SURYACHAKRA GREEN FUELS PRIVATE LIMITED

DETAILED PROJECT REPORT

FOR

2.28 MW BIOMASS BASED

POWER PROJECT AT ANDAMAN & NICOBAR

ISLANDS

NOVEMBER 2012

PROJECT CONSULTANT:

AQUATHERM ENGINEERING CONSULTANTS
(INDIA) PRIVATE LIMITED,
CHENNAI 600 004,
INDIA.

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SECTION – 1

INTRODUCTION

1. INTRODUCTION

1.1. ABOUT THE PROJECT

1.1.1. **M/s. Suryachakra Green Fuels Private Limited (hereinafter referred to as SGFPL), proposes to set up biomass based power generation plant at at Mithakhari village, Ferrargunj Tehsil in South Andaman Islands.**

1.1.2. **SGFPL is a professionally managed company promoted by well qualified people who have several years of experience in creating power generation projects using renewable energy sources.**

1.1.3. **There has been a deficit power situation in the union territory of A&N Islands. With depleting fossil fuels, the renewable source of energy has gained importance worldwide. The A&N Government has been encouraging setting up of mini power plants based on the usage of renewable sources. Keeping in view the deficit situation for power and encouragement given by Government for setting up of renewable energy projects.**

1.1.4. **In view of the above, M/s. Suryachakra Green Fuels Private Limited proposes to establish 2.28 MW Biomass based Power Project in Andaman & Nicobar Islands**

1.1.5. **Based on the availability of biomass (Coconut, arecanut, red oil palm, cashenut, cereals like paddy, maize, pulse, napier grass and wood chips) with in 50km radius from the site. The estimated availability of surplus biomass is 1,83,000 Ton, which is much more of the annual biomass requirement for the 2.28 MW plant. The annual biomass fuel requirement for proposed 2.28 MW plant is estimated at 18,754.56 MT/year**

1.1.6. **The power will be evacuated to 33 / 11 kV through generator transformer.**

1.2. PREFACE

1.2.1. **Today, most of the regions in the country are plagued with power shortages leading to erratic and unreliable supply. The problem becomes acute during peak hours and thus necessitates planned load shedding by many utilities to maintain the grid in a healthy state. The all India average shortages during 2001-2002 were 7.8 percent in terms of energy and 13 per cent in terms of peak load. Based on the projections of demand made in the 16th Electric Power Survey, additional generation capacity of over 1,00,000 MW needs to be added to ensure 'Power on Demand by 2012. This amounts to nearly doubling the existing capacity of about 1,00,000 MW. In other words, the achievements of more than five decades need to be replicated in the next decade. Apart from massive resource mobilisation, the task of identifying a basket of techno-economically viable and environmentally sustainable projects in it is a daunting challenge. India is endowed with vast energy resources, both conventional and non-conventional Meeting the additional capacity demand of over 1,00,000 MW requires taking advantage of all economically viable sources of energy in an optimum manner within the energy mix. In the new millennium, environment compulsions on one hand and the need to achieve energy security on the other demand thrust on development power from non-conventional resources. The Ministry of New and Renewable Energy has recently announced a National Renewable Energy Policy. The policy envisages capacity addition of 10,000 MW during the time-frame 2002-2012.**

1.2.2. **Fossil fuels and hydro-electricity will continue to play a dominant role in the country's energy sector in the next few decades. However, fossil fuel resources are limited, and nonrenewable energy sources, therefore, need to be used prudently. At the same time the existing technologies of production, transmission and distribution of electricity as well as end-use have inherent inefficiencies. It is, therefore, imperative to diversify the country's energy supply. The future requirements of electricity are likely to be for decentralised, people-managed systems. This would, however, call for a major transition in terms of technologies, organisation and attitudes. Renewable energy is seen as an effective option for ensuring access to modern energy services. In addition, it also provides a degree of national energy security.**

1.2.3. **Today India is in the forefront of international effort to harness renewable energy resources and has one of the largest and most broad-based programmes in non-conventional energy. There is significant potential in India for generation of power from renewable energy sources such as wind, small hydro, biomass and solar**

energy. Special emphasis has, therefore, been given on the generation of grid quality power from renewable energy sources.

1.2.4. **Over 3700 MW of power generating capacity based on renewable energy sources has already been installed in the country. This constitutes about 3.4 percent of the total installed capacity. This has largely come about through private investment The Prime Minister has already announced a goal of 10 per cent share for renewable, or 10,000 MW, in the power generating capacity to be added in the next twelve years. The notable initiatives include a biomass resource assessment programme with a view to bringing out a Biomass Resource Atlas for India; a programme to identify fast track projects and accelerate their financial closure.**

1.2.5. **As per the 16th Electric Power Survey of India conducted by CEA, New Delhi and published during September 2000 the projected power requirements for A & N Islands is detailed below;**

Categories	**2001-02**	**2002-03**	**2003-04**	**2004-05**	**2006-7**	**2011-12**	**2016-17**
	----------**Estimated**----------						
Energy							
Consumption(MU)	119.31	130.48*	142.41	157.00	236.00	374.00	591.00
Requirement(MU)	148	161	176	194			
Demand							
Peak Load (MW)	31	33	37	40	49	70	111
Capacity required (MW)	44	47	53	57	70	100	158

1.2.6. **To meet the energy requirement as detailed above, present development model for generation of power followed so far has been based on excessive consumption of conventional fossil fuels, diesel. Dependence on this model has endangered the environment and ecology with disastrous consequences to natural resources and has proved to be highly expensive and unviable. It is estimated that, at this rate well before the end of the new millennium the world will run out of conventional source of energy. Environmental degradation, socio economic pressures and geo political tilts would only aggravate the situation. Already the impact is visible in the peak atmospheric pollution leading to climate change as manifested in global bio diversity and ecology of different regions**

1.2.7. **It is in the above background, the renewable sources of energy have attracted global attention and evoked interest among planners, policy makers, economists and environmental activists as a viable option to achieve the goal of sustainable development. If the current interest in renewable source of energy gets concretized into projects to tap their enormous potential, the energy generation in 21st century can be expected to move away from fossil fuels.**

1.2.8. **The commitment has been received from all nations in the Kyoto Protocol to pursue the goal of sustainable economic development. Following this the MNCs and Multilateral agencies like World Bank and Asian Development Bank have pledged to provide resources necessary to achieve the goal. Carbon free energy technologies, which do not depend on fossil fuels, are emerging as viable commercial proposals and gives exciting opportunities for potential investors**

1.2.9. **The Ministry of Power (MoP), Ministry of New and Renewable Energy (MNRE) and Government of Andaman & Nicobar have decided to promote biomass based sources of energy, recognizing the need to explore alternatives to fossil fuels, socio-economic aspects and the environmental benefits associated with such Projects. Andaman & Nicobar energy scenario calls for the optimum management of all available resources in order to attain the national goals of development and social equity. A well-balanced energy mix, in which all energy resources are utilised on the basis of their economic value and environmental costs, is essential for sustainable development Renewable energy resources are non-depleting, can effectively meet energy demand and are environmentally benign.**

1.2.10. **Biomass based Projects offer several other benefits such as avoided use of fossil fuels, modular nature and efficient generation of heat and power, improved local and general security of supply, increasing cost effectiveness, and reduced need for waste disposal. The environmental benefits associated with these projects include reduction in greenhouse gases and protection of the ozone layer.**

1.2.11. **Since biomass fuels will be used in this power plant, this plant qualifies for MNRE subsidy on capital cost and interest on loan.**

This plant will also qualifies for CDM benefits, since the biomass fuels will be used instead of fossil fuels, thereby generate carbon credits.

1.2.12. **PROMOTERS**

M/s. Suryachakra Green Fuels Private Limited [SGFPL] was promoted by Sri S.M. Manepalli & Associates.

Dr. S. M. Manepalli hails from an agricultural and business family from Bhimavaram, West Godavari District, Andhra Pradesh and is a qualified medical doctor. During the period 1974-87, he was engaged in the rice milling business and operated 6 rice mills belonging to the family. He had served as the President of Bhimavaram Rice & Oil Merchants Association during 1983-87. He had also operated Deep-sea Foreign Fishing Vessels on Charter basis during 1987-92.

Since 1992 he was engaged in Aqua-culture Business. During this period he was also engaged in Construction & Operation of Prawn/Fish Tanks, Hatchery, Feed Mill & Processing Plants

Inspired by the liberalization policies of Govt. of India, during 1995 he diversified his business interests by setting up power generation plants following the privatization of power sector. He promoted Suryachakra Power Corporation Limited (SPCL) for setting up of 20 MW power plant in A & N islands.

At present, Suryachakra Group has been operating 4 units of 10 MW biomass power plants at various places in India.

Mr. M. Seshavatharam is a graduate in commerce. He hails from business community. He has to his credit varied business experience. He has gained experience particularly in power projects, agriculture and fresh water fish culture. He is the Director on the Board of M/s. Suryachakra Power Corporation Limited, a company which established a 20 MW Independent Power Project at Port Blair in Andaman & Nicobar Islands. He is also a Director in various other Companies whose main business is generation of Power.

Mr. K. Vijay Kumar is Bachelor of Engineering (Electrical). He had worked in APSEB/ APGENCO as Asst. Engineer to Superintending Engineer. He has over 30 year of experience.

Mr. K. Satyanarayana is a graduate in engineering and having rich experience in **development** of power projects and engineering related projects. He has over all experience of 30 years in various fields. He had worked with reputed firms in India. He also worked in Malaysia and Singapore for several years in engineering related projects

1.2.13. **About the Consultants**

Aquatherm Engineering Consultants (India) Pvt. Ltd., is engaged in the consultancy services for various types of power plant in India and abroad. The field of operations involved offering total consultancy services right from project feasibility stage to performance testing stage.

The Company offers services like preparation of feasibility report, Detailed Project Report, Preparation of detail technical specification for the equipment to be procured, preparation of detail engineering drawings wherever required by the client, purchase management and project management.

The company assists the client in floating of tenders for procurement of major equipment and helps them in evaluating the offers to arrive at the best choice. Wherever necessary detailed engineering, drawings are prepared on behalf of the client for the equipment, which are to be directly procured by them.

The company offers necessary support to the client in project monitoring in order to complete project on schedule and co-ordinate the activities with the main equipment suppliers to achieve the guarantee performance figures. The Company is involved in the above mentioned activities in thermal power plant namely coal based, combined cycle plant, engine based power plant, Bagasse fired sugar biomass plants, biomass based and Hydro power plant.

Company had successfully relocated 63.75 MW coal fired thermal power plant from South Africa to Chennai, Tamil Nadu. The plant has been running satisfactorily from 1999 with a PLF of 95% plus. Aquatherm is also currently executing biomass power plant in Tamil Nadu with capacity ranging from 5 MW to 18 MW. Aquatherm is executing a 60 MW Combined Cycle Power Plant using natural gas as fuel in Tamil Nadu.

Aquatherm Engineering has built up substantial experience in power plant engineering, having been responsible for over 450 electric generating plants completed or in progress, with a total value of engineering projects handled over Rs.7000 Crores

Power Generating Experience

Steam Power Plants	-	36 nos. upto 660 MW rating
Overseas Projects	-	23 nos. upto 190 MW rating
Biomass Projects	-	19 nos. upto 22 MW rating
Cogeneration Projects	-	12 nos. upto 27.3 MW rating
Gas Turbine	-	7 nos. upto 59 MW rating

SECTION – 2

EXECUTIVE SUMMARY

2. EXECUTIVE SUMMARY

- Project : 2.28 MW Biomass Power Project

Location

- Plant : Mithakhari village, Ferrargunj Tehsil
- union territory : Andaman & Nicobar
- Promoters : Suryachakra Green Fuels Private Limited., Hyderabad.
- Report Prepared by : Aquatherm Engineering Consultants (India) Pvt. Ltd., Chennai.

The scope of this detailed project report includes the following:

- Justification for installation of a power project at Mithakhari village, Ferrargunj Tehsil, Andaman & Nicobar Islands.
- Confirmation regarding the maximum power generation capacity possible, considering the quantum of Biomass / alternate fuel availability for sizing the Turbo-alternator
- Basic design of all main and auxiliary systems based on selection of optimum alternatives / configurations.
- Preparation of plant overall layout covering all buildings and equipment.
- Proposals for meeting the pollution control board norms.
- Outline of project implementation plan.
- Plant operation philosophy and manning schedule for Operation and Maintenance.
- Preparation of capital cost estimate and financial analysis.
- The tariff fixed by Andaman & Nicobar Government for purchase of power from biomass based power plant is Rs. 9.81 per unit. The same is considered for the financial calculations.
- The power plant will use Coconut, arecanut, red oil palm, cashenut, Hybrid Napier Grass, cereals like paddy, maize, pulse, napier grass and wood chips. The annual requirement will be approximately 18,754.56 MT/year. The availability of biomass in the area covering 50 kms radius is more than 183,000 tons.

- The water requirement of the plant will be 6.74 m^3/hr. The water requirement will be met from the bore wells to be dug in the project site.
- The generated power will be exported to grid through 33 kV lines. The power will be evacuated to the Electricity Department sale through UT grid by stepping-up the generated power to 33 KV.
- The project cost works out to Rs.1495.18 lakhs including interest during construction and working capital margin.
- The promoters are contributing Rs 448.55 lakhs of the project cost as equity and the balance Rs 1046.63 lakhs will be met by term loans from financial institutions.
- The moratorium is considered as 18 months including construction period
- The results of the financial analysis are as follows:

IRR– Internal rate of return	: 14.54 %
DSCR (debt service coverage ratio)	: 1.40
Payback period	: 7 years
Return on equity	: 19 %

- The project is techno economically viable, based on the various technical and financial analyses for generating power using biomass, and it is recommended to implement the project.

