam - Conductivity
- Main steam - Conductivity, pH

The analysers listed below shall be provided as part of the plant continuous emission monitoring system (CEMS) for continuous monitoring of flue gas emission levels at the stack in accordance with the norms stipulated by the environmental authorities.

- Solid particulate emission monitor
- SOx analyser
- NOx analyser
- CO analyser

CHAPTER – 5

ENVIRONMENTAL ASPECTS

5.1 INTRODUCTION

The operation of the captive power plant will produce air emissions, waste water and solid wastes such as boiler ash. The release of pollutants, if unchecked, can lead to negative impact on the environment. Hence, it is planned to minimize the impact of the plant on the environment through proper siting and implementation of the appropriate pollution control measures.

5.1.1 SITE

The site selected for the power plant generally meets the criteria laid down by the Ministry of Environment and Forests, Govt. of India. No significant place of archaeological, religious or tourist importance lies within a radius of 10 km from the site. A green belt of adequate width shall be provided around the proposed power plant.

5.1.2 SOURCES OF POLLUTION

The major sources of pollution from the proposed captive thermal power plant are:

- Boiler ash
- Boiler flue gases containing suspended particulate matter (SPM), sulphur dioxide (SO2), oxides of nitrogen (NOx) etc.
- Fugitive dust generated during coal handling and processing.
- Effluents from the chemical water treatment plant.

5.1.3 APPLICABLE STANDARDS FOR AIR AND WATER POLLUTION

The Central Pollution Control Board (CPCB) has developed National Standards for Effluents and Emission under the statutory powers of the Water (Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of Pollution) Act, 1981. These standards have been approved and notified by the Government of India, Ministry of Environment & Forests, under Section 25 of the Environmental (Protection) Act, 1986. These standards have recently been amended vide the Environment (Protection) Amendment Rules, 2015 notified in the Official Gazette on 7th December 2015 vide S.O. 3305(E) by the Ministry of Environment, Forest & Climate Change, Government of India. The standards applicable to new power plants which come into operation on or after 1st January 2017 (which is the case with the power plant covered by this report) is as follows:

- Air Pollution Limits

  - Particulate Matter - 30 mg/Nm3
  - Sulphur Dioxide (SO2) - 100 mg/Nm3
  - Oxides of Nitrogen (NOx) - 100 mg/Nm3
  - Mercury (Hg) – 0.03 mg/Nm3

- Water Consumption & Discharge

  - Specific water consumption – 2.5 m3/MWh (maximum)
  - Zero waste water discharge from the power plant.

In addition, in accordance with the earlier EPA Notification G.S.R. 742(E) dated 30th August 1990 of the Ministry of Environment & Forests, the stack height for the power plant needs to be calculated as per the following formula subject to a minimum height of 30 meters.

H= 14 Q0.3 where Q is emission rate of SO2 in kg/hr, and H is stack height in meters.

5.2 POLLUTION CONTROL MEASURES

The power plant will be equipped with state-of-the-art pollution control devices to bring down the emission of pollutants and effluents to a level well within the stipulated norms. Details of pollution control measures envisaged are elaborated below.

5.2.1 AIR POLLUTION CONTROL

- The coal to be used in this power plant is expected to have an ash content between 5.7% (Nagaland Coal) and 48% (other Indian Coal). In the boiler furnace about 20% of ash is generated as Bed Ash, and the balance 80% would be carried along with the flue gas in the form of fine particulate matter as Fly Ash. To limit the concentration of the Fly Ash in the exit flue gas, an Electrostatic Precipitator (ESP) with suitable number of fields will be installed to limit the suspended particulate matter (SPM) in the boiler flue gas at the outlet of the ESP to less than 30 mg/Nm3.

- Limestone dosing system will be provided in the boiler to reduce the SO2 content in the exit flue gas. However, space provision will be made to incorporate, in future, a flue gas desulphurization (scrubber) system downstream of the air heater to reduce the SO2 content in the exit flue gas to within permissible limits if required by the environmental clearance obtained for the project

- Space provision will be made to incorporate, in future, a suitable Selective Non-Catalytic Reduction (SNCR) system with ammonia/urea injection downstream of the economizer for reducing the NOx content in the exit flue gas to within permissible limits if required by the environmental clearance obtained for the project.

- Since the presence of mercury in both Nagaland and Other Indian Coal is below detectable limit, the limit of 0.03 mg/Nm3 with regard to presence of mercury in boiler flue gas will be complied with.

- The two boilers will be provided with a common RCC stack of height 105 meters which is well above the stack height calculated based on the BMCR flue gas flow, sulphur content in the boiler exit flue gas and the stack height formula indicated by the Ministry of Environment & Forests (refer Clause 5.1.3 above). This will facilitate dispersion of air borne emissions over a large area and thus further reduce the impact of the power plant on ground level concentrations.

5.2.2 WATER CONSUMPTION & DISCHARGE

- The Air Cooled Condenser (ACC) system proposed for the power plant will significantly reduce the consumptive water requirement for the power plant since a major source of consumptive water consumption (make-up water to cater to evaporative and blow down losses in the cooling tower based condenser circulating water system) is avoided.

- As seen from the enclosed Drg. No. FTZ-DPR-102-4 (Plant Water Balance Diagram), the consumptive water requirement is 600 m3/day which works out to 25 m3/hr. Based on the rated power plant capacity of 2 x 30 MW, this works out to about 0.4 m3/MWh which is much below the stipulated norm of 2.5 m3/MWh.

