DETAILED PROJECT REPORT
ON
RICE HUSK COGENERATION – 290 kW
(WARANGAL RICE MILLING CLUSTER)





Bureau of Energy Efficiency

Prepared By

APITCO LIMITED
Engineering Growth

COGENERATION SYSTEM (290kW CAPACITY)

WARANGAL RICE CLUSTER

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Detailed Project Report on Cogeneration system

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For more information

Bureau of Energy Efficiency (BEE)

(Ministry of Power, Government of India)

4th Floor, Sewa Bhawan

R. K. Puram, New Delhi – 110066

Telephone +91-11-26179699

Fax+91-11-26178352

Websites: www.bee-india.nic.in

Email: jsood@beenet.in/
pktiwari@beenet.in

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Dr. Ajay Mathur, Director General, BEE

Smt. Abha Shukla, Secretary, BEE

Shri Jitendra Sood, Energy Economist, BEE

Shri Pawan Kumar Tiwari, Advisor (SME), BEE

Shri Rajeev Yadav, Project Economist, BEE

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List of Abbreviations

- BEE - Bureau of Energy Efficiency
- DPR - Detailed Project Report
- DSCR - Debt Service Coverage Ratio
- GHG - Green House Gases
- HP - Horse Power
- IRR - Internal Rate of Return
- MoP - Ministry of Power
- MSME - Micro Small and Medium Enterprises
- NPV - Net Present Value
- ROI - Return On Investment
- MoMSME - Ministry of Micro Small and Medium Enterprises
- SIDBI - Small Industrial Development Bank of India

EXECUTIVE SUMMARY

Bureau of Energy Efficiency (BEE) appointed Andhra Pradesh Industrial Technical Consultancy Organization Limited as the executing agency for Rice Milling Cluster of Warangal under BEE's SME programme. Under this project, the executing agency carried out studies in the Rice Milling cluster of Warangal. Out of a total of 110 rice mills, study was conducted in 30 units. Preliminary audits were done in all the 30 units whereas detailed energy audits were conducted in 30 of these units.

Based on the energy audits, the executing agency submitted their report to BEE in form of a cluster manual with recommendations for energy conservation & savings potentials in the Rice Milling units.

The existing system has an inefficient boiler which is being used to generate steam for the processing of rice. The proposed Cogeneration system is a system which has higher capacity, efficient boiler than the existing boiler. The steam generated from the system is of better quality and is used first in Power generation and then in the process. The proposed system consumes more fuel but the benefits from it are much more beneficial to the owners, which are being covered in the DPR.

This bankable DPR also found eligible for subsidy scheme of MoMSME for "Technology and Quality Upgradation Support to Micro, Small and Medium Enterprises" under "National Manufacturing and Competitiveness Programme". The key indicators of the DPR including the Project cost, debt equity ratio, monetary benefit and other necessary parameters are given in table below:

S. No	Particular	Unit	Value
1	Project cost	` (in Lakh)	180.38
2	Power Generation	MW/year	2436
3	Monetary benefit	` (in Lakh)/ year	48.87
4	Simple payback period	years	3.69
5	NPV	` (in Lakh)	20.60
6	IRR	%	12.77
7	ROI	%	18.76
8	DSCR	Ratio	1.33
9	Procurement and implementation schedule	Week	12

The projected profitability and cash flow statements indicate that the project implementation i.e. installation of Cogeneration will be financially viable and technically feasible solution for the cluster.

ABOUT BEE'S SME PROGRAM

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 29 selected SMEs clusters. Warangal Rice milling unit Cluster is one of them. The BEE's SME Programme intends to enhance the energy efficiency awareness by funding/subsidizing need based studies in SME clusters and giving energy conservation recommendations. For addressing the specific problems of these SMEs and enhancing energy efficiency in the clusters, BEE will be focusing on energy efficiency, energy conservation and technology up-gradation through studies and pilot projects in these SMEs clusters.