SECTION 3

PROJECT AT A GLANCE

3. PROJECT AT A GLANCE

3.1. PLANT DETAILS

- Name of the plant : 2.28 MW Biomass Power Plant., Andaman & Nicobar.
- Site Address : Mithakhari village, Ferrargunj Tehsil, Andaman & Nicobar Islands

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3.2. TECHNICAL DETAILS OF THE PLANT

Boiler data:

Boiler capacity at MCR (100% load)	:	12.50 tons / hr
Steam pressure at Superheater Outlet	:	44 Kg/sq.cm (a)
Steam temperature at Superheater outlet	:	450 Deg C
Design fuels	:	Coconut, arecanut, red oil palm, cashew nut, Hybrid Napier Grass, cereals like paddy, maize, pulse and wood chips

Turbo generator data:

Rated capacity of the turbine	:	2280 kW
Steam pressure at the TG inlet	:	42 kg/sq.cm (a)
Steam temperature at the TG inlet	:	445 Deg. C
Type of turbine	:	Bleed cum condensing
Generator voltage	:	11 kV
Condenser type	:	Air Cooled

Water:

Water sources	:	Ground water.
Water requirement	:	6.74 m^3/hr

Power evacuation:

Voltage	:	33 kV
Nearest Substation	:	Garacharma
Fuel handling	:	Series of Belt and Slat Conveyors

Ash handling

Bottom ash	:	Manually handled
Fly ash	:	Dense Phase Ash Handling System
Chimney	:	Steel
DM plant capacity	:	1.5 m^3/hr
Biomass proposed to be used	:	Biomass from Coconut, arecanut, red oil palm, Hybrid Napier Grass, cashenut, cereals like paddy, maize, pulse and wood chips. Densification of the above material in to Pellets & Briquettes. Backward integration of biomass
Yearly consumption in Tons	:	1st year – 16,410.24 MT/year 2rd year onwards – 18,754.56 MT/year
Radius of Collection	:	Largely Andaman Group of Islands. A&N Islands
Fuel GCV	:	3800 kcal/kg
Cost of Biomass Rs./MT	:	4850 (Total Fuel price Rs.5338/MT)
Supplementary fuels	:	Diesel
Operating Hours	:	7920 hours with PLF 70% on 1st year, 7920 hours PLF 80% on 2nd year onwards

Electricity output

a. Auxiliary consumption	:	14 %

b. Exportable Power	:	1st year 110.88 lakhs kwh 2nd Year 126.72 lakhs kwh
Financing	:	Debt Equity ratio – 70:30
Equity : 448.55		
Debt : 1046.63		

3.3. EXCERPTS FROM BIOMASS ASSESSMENT REPORT

3.3.1. Availability of Biomass Fuel in the Command Area

M/s. Aquatherm Engineering Consultants India (P) Ltd., a reputed renewable energy consultants conducted biomass resource assessment study in the islands and locations surrounding the proposed plant location at Mithakhari village, Ferrargunj Tehsil in South Andaman Islands and assessed the availability of surplus biomass residues consists of Coconut, arecanut, red oil palm, Hybrid Napier Grass, cashenut, cereals like paddy , maize, pulse and wood chips.of 1,83,000 MTs. It may be noted that in the islands, the length of the Andamans is 467 km with an average width of 24 km, whereas the maximum width is 52 km. The length of the Nicobar Islands is 259 km with a maximum width of 58 km. The estimated availability of surplus biomass is 1,83,000 MTs, which is much more of the annual biomass requirement for the 2.28 MW plant.

Therefore, the available source of biomass was considered as Andaman & Nicobar Islands.

However, it may be noted that most of the population is settled in and around Port Blair.

1. Major sources of biomass are the agricultures are a significant source only in certain areas, especially in the Nicobar group of islands.
2. The difficulty, however, in the case of the above biomass, is unlike in the mainland, where these wastes have some commercial value and therefore a collection, transporting and a trading channel, none exists in these islands. Therefore, a mechanism to collect these wastes is required.
3. In addition, any collection mechanism has to take into account accessibility of the area or island. However, in general, biomass from agriculture is concentrated in a narrow area within an island.
4. In Great Nicobar, where some potential exists for using the biomass generated from coconut and arecanut plantations, the farmers and traders are more interested in copra dryers than in producing power from waste.

A detailed assessment of the identified sources of biomass generation – agriculture, plantation and timber cuttings and saw dust has been made. The surplus biomass availability has been ascertained from the following observations:

Surplus Biomass Availability all Sources

S.No	Source	Quantity [MTs]
1	Crop residue	57135
2	Paddy husk	5832
3	Coconut fronds	56610
4	Coconut husk	40000
5	Coconut shells	10680
6	Arecanut	2589
7	Timber lops /saw dust	10320
	Total	**1,83,166**

About 1.1 to 1.4 kg can be converted into 1 unit of power generation. Therefore, the available surplus biomass of 1,83,166 MTs can support a power generation unit of an installed capacity of 17.5 MW. Based on the estimates Suryachakra Green Fuels Pvt. Limited proposes to install 2.28 MW biomass based power plant in the islands by supplementing the biomass with the following net fuel ratio:

Particulars	**% Net Fuel Ratio by weight**
Bio mass	98.7%
Diesel	1.3%

The woodchips may be imported from main land or from neighboring countries such as Malaysia, Indonesia etc. Therefore, it may summarize that the availability of biomass is not a constraint for the setting up of a 2.28 MW biomass power plant at Mithakhari village, Ferrargunj Tehsil in South Andaman Islands. The cost of biomass collection, dealer commissions and transportation to the site has been estimated to be Rs.5250 per MT. The estimation of fuel requirement based on 1.1 to 1.4 Kg of fuel per unit of power generation has been arrived as Rs.9.81 per unit generation.

SECTION 4

SALIENT FEATURES OF THE SITE

4. SALIENT FEATURES OF THE SITE

4.1. SITE LOCATION

The proposed biomass based plant at Mithakhari village, Ferrargunj Tehsil in South Andaman Islands.

4.2. METEOROLOGICAL DATA

Height of the plant above MSL	:	meters
Maximum daily mean temperature	:	32 ºC
Minimum daily mean temperature	:	22 ºC
Maximum temperature recorded on a day	:	33 ºC
Minimum temperature recorded on a day	:	21 ºC
Max. Relative Humidity	:	87 %
Min. Relative Humidity	:	74 %
Range of average rainfall received per year	:	3176 mm
Nearest substation	:	Garacharma

4.3. WIND AND SEISMIC DATA

Basic wind speed as per IS 875 Part III

Seismic zone as per IS 1893

4.4. WATER SOURCE

Water is taken from the bore well in the plant site. The biomass power project will require about 6.74 m^3/hr. of water for normal plant operation.

4.5. FUEL

The main fuel for this Biomass based project will be Coconut, arecanut, red oil palm, cashenut, Hybrid Napier Grass,cereals like paddy, maize, pulse and wood chips. Availability of biomass with in 50km radius from the site is 1,83,000 MTs per annum. SGFPL can collect the required quantity of biomass from the command area.

4.6. POWER EVACUATION

The power generated from the Biomass power plant will be exported to Electricity Department of A&N Government through the 33 kV grid.

SECTION 5

SELECTION OF MAIN PLANT AND MACHINERY

5. SELECTION OF COMBUSTION TECHNOLOGY

A thermal steam power plant continuously converts energy stored in fuels (fossil / biomass) into mechanical energy and ultimately into electrical power. Water is used as the working medium to carry energy released by fuels and to convert the energy into mechanical energy.

Upon transfer of energy released by fuels, water becomes high pressure and high temperature steam, which is a very potential pack of thermal energy and is ready to do any mechanical work. High potential steam exerts a mechanical force if passed against an obstruction. Same principle is used in conversion of thermal energy into mechanical energy in which the high pressure and high temperature steam is continuously passed on to a series of obstructions in a guided manner and the forces exerted by steam on each obstruction collectively forms the source of mechanical energy. After doing work steam becomes expanded to a low pressure and low temperature steam and finally condenses into water. Thus, energy acquired by the water is transferred into mechanical energy. The mechanical energy generated by the working medium is converted into electrical power according to Faraday's laws of electromagnetism.

5.1. MACHINERY REQUIRED FOR DIRECT COMBUSTION TECHNOLOGY

Combustion of fuels, release of energy and energy transfer to the working medium i.e. water takes place in the Boiler. Hence, the boiler requires fuel as input material and delivers high pressure and high temperature steam. Thermal energy in the form of steam is converted in to mechanical energy in the Steam Turbine. Electrical power will be generated in the Alternator / Generator utilising mechanical motion of the steam turbine. Hence, the proposed power plant mainly consists of the following elements.

A **BOILER UNIT**, which converts the energy available in fuels into thermal energy,

A **STEAM TURBINE UNIT**, which converts potential thermal energy into mechanical energy,

An **ALTERNATOR UNIT** which converts mechanical energy into electrical power. Apart from the above main equipment, number of other equipments as listed below are also form part of the power plant.

- Fuel and ash handling systems
- Air Cooled Condenser
- Aux Cooling Water system including Cooling tower

- DM Water system and Air Compressor Plant
- Electrical systems and Instrumentation system
- Miscellaneous supporting machinery as required

5.2. PROCESS FLOW OF THE POWER PLANT

Raw fuel from the collection points will be transported to the power plant, where fuel will be weighed and stored in fuel storage yard near boiler house. Fuel will be screened/ chipped/shredded and then conveyed to fuel bunkers located near the Boiler unit from where it will be fed to the boiler by Screw / Rotary feeders. Quantity of fuel fed to boiler will be controlled by variable frequency drives depending on steam requirements for the power plant.

Fuel fed into the boiler will be burnt directly in the combustion chamber / furnace of the boiler through combustion air from the Forced draught fan to generate high pressure and high temperature steam. Steam generated by boiler will be supplied to steam turbine where all the thermal energy available in the high pressure steam will be converted into mechanical energy. Steam gets expanded over a series of specially profiled blades attached to a cylindrical rotor thus creating a rotary motion. Steam turbine is coupled to a Generator for converting mechanical energy into the electrical energy. Power generated at the terminals of the generator will be evacuated and connected to the grid through a series electrical equipment like Transformer, Switch yard, Control gear and protection systems etc.

The high pressure & high temperature steam after utilizing the thermal energy in the steam turbine becomes low pressure and low temperature steam with a small amount of remaining thermal energy. In between one uncontrolled extractions will be at 3.5 ata for Deaerator respectively. The final low pressure steam will be condensed in the Air cooled condensing system. Air is blown over the finned tubes carrying the steam which is condensed by cooling. Condensing system includes an Air Cooled condenser, condensate extraction pumps, steam ejectors etc. The condensate will be collected in the condensate storage tank and from the storage tank condensate extraction pump sucks the condensate to send to the Deaerator cum feed water storage tank. Condensate will be re-circulated to the condensate storage tank.

Condensate will be deaerated in the Deaerator to remove all dissolved non-condensable gases and oxygen, which affect boiler performance in long run. Temperature of the condensate will also be raised in Deaerator for better boiler efficiency using the steam taken from turbine and the same will be stored in Feed water

storage tank. Feed water from the storage tank will be pumped to steam drum through economiser, by means of two numbers of boiler feed pumps of which, normally one will be working and the other will be standby. The feed water gets heated in the boiler to form high pressure and high temperature super heated steam. Thus the thermal cycle gets completed.

Combustion gases after maximum heat transfer in the boiler will be led to the exhaust stack through ESP, Induced draught fan. Ash particles remaining in the exhaust gases will be removed to the maximum extent in the ESP.

Ash generated in the boiler after burning the fuel will be collected in ash hoppers located at the bottom of the furnace, economizer, air preheater & ESP. This ash will be removed through pneumatic ash handling system to the ash silo which is also located near the boiler. Ash from ash silo through ash conditioner will be transported outside the plant using trucks. Complete system which includes pneumatic vessels, rotary air lock valves, air compressor, air receiver, ash silo, ash conditioner etc. constitutes ash handling system.

Other systems required for power plant include Auxiliaries Cooling Water System, DM Plant, Instrument air compressor system etc. Cooling water enters the various coolers provided for the auxiliaries and takes away the heat available. Heat acquired by the cooling water will be again removed in the aux. cooling tower. Two numbers of cooling water pumps will be used for pumping cooling water to the various coolers provided.

DM Water system is used to feed make up water for boiler to compensate the losses associated with boiler operation. Only treated DM water has to be supplied for better performance of the boiler and to avoid rusting of boiler heat transfer tubes. Makeup water will be regulated to the deaerator through deaerator level controller.

5.3. SELECTION OF EQUIPMENT

For a biomass power plant various factors influence the selection and sizing of the plant equipment, auxiliary equipment. Hence, for economical power generation, the following shall be considered for the biomass power plant.

- Type of biomass fuels and combustion mechanisms
- Type and size of power plant
- Thermal cycles and Steam parameters
- Cost economics of power generation
- Each of these is described below:

5.4. TYPE OF BIOMASS FUELS AND COMBUSTION MECHANISMS

As the proposed biomass power plants are located in the densely forested islands, the biomass available is in the form of Coconut, arecanut, red oil palm, cashenut, cereals like paddy, maize, pulse, wood chips or empty fruit bunches. SGFPL has considered the following fuel ratio for their proposed power plants.

Biomass : 98.70%
Diesel : 1.30%

The company proposes to import wood chips from neighboring countries Malaysia or Indonesia or from main land.

The availability of biomass for the proposed plants is summarized as below based on a biomass assessment study conducted.

Surplus Biomass Availability all Sources

S. No	Source	Quantity [MTs]
1	Crop residue	57,135
2	Paddy husk	5,832
3	Coconut fronds	56,610
4	Coconut husk	40,000
5	Coconut shells	10,680
6	Arecanut	2,589
7	Timber lops /saw dust	10,320
	Total	**1,83,166**

The composition of the fuel (Napier grass) as per the mentioned ratio is estimated to have the ultimate analysis details as given below:

ULTIMATE %Wt	Biomass
Carbon	43.51
Hydrogen	6.76
Nitrogen	0.68
Sulphur	0.13
Ash Content	9.04
Oxygen as O (balance)	39.88
TOTAL	**100.00**

Type of fuel and its characteristics influence the selection of boiler and fuel handling equipment. While selecting boiler, fuel characteristics are to be studied for their efficient combustion. Another factor, which is to be considered is multi-fuel firing capability since different fuels as indicated above will be used based on their availability. Various types of combustion mechanisms are available for burning of various fuels.

- Packed fuel bed combustion using stokers (Travelling / Dumping grate)
- Cyclone combustion
- Fluidized bed combustion
- Pulverized fuel combustion

The travelling grate type of boiler will perform effectively for burning of variety of biomass fuels & hence it is preferred. Hence travelling grate boiler is selected for this project.

5.5. TYPE AND SIZE OF POWER PLANT

Type and size of the proposed power plant also influence the size of various plant and equipment. The proposed biomass power plant is new and only an Independent power plant generating electric power and exporting the same to the grid.

Hence, the proposed biomass power plant is not required any additional systems like process steam systems other than its auxiliary consumption for deaerator.

5.6. THERMAL CYCLES AND STEAM PARAMETERS

Thermal cycle indicates the thermal processes that take place in a cyclic manner right from the combustion of fuel till generation of mechanical output. Generation of electrical power by using mechanical output from the cycle however will not be included in the cycle. Any thermal cycle is designed for getting work output from heat input and vice versa for which the basic requirement is a working fluid.

Number of thermal cycles are proposed for power generation out of which only one cycle i.e. RANKINE CYCLE is being used for almost all thermal power plants. Same cycle can be used for conventional power plants as well as biomass power plants. The variables to work with in the Rankine cycle are temperature, pressure, dryness fraction, heat quantity, quantity of work, rate of heat quantity transferred as related to the temperature at which the heat transfer takes place.

After selecting the cycle, next important task is the selection of proper steam parameters. The following aspects shall be considered while selecting the steam parameters.

- Efficiency of the thermal cycle
- Capacity of the Power Plant
- Specific steam consumption of the steam turbine
- Fuel requirement to generate the steam

It can be seen from the thermal cycle diagrams that higher steam parameters yields better efficiency and reduce the steam consumption of the turbine. Hence, requires less fuel to generate the required quantity of steam.