- As seen from the enclosed Drg. No. FTZ-DPR-102-4 (Plant Water Balance Diagram), the waste water generated is estimated at 75 m3/day which works out to about 3.1 m3/hr. This waste water is primarily filter backwash water, ion exchange unit regeneration waste water, UF reject water and auxiliary cooling tower blow down. The acidic effluents generated during regeneration of cation and mixed bed exchangers and alkaline effluents generated during regeneration of anion and mixed bed exchangers of the DM plant, along with the filter backwash water and UF reject water, shall be led into a neutralization pit. Normally, these effluents are self-neutralizing, but provision will be made for dosing alkali for final pH adjustment in the neutralizing pit before disposal. Auxiliary cooling tower blow down will also be led to the neutralizing pit. After necessary pH correction, the neutralized waste water will be pumped out through 2x100% capacity pumps. Though the quality of this neutralized waste water (pH, TDS) is such as to be fit for discharge into the external environment, in accordance with the zero discharge stipulation vide Notification dated 7th December 2015, the waste water will be used within the plant for coal dust suppression, ash conditioning, gardening and as service water for general plant use.

- Boiler blow down water will be used for auxiliary cooling water system make-up and for this purpose will be separately led to the auxiliary cooling tower basin. Based on the boiler blow down quantity, the generation of softened water make-up to the auxiliary cooling water system will be correspondingly reduced.

5.2.3 COAL HANDLING SYSTEM

For the control of fugitive dust emission in the coal handling plant, dust extraction and suppression systems shall be provided. Dust suppression system shall be installed at the ground hoppers of the Coal Handling Plant. Dust extraction systems shall be provided at the boiler bunkers, crusher house and at all transfer towers.

5.2.4 ASH COLLECTION & DISPOSAL

The annual total ash generation from the power plant will be in the range of 13,500 tonnes (if 100% Nagaland Coal is used) to 210,000 tonnes (if 100% Other Indian Coal is used). About 20% of this total ash will be bed ash and the balance 80% will be fly ash. The power plant will collect all the bed ash and fly ash in dry form through dense phase pneumatic ash handling systems for storage in bed ash and fly ash silos. The ash so collected will be loaded into trucks for transport to the end user. In order to minimize fugitive dust emission during unloading into open trucks, suitable ash conditioners shall be provided at the outlet of the silos. It is envisaged that the fly ash will be used by cement plants and the bed ash will be used as land fill.

5.2.5 NOISE

The plant and equipment shall be designed and specified with a view to minimize noise pollution. Major noise producing equipment such as turbine generator and compressors shall be provided with suitable noise abatements. Blow-off valves and relief valves shall be equipped with silencers. The abatement measures shall ensure that noise levels are kept below 90 ±2 dBA at a distance of 1.5 m from the rotating equipment. Employees in high noise areas will be provided with ear protection devices.

The noise level at the plant boundary will be maintained as stipulated in the environmental clearance obtained for the project.

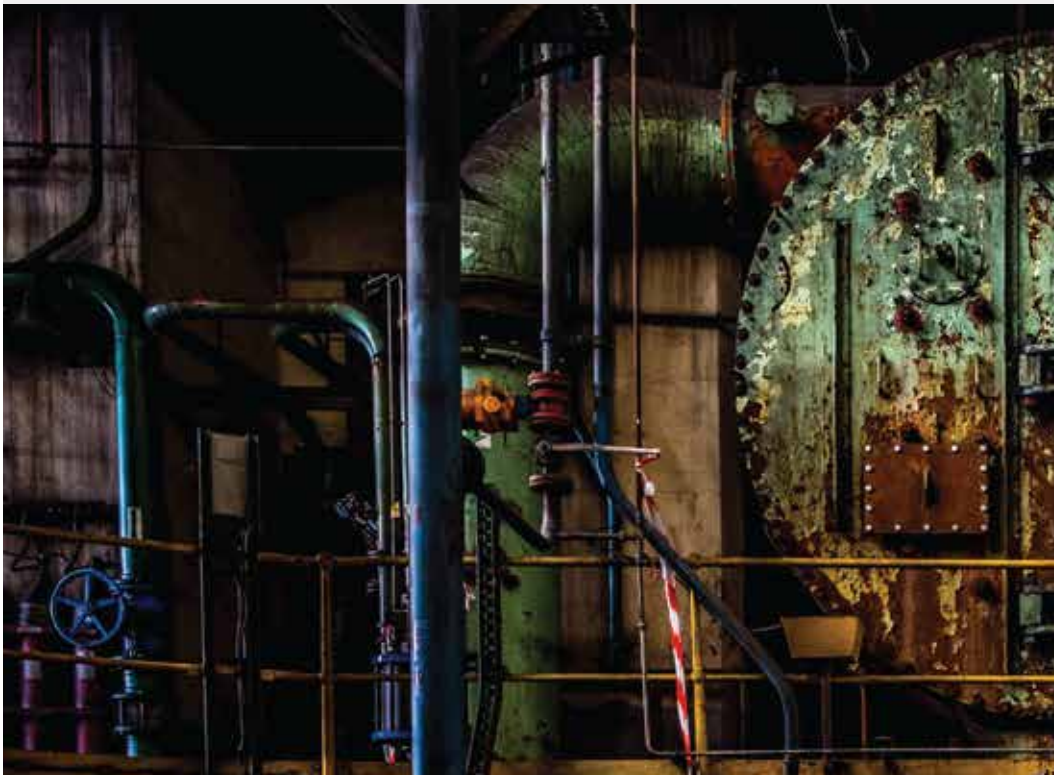
5.3 ENVIRONMENT IMPACT ASSESSMENT (EIA) STUDY