Major activities in the BEE -SME program are furnished below:

Activity 1: Energy use and technology audit

The energy use technology studies would provide information on technology status, best operating practices, gaps in skills and knowledge on energy conservation opportunities, energy saving potential and new energy efficient technologies, etc for each of the sub sector in SMEs.

Activity 2: Capacity building of stake holders in cluster on energy efficiency

In most of the cases SME entrepreneurs are dependent on the locally available technologies, service providers for various reasons. To address this issue BEE has also undertaken capacity building of local service providers and entrepreneurs/ Managers of SMEs on energy efficiency improvement in their units as well as clusters. The local service providers will be trained in order to be able to provide the local services in setting up of energy efficiency projects in the clusters

Activity 3: Implementation of energy efficiency measures

To implement the technology up-gradation project in the clusters, BEE has proposed to prepare the technology based detailed project reports (DPRs) for a minimum of five technologies in three capacities for each technology.

Activity 4: **Facilitation of innovative financing mechanisms for implementation of energy efficiency projects**

The objective of this activity is to facilitate the uptake of energy efficiency measures through innovative financing mechanisms without creating market distortion.

1. INTRODUCTION

1.1 Brief Introduction about Cluster

Andhra Pradesh historically called as rice bowl of India has 77 % of cultivated land under paddy cultivation and produces around 17 million tones of rice. There are around 6000 rice milling units are established in the sate, out of which 408 registered rice mills are with in Warangal district to process the produced paddy. Due to high concentration of many rice mills in Warangal district, the Warangal district rice milling units are considered for BEE –SME Program. The rice mill units in Warangal district are formed association namely The Warangal District Rice Milling Welfare Association and have around 408 rice millers are registered. Warangal is well known for rice milling industry and about 110 rice mills are in and around Warangal town.

These rice mills owners are procured the paddy from different sources and processed in these rice mills. The final product i.e. rice from these mills is supplied to Food Corporation of India (FCI), other marketing channels for selling. These units are in operation since 10-15 years and most of rice mills are family owned. Majority of the units generally operate for one shift a day but some run for two shifts both raw rice and parboiled rice mills. Rice processing is seasonal in nature and has two main seasons in a year depending on the paddy availability. First season is during April- May and paddy available during this season is fit for the production of boiled rice whereas the paddy available during the second season (November-January) is used mainly for raw rice production.

The major equipments employed in a typical rice mills are rubber shellers, polishers, dryers, whiteners, boilers, elevators, air compressors, motors, etc which are operated by power from the State Electricity Board (SEB). DG sets are operated when power off situation by the SEB. The major fuel used in the cluster is rice husk which is generated in the rice mills as a waste after process the paddy. The rice husk is used in boilers as a fuel for generating the steam which is required for different process in parboiled rice mills. Surplus rice husk from these rice mills is sold to outside buyers.

1.1.1 Existing production process & Technology

The product i.e. Rice is produced by processing the paddy in mill by removing the husk. There are two types of paddy processing technologies as discussed below:

Raw Rice Mills: Paddy procured from different sources is dried & then sent for milling without any other process.

***Parboiled Rice Mills*:** The procured paddy from different sources is first sent to partial cooking with the help of steam and then dried with help of air dryers. The steaming of paddy is two types: 'Once steamed paddy', and 'Twice steamed Paddy'. After steaming the paddy, it is sent to the driers for drying, then after it is sent for milling operations. The drying of paddy is of two types, Open Dryers and Closed Dryers. The dried paddy from dryer is then sent to the milling process which is similar to the raw rice processing.

Process description and flow: The paddy received from the farmers contains around 20 % moisture and also contains lot of foreign matter. In order to maintain a uniform moisture level of 12 %, the paddy is passed through a cleaner cum drier to reduce moisture and remove foreign particles. Grading and cleaning operation would involve removal of moisture and foreign material. The cleaned and dried paddy is stored for milling. The dried paddy is again passed through a secondary cleaning system to remove the foreign particles; stones etc are remained in preliminary cleaning. The cleaned paddy is de husked in huller mill with the help of rubber roll hullers. The husk thus separated is either sold or sent to the boiler section for use as fuel. The de-husked paddy is passed through table separators and then to polishing section. In the polishing section the thick brown layer of the paddy is removed with polishers/whiteners. The thick brown layer thus removed by the polishers/ whitener is called bran and this will be used in the solvent extraction plant as raw material. The polished rice is then passed through sieves to remove brokens. The broken rice obtained is put for sale in packed condition. The un broken polished rice finally passes through sorters to remove discolored rice and then sent for packing.