On the other hand, various power plant equipment like Steam turbine, boiler heat transfer elements, High Pressure heater, boiler feed pumps, process piping, valves etc. are to be selected to suit steam conditions. If high steam parameters are selected, equipment shall be designed to withstand and operate under high steam pressure and temperature conditions which require special types of materials for construction, special manufacturing processes etc. which further increase the cost of the equipment. Hence, the equipment cost is directly proportional to steam parameters.

The combinations of parameters that are being adopted in various power generating equipment are given below.

- 44 kg/cm^2 440 / 490°C For power plants of capacity less than 3 MW
- 66 kg/cm^2 490°C For power plants of capacity more than 3 MW
- 87 kg/cm^2 520°C For power plants of capacity higher than 6 MW

After considering various aspects including cost economics of the power plant, it is decided to have 44 kg/cm^2(a) / 450°C for 2.28 MW Biomass power plant due to the higher cycle efficiency and less fuel consumption. In view on the fuel that is being fired (Coconut, arecanut, red oil palm, Napier grass, cashenut, cereals like paddy, maize, pulse and wood chips) it is decided to have 42 kg/cm^2(a) / 445°C.

5.7. HEAT AND MASS BALANCE

As per preliminary thermal calculations for the proposed biomass power project, the heat and mass balance is estimated as given below.

- To generate 2280 KW of electrical power at the generator terminals, approximately 11.50 TPH of steam of 42 ata / 445°C is required at the Turbine inlet. While calculating the main steam requirement, bleed steam from the turbine is considered to meet the auxiliary steam requirements of ejectors and feed heating in deaerator.
- The exhaust steam will be condensed in ACC and pumped to the deaerator. In deaerator, the condensate will be heated to by the auxiliary steam taken from the turbine bleed.
- The condensate after raising the temperature will be fed to the boiler economiser by boiler feed pumps.
- The approximate quantity of fuel required to generate high pressure and high temperature steam at boiler outlet at 44 ata / 450°C will be around 2.96 TPH. The superheated steam from the boiler will be fed to the turbine. Depending on length of piping system between the turbine and boiler, the steam parameters at the turbine inlet are slightly less than the boiler steam parameters which are considered as 42 ata / 445 °C.

5.8. SIZING OF PLANT & MACHINERY

As already stated above, the power plant mainly consists of one number Steam turbine generator set of 2280 KW generating capacity. Steam requirements for the Turbine generator set will be met through one number Travelling grate boiler. The plant apart from STG and Boiler units, consists of various auxiliary plants and systems like DM Water system, Cooling water system, Compressed air system, Firefighting equipment, Fuel and Ash handling systems, switch gear and switch yard etc.

Based on power generation capacity of 2280 KW various equipment are sized in accordance with the standard engineering practices

The Steam Turbine considered for the power plant is of Condensing turbine with one bleeds for feed water heating in Deaerator. The steam required for the turbine to generate 2280 KW is around 11.50 TPH with inlet steam parameters of 42 kg/cm^2, 445 °C.

The power rating of the generator is 2280 KW at the generator terminals with 10% overload capacity. The speed of the generator is 1500 rpm and the generator is designed according to IEC 45 to generate electrical power at 11KV, 50 Hz, 0.8 Power factor.

Based on steam requirement for Turbine, one number 12.50 TPH boiler is selected.

The generating voltage at generator terminals is considered as 11KV. This will be stepped up to 33 kV of A&N grid level. Accordingly all other electrical equipment like grid transformer, switchyard etc. are sized.

It is proposed that the plant will be started using auxiliary power supply from the Diesel Generator Sets purchased by the promoter for supply of startup power and synchronized to the state grid. One number Diesel generator set is considered as back up facility to supply power in case of total blackout. Subsequently, all auxiliaries will be switched over to the internal power supply from the DG power supply. For this purpose, one number auxiliary transformer is envisaged to step down the generated voltage level at 11 KV to auxiliary consumption level of 415 V. It is estimated that about 280 KW at 415 V will be consumed by plant auxiliaries. The remaining 2000 KW net power is available for export to the grid at 33 kV level.

SECTION – 6

PLANT LAYOUT

6. PLANT LAYOUT

6.1. LAYOUT CONSIDERATIONS

6.1.1. Layout Design Issues

Major layout design issues, which have been considered while developing the proposed plant layout, are as follows:

- Available land for the Power Plant at site location
- Topography of the land and contour limitations
- Area requirements for various plant buildings, storage areas, admin building, miscellaneous areas, etc.
- Direction / velocities of wind.
- Likely ingress of dust on to cooling tower, transformers etc. and precautions to be taken to mitigate
- Optimum men and material movement
- Minimum length of high pressure piping
- Disposal of ash

6.1.2. Area available & Layout

The area available for locating Power plant equipment and biomass storage is about 9.8 acres. Water reservoir is located in the plant. Sufficient free space is provided for truck movement for the fuel & ash handling. The area for green belt development has been considered.

Based on the above considerations and the area requirement, the preliminary plant layout is prepared and presented in the report. The final layout will be frozen based on the detailed discussions with the chosen vendors / contractors. The required land is under acquisition from A&N Administration.

6.2. ASH, EFFLUENT & SEWAGE DISPOSAL

6.2.1. Ash

At 100% capacity utilization of the proposed bio mass power plant, annual ash generation is 1125 TPA. This ash will be collected in silos and given to the nearby users for manufacturing bricks.

6.2.2. Effluent

Waste water from a bio mass power plant does not have any significant BOD / COD level. The levels of liquid effluent and their treatment have been detailed in the subsequent chapters.

6.2.3. Sewage

All sewage will be collected in a common septic tank and discharged as per accepted norms.

6.3. PLANT LAYOUT

6.3.1. General

The project are located at Mithakhari Village, Ferrargunj Tehsil in South Andaman Islands. These are nearer to Port Blair, where the majority of the population of the A&N Islands is concentrated. There are various Government Departments, hospitals, schools and banks, which are established in and around Port Blair.

6.3.2. Layout of Major Outdoor Equipment

The boiler will be designed for outdoor operation. The boiler will include an electro-static-precipitator and a steel chimney. The self-supporting chimney will satisfy the environmental norms and height of chimney is 35 meters.

The Fuel will be fed to the boiler via the conveyor system.

Ash handling will be Pneumatic handling system. Ash from furnace bottom, Air Preheater, Economiser and ESP will be separately conveyed to the silos by pipes.

All water and storage tanks will be located outdoors. The tanks will be field erected and constructed of carbon steel typically with an exception of DM tank, which will be epoxy coated carbon steel. The tanks will be located to allow for optimal arrangements of piping and will be accessible by road.

The air cooled condenser & its auxiliaries will be located outdoors.

The aux cooling tower and the cooling water pumps will be located outdoors.

6.3.3. Biomass Power Plant Layout

The powerhouse will be approximately 26 m X 15 m in size, it will house the steam turbine generator and its auxiliaries, the control room, the boiler feed pumps, the electrical equipment room (distribution transformers, switchgear, motor control centres), battery room, etc.

The boiler and its auxiliaries will be located in an area of about 27 m X 8 m (Including bunker, fan, etc) Biomass will be fed through a fuel handling system from the open storage yard.

The Air Cooled Condenser will be located in line with the turbine and will be located outdoors.

It will require a space of about 19 m X 9 m. All the required auxiliaries will be located adjacent to the ACC.

The makeup water for the boiler is supplied from a DM plant and DM storage tank. The dry ash from boiler bed, Economizer & ESP will be conveyed pneumatically to the ash silo. Ash will be collected in silos and dispatched through trucks or trolleys.

Proper air conditioning will be provided for the control room. For all other areas adequate ventilation system will be provided. Special precautions will be taken for air intake and exhaust for the emergency diesel area and for the battery room.

A suitable capacity overhead crane with a suitable capacity auxiliary hook will be provided over the turbine generator bay. Its capacity will be adequate to provide lifting capability to meet the needs of all steam turbine generator components. Roll up doors will be located in the steam turbine area and the condenser area, to provide access for maintenance. Single and double doors will also be provided throughout the building for personnel access and maintenance of smaller equipment.

6.4. APPROACH & INTERNAL ROADS

The site is located near to State highway. However approach road & bridges are to be built. Required internal roads for movement of men and material will have to be constructed within the plant area. The cost for this has been provided in the financials.

An administrative office, staff quarters, Switch Yard, security office, weigh bridge & toilet blocks are located suitably. The operating engineers will be stationed at 5 m level in the powerhouse.

Tentative locations of the Power plant equipment are shown in Preliminary Plant Layout.

The steam turbine generator will be supported on a reinforced concrete pedestal. The building superstructure will be RCC construction. Pitched roof will be provided to facilitate drainage.

Control room will be in brick wall construction and the walls will be plastered. The building structure will also be used to support piping, cable trays, conduits, etc. Suitable coating materials will be used for interior and exterior surfaces. A special coating will be provided in the acid / caustic soda storage area and battery room. The site area does not have a high percentage of humidity and as such a suitable exterior coating may last for ten years after which the building will be repaired.

SECTION - 7

DESCRIPTION OF MECHANICAL SYSTEMS

7. DESCRIPTION OF THE MECHANICAL SYSTEMS

7.1. GENERAL DESCRIPTION

The proposed power plant will consist of 1 no. high pressure travelling grate type Boiler of 12.50 TPH capacity with steam parameters at 44 ata, 450 Deg. C and 1 no. bleed cum condensing steam turbine with a nominal capacity 2.28 MW. The steam pressure at the inlet of the turbine will be 42 ata and temperature 445 Deg. C.

Apart from the boiler and turbo generator, the Biomass based power plant will consist of fuel handling system, boiler feed water system, Air cooled condenser system, electrical system, power evacuation system, control system, utilities like compressed air system, ash handling system, fire protection system etc.,

7.2. BOILER SYSTEM

7.2.1. Boiler

The boiler will be designed for firing Coconut, arecanut, Hybrid Napier Grass, red oil palm, cashenut, cereals like paddy, maize, pulse , wood chips, etc., The superheated outlet steam will have a pressure of 44 ata and temperature of 450 Deg. C. The boiler will be designed for outdoor installation. The boiler will have sub systems like pressure parts, feeding system, firing system, draft system, feed water system, ESP and chimney.

7.2.2. Furnace – Water wall System

The furnace which is fully water cooled is formed by carbon steel seamless tubes of membrane wall construction connecting the respective top and bottom headers. The bottom headers for all the walls are fed with water from mud drum through down comers and bed evaporator headers. The heated water rises along furnace tubes to the top headers which in turn are connected to the steam drum by riser pipes.

Necessary provisions will be made in the furnace for admitting the required quantity of over fire air at various levels. Adequate number of inlet and outlet headers, with the necessary stubs, commensurate with the arrangement of the furnace will be provided. The down comers, supply pipes and relief tube sizing will be based on the circulation calculations.

7.2.3. Travelling grate assembly

The firing of biomass fuel will take place on the travelling grate unit. An electric drive with VFD control or an hydraulic drive will be driving the grate. The speed of the travelling grate is decided so that sufficient time is available for the fuel to burn on the grate. The main combustion air is supplied by FD fan. The hot air is admitted in the plenum below the grate. The ash remaining on the grate is dumped on one side of the furnace which is connected to the ash hopper. The temperature in the grate zone will be around 800 – 850^0 C.

7.2.4. Boiler Drums

The boiler will be provided with one steam and one water drum and drums will be of fusion welded type. Both the drums will be provided with Torispherical / Semi-Ellipsoidal dished ends fitted with 320 x 420 MM elliptical man ways at either end. The man way doors will be arranged to open inwards. The drum shell, dished ends and the man way doors will conform to SA 515 Gr. 70 or equivalent material specification. The steam drum will be liberally sized to assure low steam space loading, with adequate space to accommodate the internals. The drum design pressure will have a minimum margin of 6% over drum operating pressure.

The steam drum will be provided with internals of proven design, shall be bolted type, and of size that will enable removal through the man ways. The system of internals consisting of the primary and secondary separators will ensure steam of highest purity with dissolved silica carry over limited to a maximum of 0.02 ppm, at all loads of the boiler. All the components of the internals, except the dryer screens, shall be carbon steel and the dryer shall be of SS 304.

7.2.5. Bank Tubes

The bank design will be of inline arrangement and the tube spacing will enable easy removal of the tubes in case of any failure. The bank tubes will be expanded into both the top and the bottom drums, and the tubes after expansion will be bell mouthed. There will be adequate approach space to the tubes of the bank for maintenance.

7.3. SUPERHEATER SYSTEM

The superheater (SH) system will be of Two(2) stage design with interstage desuperheating to achieve the rated steam temperature over 60 to 100% load range. The superheater will be of convection or a combination of convection and radiation type arranged to give the minimum metal temperature. The superheater pressure drop, the inlet and outlet header sizing, arrangement and sizing of their respective inlet and take off connections will be so as to give minimum unbalance and the tube element material selection will be based on the actual metal temperature calculations.

7.4. ATTEMPERATOR SYSTEM

The attemperator system to control the temperature of the final superheater outlet steam temperature within the specified value will be provided in between the two stages of the superheaters. The interstage attemperator will be drum coil type with single 3 way control valve.

The desuperheating system will be complete with all required control valve, bypass, piping and supports, etc.

7.4.1. Economiser

The Economiser will be located immediately downstream of the boiler bank. The design will be of bare tube construction with inline, counter flow, and drainable arrangement.

The Economiser will be designed for an inlet feed water temperature of 105°C. The coil arrangement will take care of proper calculated end gaps to avert gas bypassing and the consequent erosion of the element tubes. Tubes will be of seamless type.

7.4.2. Air Heater

The Air heater will be arranged as the last heat recovery section downstream of the economizer. The Air heater will be recuperative type with flue gas flowing inside the tubes and the combustion air flowing over the tubes. The air heater will be arranged with the tubes in the vertical direction. The tubes except those required for staying purposes will be expanded into the tube sheets on both ends.

The air heater arrangement will be provided with adequate access for replacing the tubes. Considering the high moisture in the flue gases, suitable precautions should be taken to prevent the tube corrosion at the air inlet side of the air heater. The Low

Temperature bank of the Air preheater will be designed to prevent corrosion and the cold end material of the air heater tubes will be Carbon Steel.

7.5. SOOT BLOWING SYSTEM

The boiler will be provided with a complete system of soot blowers to effectively dislodge deposits from the heat transfer areas. The soot blowers will be motor operated with steam, taken from the outlet of Super heater First stage, as the cleaning medium.

7.6. FUEL FEEDING SYSTEM

The Boiler will be designed for firing Coconut, arecanut, red oil palm, cashenut, cereals like paddy, maize, pulse, wood chips and a combination of the available biomass fuels independently or in combination. The bunker will have suitable lining, inerting system, isolation gates, manholes, vibrators etc. Fuel is extracted from the bunker by drag chain feeders and fed into the bed by mixing nozzles, cross and fuel nozzles. The fuel is transported by the required number of feeders which transfer the fuel on to the travelling grate through suitable chutes.