Environment Impact Assessment (EIA) studies shall be conducted and base line data collection shall be completed. The study shall provide the information as to whether after the project is completed the Ground Level Concentrations will still be well within the limits specified by MoEF in and around the project area. The EIA shall identify all the impacts on various environmental components and suggest mitigation measures.

5.4 POST OPERATIONAL MONITORING PROGRAMME

The Continuous Emission Monitoring System (CEMS) being provided as part of the power plant will monitor suspended particulate matter (SPM), sulphur di-oxide (SO2), Nitrogen Oxide (NOx) and Carbon monoxide (CO) to ensure that these are within the stipulated limits.

In addition, a Weather Monitoring Station will be set up at the site to monitor and record weather parameters such as temperature (Maximum & Minimum), humidity, wind direction, wind speed and rainfall on daily basis.



CHAPTER – 6

PROJECT IMPLEMENTATION

6.1 PROJECT IMPLEMENTATION SCHEDULE

Successful execution of the power project largely depends on the coordinated approach of all the project implementing agencies. The Owner, in association with the EPC Contractor, will assume overall responsibility for implementation of the project covering proper co-ordination between the various project execution agencies, monitoring of project schedules, appropriate mobilization of manpower and other resources so that effective cost control and timely completion of the project can be ensured.

The power project is proposed to be executed under an EPC package which includes the Main Plant Package (BTG) all Balance of Plant mechanical, electrical and control & instrumentation works as well as all civil & structural works.

The proposed power project would have a capacity of 2 x 30 MW (Net). The proposed project is scheduled for commissioning in 24 months for Unit-1 and 27 months for Unit-2, both reckoned from the date of issue of Notice to Proceed (NTP) to the EPC Contractor which is expected to be the same as the date of Financial Closure of the project. Resurgent Power Projects Limited (formerly Enmas GB Power Systems Projects Limited) has been selected as the EPC Contractor for the project. Financial closure of the project is scheduled by end of December 2018. This schedule is based on Enabling Works such as survey, grading, leveling, soil investigation and provision of construction power, construction water and other communication requirements being carried out as Pre Financial Closure works.

An experienced and well-equipped Project Execution Group would be organized to overview and steer the project through from the inception to the commissioning stage. This Group will cover the following:

- Project planning, scheduling and monitoring
- Review of the EPC Contractor's Engineering and sub-ordering
- Monitoring of manufacturing, inspection and expediting
- Construction and Commissioning
- Manpower deployment and training

The proposed power plant would consist of the following major equipment/systems:-

- Steam Generator along with all ancillaries and auxiliaries
- Steam Turbine Generator sets with all ancillaries and auxiliaries
- Air cooled condenser
- Balance of Plant System having major systems as below :-
- Main and Start-up Fuel System
- Ash Handling System & Ash Silos
- Plant Water System
- Fire Fighting System
- Instrument and Service Air System
- AC & Ventilation System
- Electrical Distribution System
- Step-up & Auxiliary Transformers
- Switchyard
- Illumination & Communication System
- Control & Instrumentation System
- Civil and Structural Works

The entire project would be monitored by the Project Execution Group. The group would also ensure appropriate interfacing with different stake holders.

The project schedule is attached for information. The ‘zero date’ of the project has been reckoned from the date of Notice to Proceed which is presumed to be the same as the date of Financial Closure. The schedule is based on Enabling Works such as survey, grading, leveling, soil investigation and provision of construction power, construction water and other communication requirements being carried out as Pre Financial Closure works.

6.2 CONSTRUCTION FACILITIES

The proposed power plant will require mobilization of construction facilities in various stages for timely and unhindered implementation of the project. Site office will be established before the main construction works are commenced to complete the enabling works. Necessary boundary wall to demarcate the power plant area will be constructed as required. The two main requisites for starting major construction works are construction power and construction water. Necessary arrangements for providing these will be made before commencing the power plant site work. The plant layout will be prepared in such a manner that adequate space is available for site offices, covered and open storages, fabrication and pre-assembly yard, etc., during the construction period.

CONSTRUCTION OF ROADS

Access road to the power plant site from the existing National Highway No. 61 is already available and this will be strengthened as required to facilitate the movement of materials and equipment during construction / erection and operation of the power plant. Further, additional temporary roads inside the plant area would be built on the basis of plant layout during the construction period, which will be subsequently converted to permanent roads.

CONSTRUCTION YARD

Adequate space is available for construction purpose including fabrication yard, storage, temporary facilities which shall be erected during construction period. In addition, it is envisaged that facilities with regard to canteen, vehicle parking, toilets, etc. will also be made available during the construction period.

CONSTRUCTION WATER

Water for construction purpose will be sourced from bore wells at the site. The construction water requirement will be around 40 m3 /day during the peak period when maximum civil works are under execution.