- **Pre Cleaning**: Removing all impurities and unfilled grains from paddy
- **De-stoning**: Separating small stones from paddy
- **Parboiling (Optional)**: Helps in improving the nutritional quality by gelatinization of starch inside the rice grain. It improves the milling recovery percent during deshelling and polishing / whitening operation
- **De-Husking**: Removing husk from paddy
- **Husk Aspiration**: Separating the husk from brown rice/ unhusked paddy
- **Paddy Separation**: Separating the unhusked paddy from brown rice
- **Whitening:** Removing all or part of the bran layer and germ from brown rice
- **Polishing:** Improving the appearance of milled rice by removing the remaining bran particles and by polishing the exterior of the milled kernel
- **Length Grading**: Separating small and large broken from head rice

- **Blending:** Mixing head rice with predetermined amount of broken, as required by the customer
- **Weighing and bagging**: Preparing the milled rice for transport to the customer

The flow diagram of the various unit operations are in Annexure 2:

1.2 Energy performance in existing system

1.2.1 Fuel consumption

Average fuel and electricity consumption in a typical unit is given in Table 1 below:

Table 1 Average fuel and electricity consumption

Type	Capacity (TPH)	No. of Units	Electrical Energy kWh / Yr	Production MT/Yr	Fuel Cons. MT/Yr
Type-1 Raw Rice Mills	1	24	2225283	57600	-
	2	49	5431820	235200	-
	Sub-Total	**73**	**7657104**	**292800**	**-**
Type-2 Par-boiled Rice Mills	2	1	129454	4800	1272
	3	10	2036309	72000	15600
	4	24	7824060	230400	44928
	Sub Total	**35**	**9989824**	**307200**	**61800**
	Total	**108**	**17646928**	**600000**	**61800**

1.2.2 Average annual production:

The annual production of raw rice and parboiled rice for various capacities is briefed here. It is clearly depicted in the **Table No 2 & Table No 3**

Type-1: Raw Rice Milling: From the annual production in raw rice mill units for different capacities it is seen that for a 1 TPH capacity, the annual production is 57600 MT/Yr from 24 units, whereas for a 2 TPH capacity the annual production is 235200 MT/Yr form 49 units. **Table 2** illustrates the annual production of raw rice mill based on capacity of production.

Table 2 Average annual productions in raw rice mills

Capacity (TPH)	Processing Methodologies	Number of Units	Annual Production (MT/Yr)
1	Raw Rice Mill	24	57600
2	Raw Rice Mill	49	235200

Type-2: Parboiled Rice Milling: From the annual production in parboiled rice mill units for different capacities, it is seen that for a 2 TPH capacity the annual production is 4800 MT/Yr from 1 unit, whereas for a 3 TPH capacity the annual production is 72000 MT/Yr

from 10 units and 4 TPH is 230400 MT/Yr from 24 units. **Table 3** illustrates the annual production details of parboiled rice mills based on capacity of production.

Table 3 Average annual production in Parboiled rice mills

Capacity TPH	Processing Methodologies	No of Units	Annual Production (MT/Yr)
2	Parboiled Rice Mill	1	4800
3	Parboiled Rice Mill	10	72000
4	Parboiled Rice Mill	24	230400

The annual production from these rice mills is dependent on the availability of the paddy. The paddy is available during two seasons in a year i.e. First season is during April- May and paddy available during this season is fit for the production of boiled rice whereas the paddy available during the second season (November-January) is used mainly for raw rice production.