Drag chain feeders will be provided with variable frequency drives. Isolation gates will be provided at Bunker outlets. Surge hoppers will be provided in between the Bunker chute outlet and drag chain feeders' inlet.

Fuel feeding system will be designed in such a way that there are no bends on the feed chutes. This avoids choking of fuel in the fuel line and improves the flow ability.

High pressure air from SA fan (if required) is admitted above the grate area for aiding combustion.

7.7. DRAFT SYSTEM

The draft system for the boiler will be suitable for producing a balanced draft with sub-atmospheric pressure conditions in the furnace.

The boiler will have 1 x 100% capacity Induced Draft Fan, 1 x 100% capacity Forced Draft Fan and One (1) x 100% capacity Secondary Air Fan (if required) making up the complete draft system for the boiler. The FD fan flow will be varied according to the fuel flow by a combustion control system. The ID fan will handle the flow of flue gas corresponding to 12.50 TPH of steam generation.

7.8. DUCTING SYSTEM

All ducts will be rectangular in cross section and will be of welded construction, properly stiffened. All the air ducts will be fabricated from steel plates of minimum 5 mm thick, and all flue ducts will be of minimum 6 mm thick. The duct plate material will conform to IS 2062 Gr A. Carbon steel plates will not be used for ducting system if the operating temperature of flue gas exceeds 425°C. The duct corners will be stitch welded internally and full welded on the outside.

All ducts will be suitably stiffened and reinforced on the outside and designed to withstand the pressures encountered.

Ducts will be sized considering a maximum velocity of 15 m/sec for hot air and flue gases and 12 m/sec for cold air. The duct design consideration will include the operating internal pressure, medium temperature, dead loads, ash loads, live loads, seismic loads, expansion joint reaction etc.

Dampers, in the ducting system, will be provided as required, for the proper operation of the boiler. All dampers will be of the `louver' or butterfly type with the necessary frames, shafts, blades, bearings, linkages, seals etc.

All fans will be provided with isolation dampers at the discharge ends for online maintenance.

7.9. CHEMICAL DOSING SYSTEM

The boiler will be provided with a tri-sodium phosphate based High pressure (HP) dosing system and a hydrazine and ammonia based Low Pressure (LP) dosing system. The HP dosing system will continuously add the chemical to the boiler water and to maintain the phosphate reserve and to remove silica from drum water.

The LP dosing is done to the feed water preferably in the deaerator storage tank to scavenge the traces of oxygen and to increase the feed water pH.

7.10. ESP

The boiler will be equipped with ESP, which will remove the dust and ash particles from the flue gas, before the ID fan could handle it. The efficiency of the precipitator will be 90% and the dust concentration at the outlet of the ESP will be not more than 50 mg/Nm^3 with all fields working.

7.11. CHIMNEY

The size and height of the chimney will be designed with sufficient capacity to cater to the gas flow requirement and the local pollution control norms. The height of the chimney will be about 35 Mts.

7.12. ASH HANDLING SYSTEM

The ash handling system is a dense phase pneumatic handling system. The ash handling system is used to handle fly ash. Out of the total ash generated, the bottom ash will account to about 30% while the fly ash will constitute about 70%.

7.13. BOTTOM ASH HANDLING SYSTEM

Bottom ash is the ash that is generated due to combustion of biomass on the travelling grate and will be falling into the sump for submerged belt conveyor. The bottom ash produced is handled by a submerged belt conveyor & dumped into a storage silo from which vehicle will empty the collected ash periodically for disposal.

7.14. FLY ASH HANDLING SYSTEM

Fly ash is the ash carried over by the flue gases. The separation of fly ash is mainly done in ESP, about 70% and about 20% is removed in the economizer hopper and air heater hopper.

The suitable capacity of ash silo will be sized to hold the ash generated before it is disposed.

7.15. TURBO-GENERATOR SYSTEM

7.15.1. Steam Turbine

The proposed Biomass power plant will have 2.28 MW turbo generator. The turbine will be an bleed cum condensing type and running at high speed. The generator speed will be 1500 rpm. Hence, the turbine will be coupled with the generator through a gear box, if required.

Steam is admitted into the turbine through an emergency stop valve actuated by hydraulic cylinders. The turbine speed is controlled by an electronic governing system. The extraction pressures are arrived at based on the process requirements. Accordingly, one bleed will be provided, one at 3.5 ata. The turbine exhaust pressure will be 0.13 ata.

The turbine will be preferably single cylinder, single exhaust, extraction, condensing type. All casing will be horizontally split and the design will be such as to permit examination of the blading without disturbing shaft alignment or causing damage to the blades.

The design of the casing and the supports will be such as to permit free thermal expansion in all directions.

The blading will be designed to withstand all vibrations, thermal shocks, and other loading that may be experienced during service and system disturbances. The blades will be machined from forged bars or die forged and the materials used will be chromium steels consistent with proven experience and standards.

The glands will preferably of labyrinth type and sealed with same. A vacuum system required by the design will be provided. All piping and components of shaft seal and vacuum system will be sized for 300 percent of the calculated leakage. Steam leaving the glands will be condensed in seal steam condenser. It will be possible to inspect and replace the end seals without opening the casing and without damaging the thermal insulation.

7.15.2. Bearings

The Turbine will be provided with liberally rated hydrodynamic radial and thrust bearings. The radial bearings will be split for ease of assembly, and of the sleeve or pad type, with steel shell backed, babbitted replaceable pads.

These bearings will be equipped with anti-rotation pins and will be positively secured in the axial direction. The thrust bearings will be of the steel backed babbitted multiple segment type, designed for equal thrust capacity in both directions.

A liberal flow of lube oil under pressure will be supplied to all the bearings for lubrication and cooling.

7.15.3. Lubrication and control oil system

A pressure lubrication and control oil system will be furnished for the turbo generator unit to supply oil at the required pressure to the steam turbine, gearbox, generator and governing system. Oil in the reservoir will be maintained at an appropriate temperature when the TG set is idle by providing suitable electric heaters and temperature controls.

The oil system will include the following:

- The oil system will include the Main oil pump, Auxiliary oil pump, Emergency oil pump, Control oil pump, Oil storage and settling tank, Centrifugal type oil purifier, Oil cooler and Oil filter.

7.15.4. **Oil coolers**

The oil coolers will be water-cooled with a duplicate arrangement and changeover valves. The coolers will be of shell and tube type.

The coolers will be constructed in accordance with TEMA class C. The provided surface area will be adequate to cool the oil with Inlet cooling water temperature at 32 °C even with 20% of the tubes plugged.

7.15.5. **Filters**

Full flow oil filters will be used downstream of the coolers and will be piped in a parallel arrangement with a continuous flow transfer valve. Filtration will be 10 microns nominal. Filter cartridges will be designed for minimum pressure drop and suitable for maximum discharge pressure of the oil pumps.

7.15.6. **Oil reservoir**

The interior of oil reservoirs will be de scaled and made rust proof with a permanent coating. Reservoirs with top mounted equipment will have sufficient rigidity. All openings for piping will be made dust and waterproof.

7.15.7. **Oil purifier**

A centrifugal type oil purifier will be provided for the removal of water, sediments and other oxidation products. The purifier will be a separate package.

7.16. STEAM TURBINE GOVERNING SYSTEM

The turbine governing system will be electro-hydraulic or electronic type designed for high accuracy, speedy and sensitive response. The electrical/electronic and hydraulic component of the control system will be selected on the basis of reliability over a wide range of operating conditions.

All components used will be well proven to assure overall system reliability and will be designed for easy and quick replacement when necessary. The governor will ensure controlled acceleration of the turbo generator and will prevent over speed without tripping the unit under any operating conditions including the event of maximum load rejection.

The governor will also ensure that the unit does not trip in the event of sudden frequency fluctuation in the grid and also sudden grid failure / load through off.

The governor will have linear droop characteristics with a suitable range for stable operation and will have provision for adjusting the droop in fine steps.

The governing system will have the following important functions:

- Speed control
- Over speed control
- Load control
- Steam pressure control

7.16.1. **Condensing Equipment – Air Cooled Condenser**

The condensing plant will consist of one air cooled condenser. The condenser will be designed for the maximum anticipated steam flow conditions under maximum output of turbine. Exhaust steam from the turbine is conveyed into the fin tube heat exchangers via the exhaust steam duct and the upper steam distribution ducts connected to it. The cooling air supplied by the fan flows over the fin, tube bundles and removes the heat from condensation.

The ambient temperature considered for the ACC design will be 33 Deg. C based on the meteorological data provided by the promoter of the project.

2 x 100% capacity steam jet ejectors units' along with all accessories for efficient and trouble-free operation of the unit, 2 x 100% horizontal condensate extraction pumps with, suction and discharge pipe, valves, temporary strainers, expansion joint and drive motor will form a part of the ACC package.

- Maximum heat load delivering rated 2.28 MW power.
- Cleanliness factor of 85%.
- ACC capacity shall be designed for an exhaust flow of 10.16TPH.

7.16.2. **Steam Ducting**

A carbon steel steam duct form the turbine exhaust to the ACC inlet header shall be furnished including expansion joints as required.

7.16.3. **Steam Ejector System**

Steam ejector shall be able to remove the specified quantity of dry air from the condenser shell during operation. The capacity shall be as per recommendation of the Heat Exchange Institute Standards.

Each of the condensate extraction pumps shall have 100% capacity and shall be capable of handling the full condensate during the various conditions of operation. Selection of pump capacity shall consider maximum steam flow condensed under worst back pressure plus 10% leakage through recirculation valve and various condenser drains coming to condenser.

7.16.4. **Hot well Tank**

The condenser shall be provided with a hot well made of fabricated steel having a total storage capacity of at least 5 minutes with the water level at normal operating position. Nozzles shall be provided in each half of the hot well for connecting the condensate to the pump suction pipes. Suitable strainers shall be provided at the inlet of each condensate pump. The hot well shall be provided with suitable access doors.

Hot well level shall be controlled by a control valve situated in the discharge line of the condensate pump connected to deaerator and in unison with a recirculation control valve. The hot well level control valve at condensate discharge shall be capable of controlling the flow from full extraction to zero extraction of condensate flow. Water System.

7.16.5. **Water Requirement**

Water is used as a cooling medium in the heat exchanger equipment in this power plant such as lube oil coolers, generator air coolers etc. of turbo-generator. In addition, it is used as make-up water for boiler after de-mineralization, dust suppression system in fuel storage area, dust conditioning in dry ash handling system and fire -fighting system. A small quantity of water will be required for drinking and sanitation for plant personnel.

The break-up of make-up water for various consumers are given in Table 7-1.

TABLE 7-1 – MAKE-UP WATER REQUIREMENT

Sl. No.	System	Maximum make-up water (m3 / hr)
1	Auxiliary Cooling System, Evaporation loss and Blow down	3.04
2	De-mineralised make-up water for boiler make-up	1.30
3	Drinking, sanitation & miscellaneous use	2.4
	TOTAL	6.74

The total treated effluent from the plant is expected to be about 1 m^3 / hr. and the same will be used in ash handling system and green belt development.

7.16.6. Water Source

Total plant make-up water requirement is around 6.74 m^3 / hr. and the same has to be drawn from network of bore wells in the plant.

7.16.6.1. Water Supply System

The following facilities will be envisaged to meet the power plants water requirements:

a. Make-up water, pumping and piping system of capacity 6.74 m^3 / hr. to meet the make-up water requirements of the plant

b. Softener plant of capacity 3 m^3 / hr. to cater the make-up water for auxiliary cooling

c. Auxiliary cooling water system of capacity 150 m^3 / hr. for the turbo-generator, boiler, and other auxiliary cooling loads.

d. Fire hydrant system complete with piping and hydrant accessories.

e. De-mineralised water system of 1.5 cu m/hr. to meet the make-up water requirement of boilers.

f. Drinking water system.

7.16.6.2. Water System

The water will be drawn from bore well in plant. The water will be stored in reservoir having capacity of 600 m3. It will cater for plant requirement as well as fire protection system.

The auxiliary cooling water system will consist of the following major items of equipment:

i. Two (2) electrically driven horizontal centrifugal pumps of 150 m^3 / hr. capacity (one working and one standby) with associated drive motor.

ii. A compact FRP cooling tower to cool 150 m^3 / hr. over a temperature range of 8°C - 10°C

Cold water from the cooling tower basin will be pumped by the auxiliary cooling water pumps to the auxiliary consumers in the power plants. The hot water return from the consumers will return to the cooling towers for cooling and recirculation. About 3.03 m^3 / hr. of make-up water will be added in the cooling tower basin to compensate the evaporation, drift and blow-down losses.

It is envisaged to provide for a side stream filter for recirculation of water in the Cooling Tower Basin along with necessary chemical treatment.

In order to meet the requirements of treated water for the cooling tower a softener is provided which will produce soft water .

7.17. WATER TREATMENT PLANT

To cater the make-up water requirements of the boiler, it is proposed to install a DM plant having capacity 1.5 m^3/hr. The DM plant shall have a regeneration time of 4 hours/day.

7.18. SERVICE WATER

The service water required for general wash, gardening, toilets etc., required for the power plant will be taken from the outlet of the activated carbon filter in the DM plant.

7.18.1. **Drinking Water System**

To meet the drinking water and sanitation requirement of plant personnel, the water after activated carbon filter will be and chlorinated. The water will be stored in an elevated HDPE tank of 2 cu m storage capacity, where from water will be supplied to all consuming points.

7.19. FIRE WATER & FIRE PROTECTION SYSTEM

The following systems of fire protection are proposed to be provided for the power plant:

- Hydrant system for the entire plant.
- High velocity water spray (HVWS) system for transformers and lube oil tanks.
- Carbon dioxide flooding system for the generator of the steam turbine.
- Portable fire extinguishers.

The fire protection will basically comply with the Loss Prevention Association (LPA) requirements.

7.19.1. **Reserve Storage**

A reserve storage of 262 cu m will be provided in the raw water storage tank to cater to the water requirements of the fire protection system.

The suction nozzles of the fire water pumps in the common sump of the raw water storage tank will be at a lower elevation compared to the suction nozzles of the plant raw water pumps in order to ensure drawl of water from the reserve storage of 262 cu.mt. In view of the above, pump house elevation will also be suitably lowered at the location of the fire water pumps as compared to the floor elevation at the location of the raw water pumps.

7.19.2. **Hydrant System**

The hydrant system will comprise the following:

1. One motor driven and one diesel engine driven fire water pump. These pumps will take the suction from the water storage tank. As per TAC regulations, the above hydrant pump capacity will be adequate to cater to the total number of Hydrant provided in the plant.

2. One motor driven jockey pump of 10 m³/hr. capacity will be provided to keep both the hydrant and HVWS system mains pressurised. These pumps will also take suction from the raw water tank.

3. External fire hydrants in all areas of the power plant including boiler, TG, DM Plant, control room, switch yard, canteen, stores, workshop and administration buildings.

4. Internal fire hydrants in all storied buildings and structures such as Boiler platforms, TG building, fuel handling building, canteen and administration building.