CONSTRUCTION POWER

The peak construction power requirement of the project is envisaged to be approximately 800 KVA. The same is proposed to be availed either from the state grid or through DG sets.

CONSTRUCTION EQUIPMENT

All the construction equipment required for carrying out construction work will be brought by the EPC Contractor. The Owner, however, shall procure the permanent tools and plant required for operating and maintenance of all the equipment. Necessary bulldozers, mobile mounted cranes etc. required for daily use during operations shall also be procured by the Owner.

CONSTRUCTION MATERIALS

All the stone aggregates, sand, bricks are locally available in and around the proposed site. The required cement will be procured from nearby cement plants.

All the required reinforcement steel will be procured from steel plants and transported to site by road. Corrosion resistance (with appropriate coating) steel of grade Fe 415 or Fe 500 shall be used in all RCC work. All the required steel for structural fabrication will be procured from SAIL / JSW etc. Adequate space for setting up a structural fabrication yard inside the plant premises will be provided.

CONSTRUCTION MANPOWER

It is expected that the required semi-skilled and unskilled workmen would be available from the local population in the area to meet the man power requirement during construction and erection of the power plant. In case of non-availability of local man power, man power from outside may be required to be deployed during the construction period. This deployment will be essentially by the EPC Contractor. The Owner shall also build up an appropriate organization to control the safety and quality aspects of the construction activities.

The construction wing of the project would be headed by a Site In-charge who will look after the overall activities in compliance with the project schedule. He will be assisted by a team of experienced managers and engineers in different disciplines including technical, administration, staff welfare, finance, safety and security, material management, etc.

6.3 PROJECT MANAGEMENT

The Project Execution Group would co-ordinate and control all the following major activities:-

- Complete infrastructural works to ensure a smooth start of major EPC works.
- Interfacing with statutory authorities and the EPC Contractor.
- Monitoring of the EPC Contractor's engineering and procurement activities including vendor drawing review.
- Quality Assurance at shop and at site.
- Supervision of construction and erection activities.
- Preparation of Progress Reports & updating project schedule.
- Compliance of Insurance policy and any liaison required with the Insurer.
- Liaising with Lenders (Lenders' Engineer and other agencies nominated by Lenders). The group would also coordinate the release of funds from Lenders to the Project as per the financing documents and progress of work.
- Certification of Performance Testing and Acceptance of various equipment and systems.

A site office will be established which will co-ordinate the pre-project activities during conceptual engineering stage and later on take up supervision and construction management during the construction stage.

6.4 PROJECT MONITORING, CO-ORDINATION & CONTROL

6.4.1 PROJECT MONITORING SYSTEM

Progress of each activity at every stage would be physically monitored by the Project Execution Group. The group would be adequately staffed. A Project Management System would be established and overseen by the Project Execution Group. The detailed PERT / CPM network for the project would be monitored on monthly / fortnightly basis to compare with scheduled progress versus actual progress achieved.

6.4.2 CO-ORDINATION

Regular meetings would be held at Site/Office among the representatives of the EPC Contractor and the Project Execution Group to review the progress of each activity. At these meetings, slippages in progress would be identified and corrective measures shall be taken. The problems arising out of site and material constraints would be promptly sorted out. Minutes of meetings would be circulated among all concerned for necessary follow-up action.

Co-ordination meetings between the EPC Contractor and the senior executives of the Project team would be held regularly for major decisions in regard to planning, designing of various plant and equipment, execution procedures, manpower deputations, industrial relations, security, etc. A Head of Site Operations (Site Manager) with requisite experience shall be appointed. Experienced site engineers of various disciplines will be working under the Site Manager at the site office. Appropriate Information Technology system will allow close coordination with the home offices, which will also be used for back-up and to solve any upcoming design issue. Site activities of the Contractor's site teams will be coordinated by the Owner to ensure that working areas are clearly assigned and safe.

6.4.3 REPORTING

Various reports would be generated in regard to the physical and financial progress of the project on monthly, quarterly and yearly basis for forwarding to the various Government Departments, Financial Institutions as well as for internal use. Daily progress of the major items of work, along with their weekly/ monthly targets, would be reported to the project head. The progress measurement system and weighting according to various activities will be mutually decided and agreed between the EPC Contractor and the Project Execution Group.

6.4.4 FINANCIAL CONTROL

Actual cost records would be regularly monitored against forecasts, which would be forwarded to Finance Department by the Project Execution Group on monthly, half-yearly and yearly basis, depending on the actual progress of delivery and erection/construction. Fund requirements would be assessed and arranged accordingly.

6.5 POWER PLANT OPERATION AND MAINTENANCE (O&M)

6.5.1 PLANT O&M PHILOSOPHY

The power plant will be designed to manage operation of the power plant without human intervention to the extent possible so as to not only achieve high reliability but also to avert costly errors. High reliability and availability with optimum manpower requirement will be the guiding philosophy of plant design and operation in the proposed power plant.

Various safety supervisory systems like Turbine Governing System have become an integral part of modern power plant design with microprocessor based DCS systems integrated to various control packages. A state of the art microprocessor based DCS system integrating all the above will be provided in the proposed power plant. These facilities will be provided as part of the boiler, turbine control system to ensure high reliability and availability, economy and safety during operations. The generating unit will be controlled from a central control room (CCR) located in the main plant building.