1.2.3 Specific energy consumption

Specific energy consumption both electrical and thermal energy per m^2 or MT of production for different type of Rice mills are furnished in Table 4 below:

Table 4 Specific energy consumption

Type	Capacity (TPH)	No. of Units	Production MT/Yr	Sp. Power Cons. kWh/T	Sp. Fuel Cons. kg/T
Type-1 Raw Rice Mills	1	24	57600	38.63	-
	2	49	235200	23.09	-
	Sub-Total	**73**	**292800**	**26.15**	**-**
Type-2 Par-boiled Rice Mills	2	1	4800	26.96	265
	3	10	72000	28.28	216
	4	24	230400	33.95	195
	Sub Total	**35**	**307200**	**32.51**	
	Total	**108**	**600000**		

1.3 Existing Technology / Equipment

1.3.1 Description of existing technology

In parboiled rice mills, electricity cost is about 25 to 30% of total cost and the rice husk consumption cost in boiler is about 70 to 75% of total energy consumption cost in a unit. Hence, about 60 to 70% of total energy cost in parboiled rice mills plant is in the boiler only.

The boiler is the steam-generating equipment. Husk is burned in the furnace and the heat of combustion is transferred to evaporate water inside the boiler. This steam is used to soaking, cooking and drying the paddy.

In Warangal cluster the boilers are using Pneumatic over Feed (POF / POS) – The fuel is pneumatically lifted and fed from the top and is burnt over specially designed fire bars. Solid fuels like Rice husk can also be burnt using an ID fan additionally.

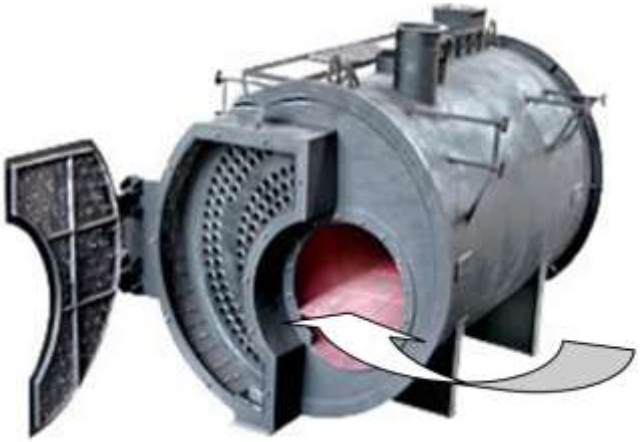


Fig 1 Existing boiler

Table 5 Boiler specifications:

Components	Different Parts	Detail
Capacity		4000 kg/hr
Type	Shell & Tube	IS 2062
	Fully Wet Back	
	Three Pass	
Fuel		**Rice Husk**
Bed	Grate Bars	Alloy CI
Feeder	Vibratory or Screw	Constant speed motor
Firing system	Front door/ Top	SA 106 Gr.B
Furnace	Internal	IS 8 (50% Alumina)
Working Pressure		10.54 kg/cm2
Material of Construction	Tubes	BS 6323 ERW
	Shell	SA 106 Gr.B
	Chimney	M.S
Fabrication		Shop as well as Site Fabrication

Demand and Energy charges

At Warangal, electrical connection is taken from Andhra Pradesh Northern Power Distribution Company Limited at the following tariff rates:

H.T Loads					
S. No	**Type of Connection**	**Category**	**Type of Consumers**	**Fixed/ Demand Charges**	**Energy Charges Ps/Unit**
1	HT	Category -1	Industrial General(Hotels, Hospitals, Restaurants, Clubs, Theaters, Cinemas Railway Stations)		

H.T Loads					
			132 kV and above	250/KVA/ Month	270
			33 kV	250/KVA/ Month	295
			11 kV and below	250/KVA/ Month	320
			Fans & Lighting Colony Consumption		440

If in any month the Recorded Maximum Demand (RMD) of the consumer exceeds his contracted demand with Licensee, the consumer will pay the following charges on excess demand and energy.