7.19.3. **High Velocity Water Spray System**

The HVWS system is proposed to be provided for the Generator transformer and the steam turbine lube oil tank. Water supply to the HVWS system will be provided by one motor driven pump. Since the parameters for the HVWS system will be identical to that of the hydrant system, the diesel engine driven pump described in the hydrant system, can serve as a common standby for both HVWS system and hydrant system.

The HVWS system will consist of a number of high velocity water projectors mounted on a pipe network around each transformer and steam turbine lube oil tank. Water supply to each pipe network from the HVWS system mains will be through a deluge valve. The HVWS system for the transformers will be of automatic type. In case of fire, quartzoid bulb sensors mounted around the transformers will automatically actuate the deluge valve on the spray water line. The HVWS system for the turbine lube oil tank will be manually actuated.

7.19.4. **Portable fire extinguishers**

It is proposed to provide an adequate number of wall/column mounted type portable fire extinguishers in various areas of the plant including the control room, administration building, canteen, stores, workshop, pump house, etc. These portable fire extinguishers would basically be of carbon dioxide and dry power type.

7.19.5. **Waste Water System**

The neutralized effluents from DM plant, blow down from cooling tower, boiler will be admitted into the waste water tank and the final effluent will be pumped to the nearby drain canal. The TDS of the final effluent is expected to be lower than the specified norms.

7.20. CRANES AND HOISTS

An electrically operated overhead travelling (EOT) crane with a span of 9.5 meters, with the main hook lifting suitable capacity and an auxiliary hook lifting suitable capacity shall be provided to facilitate erection and maintenance of the turbo generators and their auxiliaries. The crane travel will cover the entire length of the turbo generator building.

7.21. COMPRESSED AIR SYSTEM

Instrument air is required for various pneumatically operated control valves in the boiler and TG systems. The air is required to be supplied at a pressure of 5 to 7 Kg/sq.cm (g) at the various consumption points. Instrument air from the air compressors will be dried by heatless air drier making use of the dried air for regeneration of the drier medium (desiccant).

Service air is required for cleaning of various areas of the plant. Accordingly, the service air connections are proposed to be provided in the Boiler area, TG building, workshop, DM Plant etc.

Considering the quantity of air required for the power plant, two (2) air compressors will be required. These compressors will supply the instrument air and the required service air.

7.22. AIR-CONDITIONING AND VENTILATION SYSTEM

In the power plant the control room will be air conditioned. The main control room housing the control panels of boiler and TG, switch yard control panels and auxiliary panel room housing the associated system cabinets will be located on the 6.00m floor in the TG Building.

The above area will be air conditioned using window type/spilt type air conditioners. The capacity of the air conditioning units will be decided based on the area of the room and heat load dissipated in the room.

The following mechanical ventilation systems are proposed to be provided for various buildings/rooms in the power plant.

- Required no of roof exhausters of adequate capacity for evacuating the hot air from the TG building.

- Suitable number of propeller type exhaust fans in the electrical switch gear room, water pump house, DM Plant, filtration plant, workshop and stores.
- Propeller type exhaust fans in all toilets in the power plant.

7.23. TECHNICAL DATA FOR MAJOR MECHANICAL EQUIPMENT

7.23.1. Boiler

•	Number of boilers		:	One
•	MCR capacity	tph	:	12.50
•	Steam pressure at SH outlet	ata	:	44
•	Steam temp. at SH outlet	Deg. C	:	450
•	Feed water inlet temp.	Deg. C	:	105
•	Boiler efficiency	%	:	70
•	Gas temperature at the outlet of AH	Deg. C	:	150 (Max.)

7.23.2. Turbogenerator

7.23.2.1. Steam turbine

•	Power rated	kW	:	2280
•	Inlet steam pressure	ata	:	42
•	Inlet steam temperature	Deg. C	:	445

7.23.2.2. Steam flow

Bleed:

•	Pressure	ata	:	3.50
•	Temperature	Deg. C	:	191
•	Flow	tph	:	1.04

Air Cooled Condenser

•	Steam flow	:	10.16 t/hr
•	Number of Streams	:	One
•	Number on Modules	:	Two
•	Wind Wall	:	Provided

Condensate Extraction Pump & Steam Ejectors.

•	Type		:	Centrifugal
•	Capacity	m^3/hr	:	10
•	Suction pressure	ata	:	0.13
•	Discharge pressure	Kg/sq.cm g	:	5.0
•	Number of pumps		:	2 (2 x 100%)
•	Steam Ejectors		:	2 (2 X 100%)
•	Starting Ejector		:	1
•	Hot Well Tank		:	1X100%
•	Hot well Pumps		:	2 X 100%
•	Condensate Tank		:	1 No

Aux Cooling water system

•	Type of cooling tower		:	Induced draft
•	Number of cooling towers		:	One (1)
•	Capacity	m^3/hr	:	150
•	Cooling water supply temperature	Deg. C	:	32
•	Cooling water return temperature	Deg. C	:	41
•	Cooling water return pressure	Kg/sq.cm	:	0.5 (at the spray nozzle)
•	Evaporation loss and blow down	%	:	2.0
•	No. of cells		:	Two

Boiler Feed Pumps

•	Number of pumps		:	two (2 x 100%)
•	Capacity	$m^3/hr.$	:	13
•	Head	MLC	:	570
•	Type		:	Multistage Centrifugal
•	Drive		:	Electric motor with soft starter

Deaerator

• Type		:	Spray cum tray
• Capacity	tph	:	13
• Outlet water temperature	ºC	:	105
• Operating pressure	ata	:	1.23
• Design pressure	ata	:	1.8 /Full vaccum
• Steam inlet pressure	ata	:	1.3
• Oxygen content in the outlet water	ppm	:	0.007

DM Water Plant

• Capacity	$m^3/hr.$	:	1.50
• Regeneration		:	4hrs/day

DM Water Specification:

• Hardness		:	Nil
• Chloride		:	Nil
• Silica as SiO2, max.	ppm	:	<0.02
• Iron as Fe, max.	ppm	:	Nil
• Conductivity at 20 Deg.C max		:	0.5 micro siemens/cm
• pH		:	8.5 to 9.2
• Oxygen (max.)	ppm	:	0.007

DM water plant will be complete with filter unit, SAC, SBA plant, degassers, pumps, mixed bed exchangers, acid/alkali tank and pumps, raw water pumps etc.,

SECTION 8

DESCRIPTION OF ELECTRICAL AND I & C SYSTEMS

8. DESCRIPTION OF ELECTRICAL SYSTEMS

8.1. GENERATOR

The generator will be rated 2.28 MW, 11 kV, 50 Hz, 3 ph, 0.8 pf. The generator winding will have class F insulation for both rotor & stator with temperature raise will be limited to class B limits for both rotor & stator. The winding will be star connected. The star point will be earthed through a resistor to limit the fault current. The generator will be air-cooled with an air-air heat exchanger. The generators will have brushless excitation system.

The line side & neutral side terminals of the steam turbine-generator will be brought out through the terminal boxes located on both side of generator. The Line side generator terminals will be connected to the LAVT panel incoming through 11kV XLPE FRLS cable. From LAVT panel outgoing will be connected to 11kV switchgear panel by means of 11kV XLPE FRLS cable. The LAVT cubicle will house necessary current transformers, voltage transformers, lightning arrestors etc. Similarly, generator neutral side terminals will be taken to the Neutral Grounding Resistor (NGR) Cubicle through a short run of 11kV XLPE FRLS cable. The current transformers required for Protection & Metering will be housed in the NGR & LAVT cubica. The neutral star formation will be made in the generator only. The cubicle will house, motorized isolator, grounding resistor, neutral current transformer etc.

The generator shall be of closed circuit air-cooled type housed in an IP55 (CACW) enclosure and driven by steam turbine through a speed reducer, if necessary. The necessary coupling and coupling bolts shall also form part of the supply. The generator air cooler will be top mounted.

8.1.1. Stator

The stator frame shall be a single piece consisting of a cylindrical casing of welded plate construction, reinforced internally in the radial and axial direction by stationary web plates making the entire frame perfectly rigid. The stator winding shall be of the double layer lap type with Class ‘F’ insulation.

8.1.2. Rotor

- The generator rotor shall be forged from a single piece ingot of special alloy steel carefully heat treated to obtain excellent mechanical and magnetic properties and a comprehensive series of ultrasonic examinations on the rotor body shall be done to ensure that absolutely no inadmissible internal defects are present and that the material meets the quality standards.

- The design and construction of the rotor shall be in accordance with the best modern practice and shall be fully described in the offer.
- The insulation between turns of field winding shall be consistent class F insulation.
- The field poles shall be provided with adequate damper windings to ensure stability under fault conditions and to meet I_2^2 t value of 20.

8.1.3. **Earth Terminal**

Two numbers of Earth terminals shall be provided. The earth terminals shall be designed to terminate Galvanized iron conductors. The size shall be as specified in IEC 34-1.

8.1.4. **Speed Regulation**

The moment of inertia of the alternator together with that of the turbine shall be sufficient to ensure stability and the speed regulation as specified covering turbine for full load rejection.

8.1.5. **Shaft**

a) The generator shaft shall be made of best quality forged alloy steel, properly treated. The shaft shall be of ample size to operate at all speeds, including maximum over speed without vibration or distortion and shall be able to withstand short circuit and other stresses without damage. To prevent the flow of harmful shaft currents damaging the bearings, suitable shaft earthing shall be provided.

b) A complete set of test reports covering metallurgical strength, crystallographic and ultrasonic and baroscopic tests performed in each shaft during various stages of its manufacturing shall be furnished as also the complete specifications of the shaft forging material and its design parameters such as stresses and critical speed.

c) The generator shaft shall have a suitably shaped flange for coupling to the turbine/gearbox shaft. The coupling shall be forged integral with the shaft and the shaft coupling shall comply with the requirements of IEC for shaft coupling. All coupling bolts, nut and nut guards for coupling shall be furnished by the vendor. The alignment limit for the shaft shall be as per the latest NEMA/DIN standards.

8.1.6. **Space Heaters**

Suitably rated heaters shall be installed within the enclosure of the generator. Location and the maximum temperature of the heaters shall be such that no damage can be caused to any insulation. Heaters shall be suitable for operation on a single-phase 230 V AC supplies. A suitable thermostat controlled switch shall be mounted on or adjacent to the stator frame for the switching of the heaters.

8.1.7. **Excitation System**

a) A brushless exciter shall be used and it shall be mounted on the out board end of the generator frame. A static voltage regulator shall be included to control the voltage of the synchronous generator by varying the current supplied to the field. Details of the equipment shall be furnished along with the bid.

b) A self-excited static excitation system shall be provided. A high speed, fully tropicalized, printed circuit, draw out type, automatic digital voltage regulator shall be provided. It should be complete with necessary sensing PT's, cable entries, cast resin type current transformer, adjusting rheostats, and auto/manual and on/off selector switches. The following meters of class 0.2 accuracy of size not less than 144x144 mm shall be provided in the excitation cubicle and also in the unit control panel.

- Exciter Field Current
- Generator Field Current
- Generator Field Voltage
- Generator Terminal Voltage

c) The excitation system shall be provided with the following features:

- Generator voltage control
- Excitation current control
- Excitation buildup during startup and fields suppression shutdown.
- Limiter for the under excited range and delayed limiter for overexcited range.
- Feature for parallel operation of the generator with the grid system incorporating power factor control mode and feature for islanding operation during sudden grid failure.

d) The system offered shall have the following facilities:

- Manual mode of operation
- Two Auto mode of operation
- Follow on mode to have bumped less transfer from one mode of operation to the other.

Auto/Manual changeover facility shall be provided. For manual mode voltage lower/raise pistol grip type spring return type switch shall be provided. Following minimum alarms shall be transmitted to the unit control desk. The excitation system shall have diode protection relays to detect failure of the Rotating Diodes.

- AVR fault
- AVR automatic changeover to manual
- Diode failure

8.1.8. **Accessory Equipment**

a) The generator shall be provided with RTD's (temperature sensors) installed in the stator winding with leads, brought out to a separate terminal box.

These RTD's shall be hooked up to the temperature scanner in the control panel. Necessary vibration transducer, displacement transducers with transmitters shall be provided which shall be hooked up to the control panel in the control room.

b) Adequately rated neutral grounding resistor shall be supplied, the resistor shall be stainless steel edge wound type mounted in shielded safe enclosure. A current transformer shall be provided for ground fault current measurements for protection. The rating of the resistor shall be furnished.

c) Necessary surge capacitors and lightning arrestors shall be provided for generator protection. The surge capacitors shall conform to the latest IS: 2834 and shall be rated 0.25 Micro Farad. The capacitors shall be suitable for indoor mounting and shall be provided with built-in discharge resistor.

8.2. SURGE PROTECTION EQUIPMENT

The surge protection equipment would comprise lightning arrestors with suitable discharge characteristics to suit the generator insulation level in parallel with suitably rated capacitor for smoothening the rate of rise of impulse voltage. The lightning arrestors will be located as close as possible to the generator terminals.

Parameters of Generator:

Sl.No.	Parameters	Generators
1	Rating (KW)	2280 KW
2	Applicable Standard	IEC-34
3	Rated power factor	0.8
4	Rated frequency (Hz)	50
5	Rated speed (rpm)	1500
6	Excitation system	Brushless
7	Cooling	Air cooled
8	Voltage	415V
9	Insulation class	F
10.	Enclosure	IP-55
11.	Efficiency @ rated output, voltage and p.f. 0.8	97%

8.3. POWER EVACUATION

The power generated from the proposed biomass based power plant will be evacuated to the 33 kV grid through one number of 3.15 MVA, 11/ 33 kV generator transformer.

The generator is earthed through a resistor to limit to earth fault current to acceptable limits so that generator core is not damaged. Hence this system will be of non-effectively earthed type.

8.4. 11 KV SWITCHGEAR

The power generated from the generator will be fed to indoor metal clad 11 kV switchgear panel through 11kV XLPE FRLS cable. The 11kV circuit breakers will be draw out type which is either VCB or SF_6 type.

8.5. POWER TRANSFORMERS

One no Generator transformer of rating 3.15 MVA, 11kV / 33kV, Ynd1, Z = 6.25%, ONAN cooled, with OLTC on the HV side which is having the voltage variation as +10% to -10% range in steps of 1.25% will be provided for stepping up the voltage & power evacuation. The HV side will be provided with bushings and LV side will be provided with cable box for connecting the 11kV XLPE FRLS cable. The HV neutral will be solidly earthed. Generator transformer will be interconnected with the grid for the evacuation of balance power.