The objectives of plant operation and maintenance shall be to maximize the plant output and availability with safe, reliable and efficient mode of plant operation, meeting all regulatory requirements.

6.5.2 O&M ORGANIZATION

On completion of successful commissioning of the plant, operation and maintenance function will be taken over by the Owner's O&M team. The O&M team will be available at least 3 months before commencement of power plant start-up activities.

Since the plant operation and control shall be achieved by a modern state-of-the-art control and instrumentation system employing DCS, the plant O&M is proposed to be carried out by a limited number of highly qualified and motivated operating staff. To achieve high degree of efficiency in plant management and operation, proper training scheme consisting of in-house training as well as at manufacturer's works shall be developed during the execution stage of the project.

The operators to be deployed at the plant will be exposed to training by the OEM specialists at their shop and/or site. The operation and maintenance of the station would be the overall responsibility of the O&M Chief, who would be assisted by a team of experienced Executives and Operators in the respective fields. Major maintenance and annual overhaul will be contracted out to original equipment manufacturers or reputed agencies. Only routine maintenance and forced outage maintenance will be carried out by the plant maintenance staff. With regard to odd jobs such as plant cleaning, hiring of vehicles, road and drainage maintenance, plant security, gardening / green belt development etc., the existing arrangements in the polyester plant will be extended to cover the captive power plant also.

The manpower deployment for smooth plant operation & maintenance is estimated at around 50 personnel. The above staffing is based on the philosophy of minimizing the manpower requirement during evening and night shifts and concentrating on maintenance efforts during the day shifts when the Maintenance Engineers are available at the plant. A minimum number of people, therefore, will be in attendance during the evening and night shifts on the assumption that only temporary and minor repairs would be made during these hours. The number of operational personnel is kept low considering the high level of plant automation.

Qualified chemists, adequately experienced in power plant operation would be employed and placed at the work site at least three months before the initial run, so that they could set up a laboratory for water, incoming fuel, etc. and also for other testing purposes.

6.6 EMPLOYEE FACILITIES

6.6.1 IN-PLANT FACILITIES

Apart from the main power house building, housing the power generating equipment and other buildings required for operating and maintaining the power plant, the following facilities are required to be provided for the operation, maintenance and administration personnel:

- O&M Office Space
- Canteen
- First-Aid Centre and Gate Office
- Car Park and Two Wheeler Sheds
- Toilets, Wash Rooms, Change-Rooms, Drinking Water, etc. provided in main buildings and yard to meet the requirements of the Factories Act.

Of the above facilities, some of the buildings will be required at the construction stage while the others will be required during operation of the plant. The O&M Office space can be provided in the main plant building.

6.6.2 RESIDENTIAL ARRANGEMENTS

It is estimated that a total of about 50 employees would be working for operation, maintenance and administration of the power plant. Keeping in view the availability of educational and health requirements in Tuli town, it is envisaged that these employees would make their residential arrangements in Tuli and suitable transport facilities for these employees from residence to site would be arranged by the Owner.

CHAPTER – 7

PROJECT APPROVAL AND CLEARANCES

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

TABLE - 7.1

S. NO.	CLEARANCE	CONCERNED AUTHORITY	STATUS
1.	Registration of Company	Registrar of Companies	To be done separately or existing company to be used
2.	Environmental Clearance	Ministry of Environment & Forests, New Delhi (State Unit)	Application to the relevant authorities to be made
3.	Consent to Establish under Air & Water Pollution Act.a	State Pollution Control Board	Application to State PCB will be made once the MOEF clearance is under way
4.	Water	State Ground Water Board / Authority and Local Panchayat	Application to the relevant authorities to be made
5.	Chimney Height	Civil Aviation Ministry, Airport Authority of India.	Application to the relevant authorities to be made
6.	Rehabilitation and Resettlement of families displaced by land acquisition	State Government MOEF	Not applicable since land identified for the project is allotted by the State Government and is free of settlements
7.	NOC from State Electricity Board or State Regulatory Commission for setting up power plant	State Electricity Board / State Regulatory Commission	Application to the relevant authorities to be made
8.	Labour clearance	Labour Department	Application to the relevant authorities to be made
9.	Fire & safety clearance	State Fire & Safety Department	Application to the relevant authorities to be made

TABLE - 7.2
MAJOR NON - STATUTORY PERMITS AND CLEARANCES
(TO BE OBTAINED PRIOR TO CONSTRUCTION)

S. NO.	CLEARANCE	CONCERNED AUTHORITY	STATUS
1.	Land Use	District Collector	Application to the relevant authorities to be made
2.	Import Licenses and Formalitiese	Govt of India	Direct import by the Owner is not envisaged for the project
3.	Consent from Gram Panchayat	Relevant Gram Panchayat	NOC to set up the power plant will be obtained in due course
4.	Right of way for transmission lines	State Government	To be arranged by agency setting up the transmission lines

The list above is indicative and not exhaustive.

CHAPTER – 8

ESTIMATED PROJECT COST & FINANCIALS

The estimated project cost for installation of the 2 X 30 MW capacity coal based power plant has been worked out on the following basis and assumptions:

A. LIFE OF PLANT:

The life of the plant has been considered as 25 years.

B. MAIN PLANT AND EQUIPMENT:

The cost of main plant and equipment consisting of Steam Generators with all auxiliaries, Steam Turbine Generators with all auxiliaries and Air Cooled Condenser has been worked out from the cost of a project of similar type and capacity.