Excess RMD over CMD	Demand Charges on Excess Demand	Energy Charges on Excess Energy
100 to 120 %	2 times of normal charge	Normal
Above 120% and up to 200%	2 times of normal charge	1.5 times of normal charge
More than 200%	2 times of normal charge	2 times of normal charge
Excess demand and energy shall be computed as follows :- Excess Demand = (RMD – CMD) if RMD is more than CMD with Licensee Excess Energy – (Excess Demand/RMD) X Recorded Energy.		

1.3.2 Role in Process

Every parboiled rice mills requires a steam for the process of paddy before milling operation. But the steam generation by the boiler not utilized efficiently and produces the loss. The rice husk cogeneration system is effective utilization of steam both in process and also generation of power at same time. By implementation and installation of cogeneration in parboiled rice mills, the steam generation by the boiler is used to generate the power and also used for process the paddy. All parboiled rice mill in Warangal cluster requires steam at 3.5 kg/cm^2 pressure and 110^{o}C to process the paddy. By the cogeneration system the generated steam from boiler is used initially for generating the power and thereby utilizing the low pressure steam for process the paddy. This power can be used for internal consumption of the parboiled rice mills for their operation where grid power consumption reduces and remaining for sale to others.

1.4 Baseline establishment for existing technology

1.4.1 Design and operating parameters

Rice husk Consumption in boiler depends on the following parameters.

- Gear Ratio
- Steam temperature
- Combustion air flow
- Moisture in rice husk
- Calorific value of fuel
- GCV of ash in kcal/kg

- Mass flow rate of steam
- Feed water temperature
- Total power generated per day
- Flue gas temperature in ºC (T_f)
- Temperature of combustion air
- Percentage combustible in ash
- Percentage of oxygen or CO_2 in the flue gas
- Ambient temperature in ºC (Ta) & humidity of air in kg/kg of dry air.
- Ultimate analysis of fuel (H_2, O_2,S, C, moisture content, ash content)

Electricity requirement in the parboiled rice mill depend on production .Detail of rice husk consumption in parboiled rice mills is given in table 6 below.

Table 6 Electricity, Rice husk and diesel consumption

S. No.	Energy Type	Unit	Value	
			Min	Max
1	Electricity	kWh/year	307938	403824
2	***Rice Husk***	***MT/year***	***1950***	***12776***
3	Diesel	Liters/year	800	1200
Base Line				
Boiler Capacity		TPH		4
Enthalpy of feed water @ 60 C and normal pressure		kcal/kg		60
Enthalpy of steam @ 110 C temp 10.5 bar pressure		kcal/kg		644
Heat required		kcal/hr		2336000
Efficiency of existing boiler with older firing technique		%		48
Heat Input		kcal/hr		4866667
Rice Husk required (calorific value 3200 kcal/Kg)		Kg/hr		1521
Rice Husk required Annually (@ 24hrs/day and 350 days/annum)		tonne/Annum		12776

1.4.2 Operating efficiency analysis

Operating efficiency of the boiler is found to be range of 45% to 72% .Specific energy consumption in the boiler is given in Table 7

Table 7 Operating efficiency analysis for rice husk

S. No.	Type of Fuel	Unit	Specific Fuel Consumption	
			Min	Max
1	**Rice Husk**	**Kg /MT**	**174**	**247**

The operating efficiency of boiler is determined by indirect method. It includes the principal losses that occur in the boiler. Detailed parameters and calculations used for operating efficiency evaluation of boiler efficiency are given in the Annexure 1.

1.5 Barriers in adoption of proposed equipment

1.5.1 Technological barrier

In rice milling cluster at Warangal, overall technical understanding on rice manufacturing is good and is rapidly increasing. Some unit's prime equipments like rubber Sheller, whitener, polisher etc are imported from Japan and China.