Technical Parameters of Generator Transformer

Sl.No.	Description	Parameters
1	Rating (MVA)	3.15 MVA
2	Type of cooling	ONAN
3	No load voltage ratio (kV)	33 / 11
4	No. of phases	3
5	Impedance (%)	6.25%
6	Vector group	Ynd1
7	Tap range	10% to -10% in steps of 1.25% on HV side
8	Type of tap changer	OLTC

8.6. 33KV SWITCHYARD

The 33kV switchyard shall be of single bus bar arrangement with one incomer from Generator transformer and one outgoing feeder for connecting the 33kV grid. The maximum fault level at the 33kV bus will be considered as 750MVA. However, as the minimum available SF6 breaker rating for 33KV will be suitable for breaking capacity of 31.5 kA. The isolators will be horizontal centre pole double break type with motor operated closing mechanism. The current and potential transformers will be of oil filled type and will be suitable for the short time rating of 31.5kA. The switchyard will be of outdoor type with galvanized steel lattice structures.

Equipments such as

- HV circuit breakers,
- HV isolators,
- Earth switches,
- Current transformers, electromagnetic voltage transformers,
- Surge arrestors etc.

Parameters of 33kV Switchyard

Sl. No	Parameters	Ratings
1	Nominal System Voltage	33kV (rms)
2	Highest System Voltage	36kV (rms)
3	Basic Insulation Level	170KV (peak)
4	Symmetrical short circuit level	31.5 KA (rms), 1.0 sec.
5	Minimum creepage distance	31 mm/kV
6	Clearance: Phase-Phase Phase-Earth	915 mm 610 mm
7	Section clearance	2800 mm
8	Ground clearance	3700 mm

Parameters of 33kV Circuit Breakers & Isolators:

Sl. No.	Parameters	Circuit Breakers	Isolators
1	Type	SF6	Horizontal centre break
2	Normal current rating	800 A	800 A
3	Breaking capacity (rms)	31.5 KA	-
4	Short time rating	31.5 kA rms for 1 sec	31.5 kA rms

Parameters of 33kV Current Transformers & Voltage Transformers:

Sl. No.	Parameters	Current Transformers	Voltage Transformers
1	Ratio	75/1/1/1/1 A	33kV/√3 / 110 V/√3 / 110 V/√3 110 V/3
2	Short time Rating	31.5 kA rms for 1 sec	-
3	Burden & Acc. Class	As required for protection and metering	

Parameters of 30kV Lightning Arrestors

Sl.No.	Parameters	Ratings
1	Type	Gapless (metal-oxide)
2	Rated voltage (kV rms)	30
3	Discharge current (kA)	10

Parameters of 11 / 0.433kV Auxiliary Transformers

Sl.No.	Description	Parameters
1	Rating	400KVA
2	No. of phases	3
3	Type of cooling	ONAN
4	No load voltage ratio	11 /0.433kV
5	Percentage impedance	6.25%
6	Vector group	Dyn11
7	Tap range	+5 to -5% in steps of 2.5%on HV side
8	Type of tap changer	Off-Circuit Taps
9	Neutral grounding resistance	Solidly earthed
10	Quantity	One(1) number

Parameters of 11 kV Switchgear

Sl.No.	Description	Parameters
1.0	Switchgear	11kV Switchgear
1.1	Type of Construction	Indoor Metal Clad.
1.2	Bus bar rating	630A
1.3	Power frequency withstand voltage	28 kV (rms)
1.4	Impulse withstand voltage	75 kV(rms)
1.5	Short time rating	31.5kA rms 3 sec.
2.0	**CIRCUIT BREAKERS**	
2.1	Type	VCB
2.2	Rated current	630A, 31.5kA for 3Sec
2.3	Symmetrical breaking capacity	31.5kA (rms)
2.4	Rated short circuit making capacity	63kA (rms)

8.7. AUXILIARY POWER SUPPLY ARRANGEMENT

The total auxiliary load of power plant is estimated to be 250KW respectively.

The power plant load will be catered by one number auxiliary transformer of rating 400kVA, 11/0.433KV. The main single line diagram for the power plant, enclosed indicates the auxiliary power distribution. The various auxiliaries of the power plant would be supplied at the following nominal voltages depending upon their ratings and functions:

- 415V, 3 phases, 3 wires effectively grounded AC supply for motors.
- 240V, 1 phase, AC supply for lighting, space heating of motors and panels, single phase motors, etc.
- 230 V, 1 phase grounded AC supply for AC control circuits.
- 110 V, ungrounded DC supply for control and indication.

The power & motor control center (PCC) switchgear will feed the following MCCs / Distribution boards:

- Auxiliary MCC
- Emergency MCC
- Water system MCC
- ACDB
- Lighting DB

8.8. 415V SYSTEM

The 415V, 3phase, 4 wire power for the LT auxiliaries would be obtained from the auxiliary transformer. The 415V PCC switchgear would be of metal enclosed design with symmetrical short circuit rating of 65 kA/1 sec. The motor control centre (MCC) will be designed for 50kA/1 sec short circuit rating.

All the power and motor control centers would be compartmentalized and would be of single / double front execution and non-draw out design with all the circuit components mounted on a sheet metal chassis. The circuit breakers would be air break type. Motor starting would be direct on-line.

Motors rated above 160kW will be provided with HT supply, Motors rated 160kW and below up to 200W will be provided with 3phase LT supply and motors rated below

200kW, lighting, space heater, AC control & protective devices will be provided with 1 phase LT supply.

The switchgear would be located in the control building.

Parameters of 415 V PCC:

Sl. No.	Description	Parameters
1.0	**SWITCHGEAR**	
1.1	Switchgear	Metal enclosed
1.2	Type of construction	Draw out
1.3	Single / Double front	Single front
1.4	Normal current rating (A)	800
1.5	Symmetrical short circuit current (kA rms)	50
1.6	Dynamic withstand (kA peak)	110
1.7	Degree of protection	IP-52
2.0	**CIRCUIT BREAKERS**	
2.1	Type	ACB
2.2	Normal current rating (A)	800
2.3	Symmetrical breaking capacity (kA rms)	50

8.9. CONTROL & PROTECTION SYSTEM

8.9.1. Generator:

The following protections are proposed to be provided for the generators:

- Differential protection
- 95% & 100% Stator earth fault protection
- Loss of field protection
- Negative phase sequence current protection
- voltage restrained over current back-up protection
- Reverse power protection
- Over voltage protection

- Under voltage protection
- Under / over frequency protection
- Rate of change of frequency
- Instantaneous over current relay
- Instantaneous over current earth fault protection
- 1^{st} & 2^{nd} stage rotor earth fault protection
- Over fluxing protection
- Fuse failure
- Low forward power protection

3.15 MVA, 11 KV / 33 KV Transformers:

The following protections are proposed for the above transformer:

- Under voltage protection
- Differential protection
- phase over current protection
- Instantaneous over current protection
- I.D. M.T over load protection
- I.D.M.T earth fault protection
- REF protection
- Over fluxing protection
- Buchholz, oil and winding temperature protection
- Over voltage protection
- Thermal overload protection
- Under / over frequency relay
- Standby Earth fault protection

33 KV Line:

- Under voltage relay
- Instantaneous over current relay

- I.D.M.T over current relay
- I.D.M.T earth fault relay
- Over voltage relay
- Under frequency relay
- Over frequency
- Rate change of frequency relay
- Directional over current relay
- Directional earth fault relay
- Vector surge relay

8.10. EMERGENCY POWER SUPPLY

To shut down safely during complete AC supply failure, certain important plant auxiliaries will be provided with a reliable AC supply through a separate source. For this purpose, 100 KVA, 415V quick starting, automatic mains failure diesel generator (DG) sets will be provided. The diesel generators will feed power to the AC system, emergency lights and UPS. When the AC supply is healthy, these essential loads will be fed from the auxiliary transformer. When the AC supply fails, the DG set will start and come in automatically and will feed the loads connected to the emergency switchgear. When the normal AC supply is restored, these essential loads will be manually changed over to the normal power supply.

8.11. DIRECT CURRENT SUPPLY SYSTEM

The Direct Current System (DC) is the most reliable source of supply in the power station and will be used for the control and protection of the power plant equipment. The DC system will be used for the following:

- Electrical control of equipment and indications on the control panel.
- Power supply to the essential auxiliaries of the power plant and turbines in case of AC power failure.
- Power supply to the following services in case of total AC power failure.
- Communication system

The battery sizing will be done to cater to the following type of loads:

- Momentary load for 1 minute

- Emergency load for 2 hours
- Continuous load for 10 hours

Under normal conditions, the battery will be on float charger. The float charger is connected to a distribution board and meets the requirements of DC load. In case of additional demand of load or AC supply failure, the battery will meet the requirements of DC loads.

The boost charger will be designed to charge the fully discharged battery banks in 12 hours before putting it back on float charge.

A set of one 110V battery bank of suitable capacity with two float and boost chargers and a direct current switch board will meet the DC load of the power plant. Similarly another set of 110V battery bank suitable capacity with two float and boost chargers and a direct current switch board will meet the DC load of the switchyard. The batteries would be of stationary, valve regulated lead acid type, complete with racks, porcelain insulators, inter-cell and interior connectors. The chargers would be of silicon rectifier type with automatic voltage control and load limiting features.

8.12. UNINTERRUPTED POWER SUPPLY (UPS) SYSTEM

The instrumentation and control system will be powered by 230 V single phase AC uninterruptible power supply. A battery bank of suitable capacity with associated two 100% float and boost chargers and inverters would be provided. This power supply will be derived from 415 V AC supply through isolating transformer, rectifier and inverter with dedicated battery bank for back-up power supply. Sufficient redundancy will be built in the system. UPS systems each rated for 100% capacity and with each battery having one (1) hour back-up will be provided. The type of batteries and chargers for the UPS system would be similar to that described above for the DC system.

24 V DC power supply requirement will be derived from UPS bus by providing necessary rectifier and 24 V DC distribution board.

8.13. LIGHTING

The power station lighting system would comprise the following:

8.13.1. Normal 240 V AC Lightning System

The lighting circuit in the normal 240 V AC lighting system would be fed through Main lighting switchboard which in turn will be fed from main PCC. During grid/STG power

supply failure emergency diesel generator will cater power plant lighting. During the total black out, before the DG is switched ON, emergency lighting will be provided for critical areas like control room, stair case, boiler plot form, TG hall, etc. through UPS power supply or portable DC lighting.

The proposed illumination levels for various areas are given below:

Area	Illumination Level
• Control room	300 lux.
• Switchgear / MCC rooms	200 – 250 lux
• Power house	200 lux.
• Outlying areas	50 lux.
• Transformer yard & switchyard	10 – 20 lux.
• Boiler area	50 lux
• Air/Gas compressors house, DM plant	200 lux
• Workshop	300 lux
• Canteen	150 lux.
• Stores	100 – 150 lux.
• Parking area and cycle stand	70 lux.
• Battery room	150 lux.
• Cable vaults	100 lux.
• Administration building and office rooms	350 lux.
• Roads	10 lux.

8.14. CABLING

All cables would be selected to carry the load current under site conditions, with permissible voltage drop. In addition, high voltage cables would be sized to withstand the short circuit current.

The following type of cables would be used:

- For 11 kV generator system : 11 kV unearthed grade, single / multi-core, stranded aluminium conductor, cross linked polyethylene insulated, screened, Aluminium wire

/ galvanized steel wire armored and overall XLPE sheathed FRLS cables conforming to IS 7098 Part II.

- For medium voltage and low voltage power cables: 650 / 1100 V grade, stranded aluminium conductor, XLPE insulated, FRLS.

Control, protection, signaling and supervisory cables would be of 650/1100 V grade, annealed high conductivity stranded copper conductor, PVC insulated and overall PVC sheathed. Signaling and supervisory cables would be twisted pairs and screened wherever required. The inner and outer sheaths of all the above cables would have fire retardant capabilities.

Cables would be laid in steel ladder type cable trays, suitably supported in the control building, STG building, other auxiliary buildings. In outdoor areas, cables would be laid in racks/built-up trenches or would be buried directly underground depending on the environment.

8.15. LIGHTNING PROTECTION SYSTEM

A lightning protection system would be provided as per IS 2309 and Indian Electricity Rules. The protections would consist of roof conductors, air terminals and down comers and would be provided for tall structures such as the STG building.

8.16. FIRE ALARM SYSTEM

A fire alarm system would be installed to provide visual and audible alarm in the power station for fire detection at the incipient stage. This system would comprise manual call points located at strategic locations in areas which are normally manned, and automatic smoke and heat detectors located at important points such as the cable vault, the control room, switchgear room etc., to detect fire at an early stage, and provide visual and audible alarm.

8.17. FIRE CONTAINMENT

Strategic areas in the plant would be separated by adequately rated fire walls. All openings for switchgears and cable entry would be sealed by fire proof seals to prevent spread of fire from one area to another.

8.18. PLANT COMMUNICATION SYSTEM

In view of the high noise level in power plants, public address system is not recommended. For effective communication in the plant, automatic dial type telephones would be set up, having the following features:

8.18.1. **Inter-communication Telephones**

This system would comprise a telephone exchange and an adequate number of dial type hand set stations located in soundproof cabins with suitable flashing indication on top of if to indicate incoming call.

The hand sets in the control room would be provided with priority service facility to enable them to have immediate access to any of the handsets even if the hand sets are already engaged. A private automatic exchange for communication with outside parties would also be provided.

8.18.2. **Walkie-Talkie Sets**

Walkie-Talkie sets would be provided for key personnel. This would, however require special permission from the statutory authorities.

8.19. SAFETY EARTHING SYSTEM

A Safety earthing system as per IS 3043 & IEEE 80 consisting of a buried mild steel conductor earthing grid would be provide for the power plant transformer yard, switchyard and other outlying areas. These would be connected to the earth grids in various buildings. The buried earthing grid would be further connected to earthing grid would be further connected to earthing electrodes buried under ground and located at representative points. The earth electrodes will be 100 mm diameter and 3000 mm long 13mm thickness Cast iron pipe and the main earth conductors will be 75 mm x 10 mm G.I flats. The earth conductors when buried will be of mild steel and galvanized wherever exposed to atmosphere.

8.20. INSTRUMENTATION AND CONTROL SYSTEM

The objective of this Detailed Project report is to outline the design philosophy to be adopted for Control and Instrumentation (C&I) systems for 2.28 MW Biomass Power Project.

The function of the instrumentation and control system would be to aid the operator in achieving safe and efficient operation of the unit. The C&I system would be of the type which normally relieves the operator of continuous duties and would take preplanned actions in case unsafe trends or conditions develop in any regime of operation, i.e., start up, shut down, normal working and emergency conditions. The design of C&I system would be such so as to permit rectification of fault in the minimum possible time. Ease of maintenance would be given due importance at system design stage.

8.20.1 PLC CONTROL SYSTEM

The instrument and control system will be provided with a microprocessor-based PLC and a few other analog instruments and control devices. It will perform the functions of monitoring, control, alarm, protection and interlock, diagnosing, accident treatment and maintenance guidance of the unit to meet all requirements at various operational conditions.

The system will fulfill the following basic functions:

I. Monitor all major plant functions inputted to the PLC

II. Provide the operator with a central, universal and instantaneous means to monitor the plant.

III. Collect and store data for trending of various plant functions. Keep track of various plant events and record them for historical purposes.