The cost of plant and equipment included in this report, however, does not include the cost of the Selective Non Catalytic Reduction system for NOx control, the flue gas desulphurization (scrubber) system for SO2 control and any additions to the boiler system consequent to addition of these two systems.

C. AUXILIARY PLANT AND EQUIPMENT:

The cost of the Balance of Plant equipment and auxiliaries has been estimated from in- house data for similar items of other ongoing domestic projects.

D. CIVIL WORKS

The general civil, structural and architectural works of the plant has been estimated based on applicable quantities and prices for similar projects.

E. FUEL:

Nagaland Coal transported by road from nearby mines and/or other Indian Coal and bamboo has been considered as the main fuel. However, the financial analysis has been based on Nagaland Coal and bamboo.
Cost of Nagaland Coal (GCV of 6700 kcal/kg) including freight, taxes and duties as delivered to the power plant site for the first year of operation has been considered as Rs.6,000/- per tonne.

Cost of Bamboo (GCV of 4500 kcal/kg) including freight, taxes and duties as delivered to the power plant site has been considered as Rs.6,000/- per tone

Light Diesel Oil price has been taken as Rs.50,000/- per Kilo Liter.

The other considerations in respect of fuel supply are:-

- The fuel stockyard would have an average storage of 30 days coal requirement.
- Light Diesel Oil will be used as startup and low load fuel.

F. OTHER INPUTS / ASSUMPTIONS:

Other inputs and assumptions considered in the estimation of Project Cost and computation of profitability are indicated below under “Assumptions for Financial Analysis”.

8.2 THE SUMMARY OF THE PROJECT FINANCIALS FOR THE 2 X 30 MW PROJECT ARE AS FOLLOWS:

- Project Capital Cost is Rs.410 Crores including IDC & financing costs and working capital margin.
- The sale price of net power made available for export at the switchyard of the power plant has been considered as Rs. 5.65/kWh in the first year of operation escalated at 1% per year in subsequent years.
- During the first three years of operation of the power plant, the average profit before tax is estimated at around Rs. 54 Crores and the average cash accrual at around by Rs. 69 Crores as indicated in the financial model.

PARTICULARS	IN INR CRORES
Steam Generator island (2 Nos)	243.8
Turbo-Generator island (2 Nos)	
ACC (2 Nos)	
BTG	243.8
BOP Mechanical	
ACT & ACW System	
Plant Water System (DM Plant, Pre-treatment Plant)	
EOT Cranes	
Fuel oil & Storage system	
Ash Handling System	
Coal Handling Plant	
Air Compressor System	
Air Condition & Ventilation System	
Fire fighting system	
LP piping and miscellaneous equipment	
Misc. cranes	
Sub-total of BOP Mechanical -	
Electrical equipment	
Switchyard Package	
Other Electrical Packages	
Transformers Package	
Generator Associated items - GRP, UCP, BOP control panels	
Busducts (IPB, SPB & NSPB)	
Switchgear package (HV, LV) DC,UPS, NGR and DG sets	
Cables, Cable facilities, Illumination, Elevators, Communication, Grounding & Lightning protection, Lab equipment	

PARTICULARS	IN INR CRORES
Sub-total of Electrical Equipment	
Control & Instrumentation Package	
Total Plant & Equipment	243.8
Erection, testing and commissioning	20.0
Transport, Insurance, Taxes and Duties	8.0
GST	35.1
Inland Freight, Clearance charges, Departmental charges & Forwarding included in Plant material cost	0.0
GST on E&C	2.9
Cess if any	1.1
Sub-Total	47.1
PLANT & MACHINERY TOTAL	310.9
Civil and Structural Works	
Main plant Building	
CW System	
Cooling Towers	
DM Water Plant	
Clarification Plant	
Misc. Plant Civil & buildings) (coal shed, Water treatment Building, MCCs, ACC Structure etc)	
Fuel Oil Handling and Storage System	
Coal Handling Plant	
Ash Handling System	
Fire Fighting System	
Temp construction and enabling works	
Road and Drainage	
Chimney	
Civil Sub Total	40.00
Taxes and Duties	
Works contract tax on Civil works @5%	2.00
GST on 30% of supplies	2.16
CIVIL TOTAL	44.2
TOTAL WORKS COST	355.11
PLANT Cost - EPC Contractor Final Delivered Cost	355.11
Non-Plant works	4.0

PARTICULARS	IN INR CRORES
Any transmission interface works	2.00
Consumables	2.00
Project cost excluding IDC & Working Capital	359.11
Interest During Construction (IDC)	44.27
Working capital Margin (WCM)	6.54
Capital cost including IDC & WCM	410.41

ASSUMPTIONS FOR FINANCIAL ANALYSIS		
Generation capacity:		
Generation capacity (MW)	66	MW
Installed Capacity (MW)	66	MW
No of Days Working	365	Days
No of Hours	24	Hours
PLF	93%	
Gross Power Generated(MU)	**537.69**	**MU**
Auxiliary consumption %	9.00%	
Transmission losses %	2.00%	
Net Power Generation	**479.51**	**MU**
Project Cost Details:		
Project Cost	410	Rs. Crores
Debt	75.00%	
Equity	25.00%	
Debt	307	Rs. Crores
Equity	102	Rs. Crores
Debt Equity	3.00	
Cost Per MW	6.20	Rs/MW
Tariff (Net off Minimum Demand)	5.65	Rs/kWh
Coal Details		
Gross Celorific Value	5700.00	Kcal/kg
Landed Cost at Site	6000.00	Rs/Ton
Bamboo Details		
Gross Celorific Value	4500.00	Kcal/kg
Landed Cost at Site	6000.00	Rs/Ton