There is no separate electrician in each unit. In case, any problem occurs in the milling section and boiler section, the plant should be shutdown for one day. However, the first change is still a challenge, upon success, later on duplication and adaptation is extremely common in the cluster. The technologies need to be demonstrated within the cluster. While carrying out the audits and presenting the energy audit reports to the units, in the discussion with the plant owners, many of them agreed with many of the identified energy saving measures and technologies but they demanded demonstration of the energy saving technologies in any plant and thereafter they have readiness to follow.

1.5.2 Financial barrier

Availing finance is not a major issue. Among the SME's, the larger units, if convinced, are capable of either financing themselves or get the finance from their banks. The smaller units will require loan at comfortable rates and other support to raise the loan. However, as most of them have been able to expand their setup and grow, there is a readiness to spend for energy efficiency technologies which have good returns. Energy Efficiency Financing Schemes such as that of SIDBI's, if focused on the cluster, will play a catalytic role in implementation of identified energy conservation projects & technologies.

The cluster has significant potential of co-generation by using biomass (rice husk) and solar technologies. However, though there are good returns, this project is highly capital intensive and requires support of policy as well as innovative financial mechanisms. Initiative has already been taken by some of the units to install rice husk based co-generation. Clean Development Mechanism (CDM) needs to be duly applied to generate additional cash flow to further improve the returns from the project.

1.5.3 Skilled manpower

At Warangal rice mill cluster, availability of skilled manpower is one of the limitations. Number of rice mill units has grown fast as compared to the availability of skilled manpower. Two to three local electrical persons available at Warangal takes care of about 15 to 20 Rice mill units. For major equipments like polisher, whitener, capacitors

banks status checking, boiler section and remaining motors in the unit etc. Maintenance or the repair work of these equipments is take care by the equipment suppliers themselves. Local technical persons at Warangal take care of most of the matters. The units have age-old inefficient practices and well-experienced non-qualified staff in these industries. Even if the qualified staff joins for the sake of experience it jumps to other big industry after getting sufficient experience this is because of low pay packages. These are the major barriers in the technological development of the SME's.

Specialized and focused training of the local service providers on better operation and maintenance of the equipments, importance of the energy and its use and energy conservation measures will improve awareness among the unit owners and workforce. Original equipment suppliers should also participate in these programs.

1.5.4 Any other barrier

Many of the new technology provider's (especially some foreign technology leaders) have not shown keen interest in implementation of their new innovative technologies. This appears to be because of fear of duplication.

The service providers for the Warangal cluster are available in the radius of 150 to 200 kms and are mainly from important cities such as Vijaywada and Hyderabad. Warangal is well connected by intercity train service and highways to both the cities. Few of the service providers have their activities in Warangal. More than fifty service providers of technologies for energy efficiency improvements are located in these cities.

2. PROPOSED EQUIPMENT FOR ENERGY EFFICIENCY IMPROVEMENT

2.1 Description of proposed equipment

2.1.1 Detailed of proposed equipment

Cogeneration or Combined Heat and Power (CHP) is defined as the sequential generation of two different forms of useful energy - typically mechanical energy and thermal energy - from a single primary energy source. Mechanical energy may be used to drive an alternator for producing electricity. Thermal energy can be used either for direct process applications or for indirectly producing steam, hot water, hot air for dryer. Cogeneration provides a wide range of technologies for application in various domains of economic activities. The overall efficiency of energy use in cogeneration mode can be up to 85 per cent - and even above in some cases. Along with the saving of fossil fuels, Cogeneration also helps reducing the emissions of greenhouse gases (particularly CO2 emission).

Table 8 Detail design of Co-generation system

Parameter	Units	Value
Steam Pressure at Turbine Inlet (At the Turbine Main Inlet Value)	Kg/cm^2 (g)	21.0
Steam Temperature at Turbine Inlet (At the Turbine Main Inlet Value)	^0C	212.0
Steam Flow at Turbine Inlet (At the Turbine Main Inlet Valve)	TPH	8
Steam Pressure at Turbine Outlet (At the Turbine Exhaust Flange)	Kg/cm^2 (g)	3.5
Steam Temperature at Turbine Outlet (At the Turbine Exhaust Flange)	^0C	147.0
Power Output at the Generator Terminals	kW	290±3%

For implementation of the proposed technology as per the following modifications are required in existing system.