IV. Perform required basic calculations for performance monitoring and optimization.

V. Produce operating logs for record purposes and post trip review reports.

VI. Provide sequence of events monitoring and reporting.

VII. Perform self-checking and self-diagnosis

Provide capability to add, delete and modify points from the system by means of conversional mode

SECTION 9

ENVIRONMENTAL IMPACT AND POLLUTION CONTROL

9. ENVIRONMENTAL IMPACT AND POLLUTION CONTROL

The type of pollutions, which affect the environment, emanating from the biomass based plant can be classified as follows:

- Air pollution
- Water pollution
- Thermal pollution
- Noise pollution

The pollutants generated from the biomass plant are as follows:

- Dust and particulate matter in the flue gas
- Fly ash from the hoppers
- Furnace bottom ash
- Effluent from water treatment plant
- Sewage from the plant

9.1. CONTROL METHODS FOR AIR POLLUTION

9.1.1. Dust and particulate matters

The pollution control norm stipulates a maximum dust concentration of 100 mg//N.cu.mt. The proposed biomass based plant will have ESP, which will separate the dust from the flue gas and has an efficiency of 90 %. The dust concentration in the flue gas leaving the ESP will be maximum 100 mg/N.cu.mt.

The dust concentration level in the chimney will be periodically monitored. Corrective steps will be taken, if the concentration is not within the acceptable limits.

9.1.2. Sulphur dioxide and nitrogen dioxide

The main fuels, for the proposed biomass based plant are Coconut, arecanut, red oil palm, cashenut, cereals like paddy, maize, pulse and wood chips. The quantity of sulphur di oxide in flue gas determines the height of the chimney. Owing to the

negligible amounts of sulphur and nitrogen in proposed fuel, little or no sulphur di oxide or nitrogen di oxide is produced.

9.1.3. **Fly ash and bottom ash**

The ash content present in Coconut, arecanut, red oil palm, cashenut, cereals like paddy, maize, pulse and wood chips is around 4.86 %. Ash collected from the bottom of furnace is taken to an ash silo through a submerged belt conveyor. The fly ash from air heater, ESP and economiser hoppers is taken to the fly ash silo by a dense phase ash handling system. Depending on the fuel from which ash is generated, the ash produced will be disposed. For example, the ash produced by burning biomass fuels can be used as manure and can be given to the farmers.

9.2. CONTROL METHODS FOR WATER POLLUTION

9.2.1. **Effluents from Water treatment Plant**

The water drained from the water treatment plant will have to be treated so that the water let out is neutral (pH 7.0). To achieve this, the water drained from the water treatment plant is pumped to a neutralization pit.

The neutralization pit will have acid resistant brick lining. The effluent flowing into the neutralizing pit will be self-neutralizing type & hence no additional chemical is required to be used for treatment of the effluent from the DM plant.

The quantity of effluent from the softener & DM stream will be around 1 tph and from the filters will be around 0.50 tph .

9.2.2. **Boiler Blowdown**

In order to maintain the solid concentration in the boiler feed water, two types of blowdown are employed in the boiler. One type is continuous blowdown and the other intermittent blowdown.

The drain water from blowdown tank will be at a temperature of 100 Deg. C. The quantity of blowdown will be around 0.32 tph. This water can be taken to the waste water tank , where it will get cooled naturally.

Apart from Boiler blowdown there will be blowdown from the aux cooling tower which will be around 0.67 tph .

The water from blowdown, neutralizing pit will be taken to a waste water tank where the water will achieve near about atmospheric temperature. This water can be used for ash quenching / conditioning, dust suppression in the fuel storage yard and in the plant area.

Used Lube oil will be stored in barrels & will be disposed off by certified agency

9.2.3. **Sewage from the power plant buildings**

The sewage from the various power plant buildings will be taken to a common septic tank through trenches. The sewage from the septic tank will be disposed off through concrete trenches. As the sewage is taken in trenches the soil will not get contaminated.

9.3. CONTROL METHODS FOR THERMAL POLLUTION

The water used in the surface condenser to condense the steam, will be cooled in a cooling tower of either induced or forced draft type. The water let out from the cooling tower will have a temperature very close to the ambient.

9.4. CONTROL METHODS FOR NOISE POLLUTION

The major source of noise pollution in the proposed biomass based plant is from the following:

- Rotating equipments like ID, FD and SA fans
- Feed pumps
- Boiler and superheater safety valves
- Start-up vent
- Steam turbine

9.5. DG SETS

As per OSHA standards, the sound level from the rotating equipments shall be 85 to 90dBA. The rotating equipments will be designed to achieve this.

The start-up vent, safety valve outlets and the DG sets will be provided with silencers to reduce the noise level to the acceptable limits.

The power house building will be constructed with sound proof walls to keep the noise level within the acceptable limits in the control room.

Rain Water Harvesting

It is planned to have rain water harvesting in the power plant area. Suitable arrangements will be made at site for this purpose during project execution. There will not be any mix up of the plant drains & the storm water drain.

9.6. INPUTS AND OUTPUTS FROM POWER PLANT

INPUTS

Fuel	18754.56 t / yr
Water	6.74 cum / hr
OUTPUTS	
Power	126.72 Lakh kwh per annum (Gross output 80 % PLF)
Ash	1080 t / yr

a.	Boiler Blowdown	0.38 t / hr
b.	Cooling Tower Blowdown	0.7 t / hr
c.	Cooling Tower Evaporation	2.6 t / hr
d.	Steam from Deaerator Vent	0.1 t / hr
e.	Filter Back wash	0.40 t / hr
f.	DM plant effluent	0.32 t / hr
g.	Domestic waste water	2.4 t / hr

Blowdown from Boiler and Cooling Tower (water at around 42 deg. C) will be admitted into a waste water tank where it gets cooled automatically. The effluent from DM plant & the filter backwash will be admitted into the neutralizing pit where it will be self neutralizing. The effluent from neutralizing pit will be transferred to the waste water tank for further disposal.

The water from the waste water tank will be used for ash quenching, dust suppression in the plant area by water spray, gardening, etc.

The domestic waste will be admitted into septic tank & then through dispersion trenches

SECTION 10

STATUTORY CLEARANCES REQUIRED

10. STATUTORY CELARANCES REQUIRED

The following are the statutory clearances required for the proposed biomass based plant at Mithakhari village, Ferrargunj Tehsil in South Andaman Islands.

10.1. IN PRINCIPLE CLEARANCE FROM ELECTRICAL DEPARTMENT OF A&N ISLANDS

The clearances for export of power are to be obtained from A&N Government.

10.2. APPROVAL FOR PARALLEL OPERATION

Approval of the Government of A&N union territory for parallel operation of generating set with the grid has to be obtained.

10.3. CLEARANCE FROM AIR PORT AUTHORITY OF INDIA

Permission has to be obtained from the Airport Authority of India, New Delhi, for the chimney height.

10.4. POLLUTION CONTROL BOARD

Consent order for establishment from the A&N Government Pollution Control board to be obtained for the air pollution, water pollution and noise pollution. The source of pollution and the control methods proposed are discussed in the chapter, “Environmental Impact and Pollution Control”.

10.5. APPROVAL FROM LOCAL PANCHAYAT

The local Panchayat has to approve the layout and buildings of the power plant

10.6. INSURANCE

Approval from the Loss Prevention Association is required for the firefighting systems like hydrant system and portable fire extinguishers, proposed to protect the boiler, TG, switch yard and other buildings. The premium for the insurance will be fixed based on the recommendations given by the Tariff Advisory Committee.

10.7. APPROVAL FOR THE ELECTRICAL INSTALLATION

The electrical installations like transformers, switch yard equipment etc., shall be approved by the Chief Electrical Inspector, Government of A&N for the safety features, location etc.

10.8. APPROVAL FOR THE FACTORY INSTALLATION

The approval for establishing the power plant to be obtained from the Chief Inspector of Factories.

10.9. BOILER AND PRESSURE PART COMPONENTS

The approval from the Chief Inspector of Boilers, A&N is required for the installation and operation of the boilers, steam and water pipings.

10.10. APPROVAL FROM GOVERNMENT AUTHORITY

Approval has to be obtained from the Government authorities for drawl of water from the ground.

SECTION 11

OPERATION AND MAINTENANCE

11. OPERATION AND MAINTENANCE

The proposed organisation structure for the operation and maintenance (O&M) of the power plant is presented in the exhibits. In order to ensure a high level of performance of the power plant, it is proposed to induct experienced O&M engineers from the very beginning of the project.

11.1. BASIC STRUCTURE OF THE O&M TEAM

The basic structure and the broad functional area within the O&M organisation would be as follows:

The power station superintendent would have the primary responsibility for the O&M of the power plant. The organisation will comprise of four broad functional areas viz. Operation, maintenance, technical and administration. The basic duties covered under each of these functional areas would be as follows:

11.1.1. Operation

Operation of main generating equipment, fuel handling systems, water systems including water treatment plant, 33 kV switch yard and other auxiliary plant.

Except for the Power Station Superintendent, Manager Operations and Manager Maintenance, all other operation personnel would work on three shift basis.

Manpower for shift personnel planning for key areas has been generally done on 3+1 concept, to take into account leave taken by shift personnel.

The day to day operation of the power plant will be controlled by the Managers who will be assisted by the Control room operators and shift engineers.

11.1.2. Maintenance

Maintenance of mechanical and electrical plant, control systems, buildings, roads, drainages and sewage systems etc.,

Operation of the plant work shop, planning and scheduling maintenance works and deciding the requirement of spare parts.

The maintenance manager will be assisted by departmental engineers, who take care of the maintenance aspects of all the mechanical, electrical and I&C requirements.

Trained technicians will be employed to assist the maintenance group in day to day maintenance of the plant.

11.1.3. Efficiency Department

Monitoring of plant performance, plant water chemistry, maintenance of documents, improvements in the plant systems, plant safety aspects including firefighting and training.

Excepting the Chemists/Lab technicians, all other personnel in this functional area would be in general shift.

This department is also known as Efficiency Department, as the prime responsibility of them will be metering the energy exported to the Electricity Board apart from monitoring the performance of the plant.

11.1.4. Administration

The main responsibilities of this department will be as follows:

- Purchase
- Plant Security
- Liaison with local labour officers
- Stores management
- Finance & Accounts
- Medical Services
- Secretarial & Clerical
- Transport services
- HRD

11.2. FACILITIES TO BE EXTENDED TO THE EMPLOYEES

The number of employees required for the proposed power plant will be around 45 including 10 persons per shift for operation of the Plant. Maintenance department personnel will be from different disciplines like Mechanical, Electrical, I&C etc. The

personnel required for administration and Finance & Accounts will also be included in the above including the persons taken on contract basis.

11.2.1. **In plant facilities:**

The following facilities will be provided in the power plant:

- Administration building and technical office
- Construction offices and stores
- Time and security offices
- First aid and firefighting station
- Canteen and welfare center
- Toilets and change rooms
- Car parks and cycle/scooter stands.

11.3. STATION MAINTENANCE PHILOSOPHY

The power plant's maintenance philosophy is based on the following aspects.

11.3.1. **Ordinary Maintenance**

Which covers routine checking and minor and refurbishment activities to be performed according to operating manuals on component / equipment in operating conditions.

11.3.2. **Emergency Maintenance**

Which is a corrective maintenance to be performed when a significant failure occurs. To minimise forced outages duration, an effective Emergency Maintenance must be supported by:

A proper stock of spare parts.

Permanent monitoring and Diagnostic systems for main components.

11.4. MAINTENANCE PLAN AND SCHEDULED MAINTENANCE

Scheduled maintenance is carried out according to maintenance plan, which should be discussed and optimized according to the needs of the customer/client.

The maintenance plan is based on scheduled outages for the following components:

- Boiler
- Steam Turbine
- Alternator

11.5. MAINTENANCE MANAGEMENT SYSTEM

The maintenance of this plant will be carried out as per the above philosophy. This system aims at maximising the availability of the power plant, while ensuring minimum maintenance cost and safety of the plant and personnel.

11.6. SPARE PARTS MANAGEMENT SYSTEM

The primary objective of spare part management system will be to ensure timely availability of proper spare parts for efficient maintenance of the plant without excessive build-up of non-moving and slow moving inventory.

The spare parts management system for this project will cover the following areas:

- Proper codification of all spares and consumables.
- Spare parts indenting and procurement policy.
- Ordering of critical mandatory and recommended spares judicious fixation of inventory levels and ordering levels for spare parts based on the experience.
- Development of more than one source of manufacturer / supplier wherever practicable.

11.7. AVAILABILTY OF O & M MANUALS

All contracts include provision of at least 7 sets of detailed O & M manuals, which will be distributed to all departments concerned well in advance. Installation and commissioning procedures of various equipment will also be prepared as separate documents for distribution to the concerned.

11.8. SPECIAL TOOLS AND TACKLES

All contracts will include the provision for supply of one set of all types of special tools and tackles, which are required for installation, commissioning and proper maintenance of plant and equipment.

11.9. OPERATION REQUIREMENTS

With the completion of the official hydraulic test of the boiler, the pre-commissioning and commissioning activities start. Pre-commissioning checks of the individual equipment will lead to safe commissioning of the equipment. Installation procedure and commissioning procedure as stipulated in the O & M manuals supplied by the various equipment supplier shall be carefully followed.

Wherever possible, it is advisable to keep the vendor's representative at site for commissioning the critical equipment of the power plant.

However, the boiler, turbo-alternators and other critical equipment have to be commissioned by the supplier himself, as the performance guaranties are with them.

Controls and Instrumentation system along with alarm and trip interlocks should be put into operation to safeguard the equipment as well as the operating personnel.

11.10. CHECK-LIST AND PROTOCOL

A Detailed check-list for the various equipment, supplemented with the check-list submitted by the supplier shall be drawn and logged for future reference. This will also form part of the plant's base history/datum.

Whenever an equipment in commissioned, the important parameters of that particular equipment should be observed for a period of eight hours and the readings shall be logged as per the log sheets.

11.10.1. ORGANISATION LEVELS

GRADING OF POSITIONS

Every position in an organisation is graded within these decision taking bands based on a short description below. These grading levels range from A Band (unskilled labour) to E-Band (Top Management). The definitions for the classification of different positions are as follows:

A-Band

Basic elementary decisions where the options and alternatives are limited. Information required by the worker is limited, simple, and easy to understand. A-band mainly requires unskilled labour and its training requirements are minimum.

B-Band

Operational decisions are in a logical sequence of elements involved Experience and practice is essential for taking decisions in this band. Training normally takes a few months.

C-Band

Process decisions in a systematic sequence of operational activities. Problems have to be diagnosed and the best solution forms a range of alternative needs to be selected and implemented. A broad spectrum of intensive formal education, as well as experience, is required for these jobs.

D-Band

Interpretative decisions by middle Management.

E-Band

Strategic decisions by Senior Management.

SECTION 12

COST ESTIMATION AND FINANCIAL ANALYSIS

12. COST ESTIMATION AND FINANCIAL ANALYSIS

REFER ANNEXURE - I

SECTION – 13

SWOT ANALYSIS

13. SWOT ANALYSIS

While the promoters have undertaken pre-feasibility study they have also made a SWOT analysis on the project, which are summarized in the succeeding paragraphs.