ASSUMPTIONS FOR FINANCIAL ANALYSIS		
Term Loan		
Interest on Working capital	12.00%	
Interest on Term loan	12.00%	
Tax rates:		
MAT	20.00%	
Corporate	30.00%	
Depreciation Rates SLM		
Civil Works	3.34%	
Plant & Machinery	5.28%	
Miscellaneous Fixed Assets	5.28%	
Depreciation Rates WDV		
Civil Works	10.00%	
Plant & Machinery	15.00%	
Miscellaneous Fixed Assets	10.00%	
Performance		
Boiler efficiency	85.00%	
Turbine heat rate	2422.5	kcal/kwh
Gross/Plant heat rate	2850.00	kcal/kwh
Fuel data		
Quantity of secondary fuel	0.005	ml/kwh

ASSUMPTIONS FOR FINANCIAL ANALYSIS		
Cost of secondary fuel	50	Rs/liter
Cost of water	10	Rs/m3
O&M Cost	0.29	Crores/MW
Make-up water	325,900	m3 /annum
Escalations:		
On fuel price	0%	
On tariff	1%	
On O&M cost	2%	
On Secondary Fuel Charges	2%	
Working Capital Assumptions	**Holding Period**	
Fuel Cost	30	Days
O&M Cost	30	Days
Receivables	30	Days
Spares	36	Days
Creditors	60	Days

RATE OF RETURN COMPUTATIONS :

Internal Rate of Return (IRR)

PARTICULARS	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Project Cost Outflow	410.41									
INFLOWS										
Profit After Tax	51.85	47.77	45.69	45.12	44.59	42.09	41.58	41.10	38.23	37.39
Add: Interest Costs on Term Loan	28.86	29.54	25.86	22.17	18.46	14.78	11.08	7.38	3.70	0.47
Add: Depreciation & Amortization	20.02	20.02	21.89	21.89	21.89	24.35	24.35	24.35	27.33	27.33
Total Inflow	100.73	97.32	93.44	89.18	84.94	81.22	77.01	72.83	69.26	65.20
Net Cash Flow	-309.68	97.32	93.44	89.18	84.94	81.22	77.01	72.83	69.26	65.20
Project IRR for Term Loan Period	25.2%									

Internal Rate of Return (IRR)

PARTICULARS	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Equity Infusion	102.60									
INFLOWS										
Profit After Tax	51.85	47.77	45.69	45.12	44.59	42.09	41.58	41.10	38.23	37.39
Add: Depreciation & Amortization	20.02	20.02	21.89	21.89	21.89	24.35	24.35	24.35	27.33	27.33
Less: Debt Repayment	-15.39	-30.78	-30.78	-30.78	-30.78	-30.78	-30.78	-30.78	-30.78	-30.78
Total Inflow	56.48	37.00	36.80	36.23	35.70	35.66	35.15	34.67	34.78	33.95
Net Cash Flow	-46.13	37.00	36.80	36.23	35.70	35.66	35.15	34.67	34.78	33.95
Project IRR for Term Loan Period	79.3%									

Conclusion: The project is viable and profitable.

PROJECTED PROFITABILITY STATEMENT :

AS ON 31ST MARCH	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Months of operation	12	12	12	12	12	12	12	12	12	12
Installed Capacity (MW)	66	66	66	66	66	66	66	66	66	66
PLF	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%
Gross Generation at Assumed PLF (MU)	537.69	537.69	537.69	537.69	537.69	537.69	537.69	537.69	537.69	537.69
Less: Auxiliary Consumption	48.39	48.39	48.39	48.39	48.39	48.39	48.39	48.39	48.39	48.39
Less: Transmission loss	9.79	9.79	9.79	9.79	9.79	9.79	9.79	9.79	9.79	9.79
Net energy delivered (MU)	**479.51**	**479.51**	**479.51**	**479.51**	**479.51**	**479.51**	**479.51**	**479.51**	**479.51**	**479.51**
Tariff (Rs/Unit)	5.65	5.71	5.76	5.82	5.88	5.94	6.00	6.06	6.12	6.18
Sales revenue from Power (Rs. Crores)	**270.92**	**273.63**	**276.37**	**279.13**	**281.92**	**284.74**	**287.59**	**290.47**	**293.37**	**296.31**
OPERATIONAL EXPENSES (RS. CR.)										
Fuel Cost	137.23	143.94	150.65	157.36	164.07	170.78	177.49	184.19	190.90	197.61
O&M Charges	18.82	19.20	19.58	19.97	20.37	20.78	21.19	21.62	22.05	22.49
Water Charges	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Secondary Fuel Charges	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
Total Cost	**107.74**	**109.89**	**112.09**	**114.33**	**116.61**	**118.94**	**121.32**	**123.74**	**126.21**	**128.74**
PBDIT	**114.53**	**110.15**	**105.80**	**101.46**	**97.14**	**92.85**	**88.57**	**84.32**	**80.08**	**75.87**
Interest on Term Loans	28.86	29.54	25.86	22.17	18.46	14.78	11.08	7.38	3.70	0.47
Int. on Working Capital	0.84	0.89	0.94	1.00	1.05	1.10	1.16	1.21	1.26	1.32
Sub-Total	**29.70**	**30.43**	**26.80**	**23.17**	**19.51**	**15.88**	**12.24**	**8.59**	**4.96**	**1.79**
Depreciation	20.02	20.02	21.89	21.89	21.89	24.35	24.35	24.35	27.33	27.33
Preliminary Expenses w/off (Rs. Crores)					0.00					
Profit before Tax	64.81	59.71	57.11	56.40	55.74	52.62	51.98	51.38	47.78	46.74