1 Fluidized bed combustion boiler 2 Extraction cum condensing turbine

2.1.2 Equipment/technology specifications

Detailed specifications of energy efficiency boiler are furnished in Annexure 2.

2.1.3 Suitability or Integration with existing equipment

After analysis of the various system configurations it was concluded that an extraction cum condensing turbine type of system would be the best option for implementation. The steam to this turbine would be supplied from a new Fluidized bed combustion boiler in place of the existing boiler. In this scheme, steam is generated in a high-pressure boiler at a high pressure & is expanded through a extraction cum condensing turbine. A part of steam (60%- 65%) is extracted to meet the process requirement and the rest is

condensed. The advantage with this scheme is that the entire process steam & power requirement of the unit would be met through the project.

2.1.4 Superiority over existing system

The increased efficiency of the boiler and electricity produced by the system are far ahead advantages of the system to the existing boilers.

2.1.5 Availability of technology /equipment

Suppliers of this technology are available at local as well international level very easy. Even most of the suppliers took initiative and interacting with the parboiled rice mill owners for creating the awareness of use of this technology at parboiled rice mills.

2.1.6 Source of equipment

This technology is already implemented and operation in most of the parboiled rice mills in India. Though it is not a very popular technique in parboiled rice mill industry in Warangal cluster, but it is one of the most fuel efficient technologies available.

2.1.7 Service providers

Details of technology service providers are shown in Annexure 6

2.1.3 Terms and Conditions in sales of equipment

Scope of supply, terms and conditions differ from equipment suppliers. Further details of terms and condition are also shown in Annexure 7

2.1.8 Process down time

Process down time of the Cogeneration is about 12 months after all material reached site and fuel feeding line / fuel storage modified when boiler is working (Keeping existing system working).

2.2 Life cycle assessment and risks analysis

Life of the equipment is about 10-15 years. No need to any further huge modification after one time technology changes, in case of risk analysis there is a need of proper training of boiler operator for Cogeneration system.

2.3 Suitable unit /Plant for implementation of proposed technology

Suitable unit for implementation of this technology are parboiled rice mills having the production capacity of about 4tonnes/hr.

3. ECONOMIC BENEFITS FROM PROPOSED TECHNOLOGY

3.1 Technical benefit

3.1.1 Fuel savings

Rice husk consumption in the parboiled rice mills will increase about 1.3times existing consumption after implementation of the technology. Project implementation will lead to generate the power about 2436 MW per year.

3.1.2 Improvement in product quality

The Cogeneration system utilizes the fuel to its max and the fire travels in such a manner that it heats up the feed water at equal temperature. A resultant of which is high quality of steam being produced as compared to the other firing but no direct impact on the product.

3.1.3 Improvement in production

In Cogeneration mode of operation, the production will be same as in present. But after implementation of the proposed system increase the steam quantity of the boiler and additional benefit of electricity produced.

3.1.4 Reduction in raw material

Raw material consumption is same even after the implementation of proposed technology.

3.1.5 Reduction in other losses

Use of energy efficient boilers will reduce specific energy consumption of the rice milling unit. And will reduce dependency of mill units on APNPDCL for electric supply.

3.2 Monetary benefits

Rice husk consumption of new energy efficient boiler would be about 15135.36 tonne of rice husk as compared to of energy deficient boilers of about 12776.4 tonnes per year. Savings are due to the difference in electricity generation of 2436 MW per year cost and the price of electricity available from APNPDCL of about ` 2.01 per unit. Hence total monetary benefit due to implementation of this project will be about `48.87 Lakhs.

3.3 Social benefits

3.3.1 Improvement in working environment

The Cogeneration system is cleaner form energy which will certainly raise working environment workforce.

3.3.2 Improvement in skill set of workers

This system will certainly require skilled workers, so skills of the workers will definitely be improved.