SWOT analysis would bring out the strengths and opportunities in setting up the biomass based power project as well as its weaknesses and threats. The SWOT analysis would enable the promoters to consider the positive and negative aspects of setting up of these mini power projects.

STRENGTHS

Demand for the Power: In an energy starving country like ours, the energy supply and demand gap is widening at a rapid rate. It is estimated that another 100000 MW has to be added by 2012 along with the present generation to meet the future demand. This project will contribute in its own way to reduce the deficit power situation.

Easy accessibility to raw material resources: The projects will be located at Mithakhari village, Ferrargunj Tehsil in South Andaman Islands. The raw materials available as biomass fuel are Coconut, arecanut, red oil palm, cashenut, napier grass, cereals like paddy, maize, pulse, wood chips and empty fruit bunches. Wood chips may be imported from main land or from neighboring countries such as Malaysia or Indonesia.

The biomass assessment study carried out for ensuring the availability of Biomass from different sources in different islands is compiled to determine the capacity of power plant that may be established and operated on a continuous basis. The length of the Andaman is 467 km with an average width of 24 km, whereas the maximum width is 52 km. The length of the Nicobar Islands is 259 kms with a maximum width of 58 kms.

Therefore, the available sources of biomass have been considered as Andaman & Nicobar Islands. However, it may be noted that most of the population is settled in and around Port Blair within 50 km radius of the proposed sites indicates that these two fuels are abundantly available.

Rural Employment: The project contributes to the rural economy by creating rural employment and also enables farmers to earn more money by selling stalks at better prices. The project is environment friendly and reduces green house gases.

WEAKNESSES

The project is based on biomass, which is nature's gift and depends on vagaries of nature. When there is a crop failure, there will not be any production of agricultural waste.

- The viability of the project depends on the fluctuations in prices of biomass. The suppliers can hike the price of biomass.

OPPORTUNITIES

With the government encouraging, renewable projects in place of projects based on conventional fuels; there is always scope for expanding the activity.

Presently, the proposed capacities are of the order of 2.28 MW and will be operating on biomass fuel.

There is a clear cut demand supply gap in the A&N islands.

The company can export ash from the boiler since the ash from biomass fuels is supposed to have silica content having export market.

The company can manufacture bricks from ash and can be sold in the market.

THREATS

Success of the project depends on Government power policies and approvals for setting up of the units. Timely payment from the Third parties would also be a matter of concern.

The establishment of number of biomass projects could affect the availability of biomass endangering their very survival.

The state may become a surplus power generating state bringing down the power purchase policies.

As could be seen from the above the strengths are more and opportunities are enormous there by the weaknesses can be eliminated and threats can be surmounted

SECTION – 14

SOCIO-ECONOMIC & ENVIRONMENTAL BENEFITS

14. SOCIO-ECONOMIC & ENVIRONMENTAL BENEFITS

The proposed biomass project will be a landmark achievement at Mithakhari village, Ferrargunj Tehsil in South Andaman Islands. It will truly become a role model of utilizing the agro residues in the most efficient manner for eco-friendly products like renewable and decentralized power generation. The sound techno-economic and commercial viability of this project, coupled with highest efficiency in all aspects of power generation, will pave the way for Integration of agriculture industry & power industry in the union territory of A&N.

Establishment of the latest and most efficient technologies adopted for biomass power generation and biomass fuel linkages will also help the power industry of A&N and equipment manufacturers to grow leaps and bounds, at the national and the international levels.

The socio-economic benefits arising out of this project for the local populace wilt include creation of direct and indirect jobs and consequent rise in the income levels, associated commercial and social infrastructure development in the mofussil areas, improved quality and availability of power due to grid benefits (in terms of deemed generation and power factor improvement), better environment and higher returns for the crops due to higher yield and price.

At the national and the State levels, the benefits include decentralized power generation, reduction in T&D loss, reduced emissions, increased tax revenues and reduction in the transportation costs,

At the project and promoter levels, the captioned project offers excellent opportunities for expansion and diversification in to power sector, flexibility of operations depending on the market situation for each product and improved returns from trade of emission reductions due to biomass based power generation from the upcoming international emissions trade market, under the Kyoto Protocol.

The project will have excellent multiplier effect and will become truly a win-win situation for all the stakeholders. Thus, the proposed project has substantial socio-economic and environmental benefits at the local, the State, the Regional and the National levels.

SECTION 15

PROJECT SCHEDULE AND IMPLEMENTATION

15. PROJECT IMPLEMENTATION

15.1. PROJECT SCHEDULE

The project schedule for the implementation of 2.28 MW Biomass based project will be 16 months from the date of ordering of boiler and turbine. The project schedule indicates the various activities starting from Engineering, Detailed Engineering, Procurement, to Erection and Commissioning of the project.

15.2. PROJECT MANAGEMENT

15.2.1. Engineering Management system

Engineering Management System is a functional strategy developed to meet the tasks of the engineering division keeping in view the overall project and the company's objectives.

It is a set of planned and well-defined systems and procedures for each activity and sub-activity for engineering tasks to complete the project from feasibility, conceptual design, detailed engineering up to commissioning and operation of the plant. The following major constituents of the Engineering management systems are being used for the execution of this project:

15.2.2. Division of Responsibility & Authority,

Division of Responsibility & Authority which defined the role and responsibilities against the tasks identified for the engineering services, project engineering and Quality Assurance & Inspection services in various disciplines such as Mechanical, Electrical, C&I and Civil.

15.2.3. Engineering and Monitoring System

Engineering and Monitoring System covers identification of various Engineering activities and sub-activities both pre-award and post-award of the main plant equipment for this project.

The monitoring of the progress reports and look ahead planning are made on the basis of Scheduled dates against the actual date of completion of the activities or anticipated dates to complete the activities for every month.

15.2.4. **Vendor Drawing Control System**

Vendor drawing control system provides the status reporting and monitoring for Vendor submitted drawings, which give the clue to identify the vendor drawings, falling in different approval categories, drawings which are overdue for submission by the vendor, drawings which are pending for transmittal of the comments / distribution etc. This is very important from the point of vendor progress monitoring.

15.2.5. **Drawing Control Procedure**

Drawing control procedure elaborates how to control drawings received from the vendor or developed in-house. The system identifies how the drawings are to be processed and who has the authority to approve these drawings / documents and transmittal of the drawings to the site office concerned, project consultant and to the vendor.

15.2.6. **System for Feed Back**

This project has got a group of field engineers, which will perform the engineering tasks at the site office and support the engineering group concerned at the Head office. The engineering group is the focal point for all engineering issues and the field problems pertaining to engineering. They also receive drawings and documents and distribute amongst the various departments of the project, provide any clarification or modification of any nature and give the feedback during construction and commissioning stage of the project. They are also responsible to co-ordinate the project drawings and data to AS-Built information.

15.2.7. **Computer Aided Design**

The use of Computer Aided Design (CAD) for development of engineering design and drawings is being emphasized by the company. Presently almost all the engineering tasks are performed using CAD with the software programs already available and developed within the company.

15.2.8. **Assurance of Engineering Quality**

With the use of standardized document, model technical specification, design guide lines and check list, the engineering quality is possible to achieve.

15.2.9. **Cost Control**

To have control on the cost of the project, the project is split into no. of packages and the cost is worked on the basis of the price data obtained from various vendors, as well as on the basis of the trends of the cost variations.

15.2.10. **Time Control**

This is achieved during project planning and monitoring system. Monitoring is done at every place – Regional office, Consultant's office and the Site office.

15.3. CONSTRUCTION MANAGEMENT

15.3.1. **Power Plant and Facilities**

Site activities of project group shall be carried out as per Consultants Construction Management Manual Prescribing systems and procedures, their scope of responsibilities, inter-relationships as outlined in the various chapters.

This management system is a part of Integrated Project Management and Control System developed by the consultant for implementation of power projects with the object of achieving the goal within the defined schedule of time, cost and quality.

Organization tasks and frame work for construction management has been organized in four distinct headings namely :

- Construction Management Tasks.
- Construction Management Organization
- Functional Boundaries & Scope of Work
- Construction Management Interface.

The Construction Management Tasks cover the following:-

iii. Infrastructure development

iv. Construction execution supervision

v. Safety and security

vi. Planning, Scheduling, Reviewing and Control

vii. Field quality surveillance

viii. Site contracting

ix. Material Management

x. Cost control

xi. Liaison with external agencies

xii. Personnel administration and welfare

xiii. Finance and Account.

15.4. CONSTRUCTION MANAGEMENT ORGANISATION

Construction Organization at project site is headed by Project Manager a senior executive assisted by a consultant engineer from the consultant side. The project manager is assisted in carrying out site functions by functional heads viz.

- Head of project construction, planning, scheduling and project co-ordination.
- Head of Field Engineering and Field Quality Surveillance.
- Head of Personnel Management, which includes finance and accounts. The construction, erection and commissioning is carried out by the contractors with the technical supervision from the Consultant/ Customer Engineers in association with the representatives of equipment manufacturer to the satisfaction of the power plant authorities. The tools and plants for construction and erection are brought by the contractor.

The functional boundaries and scope of work cover the following areas:

- Construction planning and scheduling,
- Civil construction
- Equipment erection
- Field engineering
- Field quality control and surveillance: This group will ensure development and enforcement of quality norms and checks.
- Site contract group, which provides centralized services at site for awarding work contracts.

- Material management functions cover activities of material planning, procurement, storage issue etc.
- Site service is a centralized service group which provides and maintains all common construction facilities, tools, plants and construction utility services.
- Personnel and Administration group at site is guided by the HRD division at Head Quarters and it is responsible for man power planning, recruitment etc.
- Finance & Accounts.

15.5. INFRASTRUCTURAL FACILITIES & CIVIL SYSTEM

15.5.1. Preliminary Works

GEO TECHNICAL INVESTIGATION AND SITE SPECIFIC SIESMIC STUDIES.

Detailed geotechnical investigation to be carried out to obtain the details of soil profile, sub surface condition , soil resistivity and physical and engineering. Properties of the soil for the purpose of design of suitable type of foundation for the various structures and equipment.

Detailed geo-technical investigation to be carried out in three parts (i.e.)

- Main plant building and switchyard area.
- Site facilities like cooling tower, DM plant area.
- Raw water tank & pump house.

Water analysis to be carried out to find out the quality and quantity of raw water available. This dictates the size and type of DM plant.

Other infrastructural facility lease of land, levelling, grading, storage reservoir, internal roads, drainage and effluent system, sewage system, boundary wall and fencing has been envisaged for this project.

15.5.2. Construction & Drinking Water

The water requirement for construction purpose including drinking water is drawn from the reservoir located within the plant boundary. The water is pumped to different places with the help of pumps.

For drinking water purposes, the treated water is pumped to an overhead tank and from the tank, the drinking water is supplied through a ring header to various areas of work place.

15.5.3. **Construction Offices, Storage Sheds etc.,**

Temporary office will be constructed to accommodate the construction personnel inside the plant boundary. This shall be a single storied building with load bearing brick wall and A.C. sheet roofing. Sufficient open space has been kept for various contractor's office and storage of steel materials.

15.5.4. **Construction Power**

About 100 KVA at 415 V power is required for construction purposes.

15.5.5. **Buildings**

Separate buildings will be located within the power plant for Administration, Stores, Workshop.

15.6. QUALITY ASSURANCE & INSPECTION

In order to ensure high reliability and better performance, quality assurance programs have been developed for all packages. For this purpose, bid documents for all contract packages stipulate that the bidders have to submit their own quality assurance programs for manufacturing and field activities.

They include identification of

- Quality organization
- Documentation control
- Procedure for purchase of materials, components, selection of subcontractors, services including vendor analysis, source inspection, raw material inspection etc.
- Control and testing of calibration, measuring and testing equipment.
- Handling, storage and delivery.
- Maintenance of records to meet all the contractual requirements.

All the contractors are required to develop such QA programs after the review of all technical specification and contract requirements. The QA programs of the vendors are taken into consideration during bid evaluation by the consultants. At the time of finalisation of the agreement with the successful vendors, a detailed quality plan setting and the quality practices and procedures, relevant standards and acceptance level for all the components of all the equipment will be mutually discussed and agreed to.

Further, consultant / client witnesses tests / inspection etc as per the customer hold points (CHP) to be selected by the consultant in quality plans, beyond which the work will progress only with the consent of the consultant. Apart from this, the quality surveillance of the system and procedures of the contractor's quality control organisation will be carried out for monitoring the implementation status.

In addition, the consultant / customer will carry out quality audits on the systems and processes for the areas of manufacture and field activities to determine the effectiveness of implementation and to ensure conformance to code, contract and procedure requirements.

Control of quality in the field right from the stage of material receipt till final commissioning will be effected by the field quality control group. This group will be independent of actual execution schedules and costs and will function under technical guidance from the consultant's QA group.

15.7. MAN POWER TRAINING & PLACEMENT

15.7.1. Organisation Structure

The project will be headed by a Power Plant Superintendent, a senior level executive from the customer side, who will have overall administrative as well as technical control of the cogeneration plant. For effective operation, maintenance and administration of the project, adequate no. of suitable technical and administrative personnel will be posted under him.

15.7.2. Training and Development

Performance of the employees always depends upon the training and developmental programmes organised by the consultants / customers from time to time. This is one of the important tools to derive improved performance from the operators of the cogeneration plant.

15.7.3. **Type of Training – Pre-Employment Training**

Pre-employment training aims at providing requisite skills and confidence to the personnel, who enter the organisation as fresh trainees at different induction levels. Long duration training schemes and on the job training schemes are in vogue to take care of further training.

15.7.4. **Post – Employment Training**

Post – Employment Training provides opportunities to personnel at various levels of the organisation hierarchy to take-up higher responsibility and skills and also to re-orient them to keep pace with the advancement in power plant operations / technology. This package basically has three components Viz. Management development for senior level executives for developing functional knowledge and managerial skills, specialized training activities to acquaint the employees with the latest technology around the world in cogen industries and employee development programs to develop and upgrade skills and also to attain higher educational levels for the benefit of personnel at different levels.

SECTION 16

DRAWINGS

16. LIST OF DRAWINGS

PLOT PLAN	0-94XX-000-001
HEAT AND MASS BALANCE DIAGRAM -	4-94XX -100-001
WATER BALANCE DIAGRAM	4-94XX -100-002
HT SINGLE LINE DIAGRAM	2-94XX -400-001
PROCESS FLOW DIAGRAM	1-94XX -100-001

SECTION – 17

ANNEXURES

17. ANNEXURES

ANNEXURE –I	FINANCIAL STATEMENT
ANNEXURE –II	WATER ANALYSIS REPORT (Will be submitted shortly)
ANNEXURE –III	BIOMASS STUDY AVAILABILITY REPORT
ANNEXURE –IV	PROJECT SCHEDULE
ANNEXURE –V	SITE PLAN