PROJECTED PROFITABILITY STATEMENT :

AS ON 31ST MARCH	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Profit before Tax (Rs. Crores	64.81	59.71	57.11	56.40	55.74	52.62	51.98	51.38	47.78	46.74
Provision for Tax (Rs. Crores)	12.96	11.94	11.42	11.28	11.15	10.52	10.40	10.28	09.56	09.35
Profit after Tax (Rs. Crores)	51.85	47.77	45.69	45.12	44.59	42.09	41.58	41.10	38.23	37.39
Cash Accrual	71.87	67.78	67.58	67.01	66.48	66.44	65.93	65.45	65.56	64.73

BREAK EVEN ANALYSIS

AS ON 31ST MARCH	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Total Sales	270.92	273.63	276.37	279.13	281.92	284.74	287.59	290.47	293.37	296.31
Total Variable Costs	137.75	144.51	151.26	158.02	164.78	171.53	178.29	185.05	191.79	198.55
1. Fuel Cost	137.23	143.94	150.65	157.36	164.07	170.78	177.49	184.19	190.90	197.61
2. Interest on Working Capital	0.84	0.89	0.94	1.00	1.05	1.10	1.16	1.21	1.26	1.32
3. Water & Secondary Fuel Charges	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
Contribution	132.51	128.46	124.44	120.43	116.46	112.52	108.60	104.72	100.87	97.04
Total Fixed Costs	67.70	68.75	67.33	64.03	60.72	59.91	56.62	53.35	53.08	50.30
1. O&M Costs	18.82	19.20	19.58	19.97	20.37	20.78	21.19	21.62	22.05	22.49
2. Interest on Term Loan	28.86	29.54	25.86	22.17	18.46	14.78	11.08	7.38	3.70	0.47
3. Depreciation	20.02	20.02	21.89	21.89	21.89	24.35	24.35	24.35	27.33	27.33
4. Preliminary & Pre-Operative Expenses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Break Even (%) at Operating Capacity	51%	54%	54%	53%	52%	53%	52%	51%	53%	52%
Break Even Sales at Operating Capacity	138.41	146.45	149.54	148.41	146.99	151.60	149.94	147.97	154.40	153.58
Cash Break Even (%) at Operating Capacity	36%	38%	37%	35%	33%	32%	30%	28%	26%	24%
Cash Break Even Sales at Operating Capacity	97.48	103.81	100.92	97.67	94.00	89.98	85.46	80.43	74.89	70.11
FUEL CONSUMPTION										
Gross Generation	537.69	537.69	537.69	537.69	537.69	537.69	537.69	537.69	537.69	537.69
Fuel Consumption	0.43	0.38	0.34	0.30	0.26	0.21	0.17	0.13	0.09	0.04
Annual Consumption(tons)	228,718	205,847	182,975	160,103	137,231	114,359	91,487	68,616	45,744	22,872
Fuel(Bamboo) Consumption (KG/KWH)	0.00	0.06	0.13	0.19	0.25	0.32	0.38	0.44	0.51	0.57
Annual Bamboo Consumption(tons)	0	34,054	68,107	102,161	136,214	170.268	204,322	238,375	272,429	306,483

BREAK UP OF COST OF GENERATION – RS/KWH

BREAK UP OF COST	1	2	3	4	5	6	7	8	9	10
Fuel Cost	2.86	3.00	3.14	3.28	3.42	3.56	3.70	3.84	3.98	4.12
Weightage	67%	68%	69%	71%	73%	74%	76%	77%	78%	79%
O&M Charges	0.42	0.43	0.44	0.45	0.46	0.47	0.48	0.49	0.50	0.51
Weightage	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Interest on Term Loan	0.60	0.62	0.54	0.46	0.38	0.31	0.23	0.15	0.08	0.01
Weightage	14%	14%	12%	10%	8%	6%	5%	3%	2%	0%
Depreciation	0.42	0.42	0.46	0.46	0.46	0.51	0.51	0.51	0.57	0.57
Weightage	10%	9%	10%	10%	10%	10%	10%	10%	11%	11%
Gross (Gen) Cost	4.31	4.47	4.58	4.65	4.72	4.85	4.92	4.99	5.13	5.21
Net Export Cost	4.30	4.46	4.57	4.64	4.62	4.84	4.91	4.99	5.12	5.20

AVERAGE NET COST OF EXPORT TO GRID = RS.4.78/KWH

FITZROY
ENERGY & MINERALS

L. M Complex, 6th Foor,
Room no:13, Purana Bazar,
Dimapur, Nagaland

consulting@fitzroy.in