3.4 Environmental benefits

3.4.1 Reduction in effluent generation

Additional fuel burnt will result in additional effluent as generated.

3.4.2 Reduction in GHG emission such as CO2, NOx, etc

The Project would able be to reduce about 955 tonnes of CO_2 produced per year on the production of electricity.

3.4.3 Reduction in other emissions like Sox

As the fuel used in the system is renewable this factor is not considered

4. IMPLEMENTATION OF NEW EFFICIENT TECHNOLOGY

4.1 Cost of technology implementation

4.1.1 Cost of technology

The cost Cogeneration or Combined Heat and Power (CHP) system listed in the table below:

Table 9 Cost of equipment

S. No	Particular	Unit	Value
1	Cost of Boiler	` (in lakh)	69.50
2	Cost of system	` (in lakh)	49.87
3	Erection & Commissioning cost	` (in lakh)	5.00
4	Civil work	` (in lakh)	25.00
5	Taxes	` (in lakh)	17.42
6	Other Misc. cost	` (in lakh)	5.00
7	EPC cost	` (in lakh)	8.59
8	**Total cost**	**` (in lakh)**	**180.38**

4.2 Arrangement of funds

4.2.1 Entrepreneur's contribution

Proposed financing of Condensate Recovery System is made considering a debt equity ratio of 3:1, which is normally allowed by financial institutions for financing energy efficiency projects. On the basis of debt equity ratio of 3:1 the promoter's contribution works out to 25% of the project cost and the balance would be term loan from the Bank / FIs.

4.3 Financial indicators

4.3.1 Cash flow analysis

Profitability and cash flow statements have been worked out for a period of 10 years. The financials have been worked out on the basis of certain reasonable assumptions, which are outlined below.

The project is expected to achieve monetary savings of ` 48.87 lakh per year.

- The Operation and Maintenance cost is estimated at 4% of cost of total project with 5% increase in every year as escalations.
- Interest on term loan is estimated at 10%.
- Depreciation is provided as per the rates provided in the companies act.

Considering the above mentioned assumptions, the net cash accruals starting with ` 14.46 lakh in the first year operation and gradually increases to ` 120.84 lakh at the end of eighth year.

4.3.2 Simple payback period

The total project cost of the proposed technology is ` 180.38 lakh and monetary saving is ` 48.87 lakh hence, the simple payback period works out to be 3.69 years.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10% works out to be `20.60 lakh.

4.3.4 Internal rate of return (IRR)

The after tax IRR of the project works out to be 12.77%. Thus the project is financially viable.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 18.76%.

Financial indicator of proposed technology is furnished in Table 11 below:

Table 10 Financial indication of proposed technology/equipment

S. No	Particulars	Unit	Value
1	Simple Pay Back period	Month	44
2	IRR	% age	20.60
3	NPV	lakhs	16.60
4	ROI	% age	18.76
5	DSCR	Ratio	1.33

4.4 Sensitivity analysis

A sensitivity analysis has been carried out to ascertain how the project financials would behave in different situations like when there is an increase in fuel savings or decrease in fuel savings. For the purpose of sensitive analysis, two following scenarios have been considered.

- Optimistic scenario (Increase in fuel savings by 10%)
- Pessimistic scenario (Decrease in fuel savings by 10%)

In each scenario, other inputs are assumed as a constant. The financial indicators in each of the above situation are indicated along with standard indicators.

Details of sensitivity analysis at different scenarios are shown in Table 12 below:

Table 11 Sensitivity analysis at different scenarios

Scenario	*IRR* %	*NPV* ` in lakh	*ROI* %	*DSCR*
Normal	12.77	20.60	18.76	1.33
10% increase in fuel Saving	15.31	40.42	19.83	1.47
10% decrease in fuel Saving	10.11	0.78	17.35	1.20

4.5 Procurement and implementation schedule

Procurement will take about 6 weeks and implementation schedule for proposed project is shown in Table 13.

Table 12 Procurement and implementation Schedule

S. N.	Activities	Weeks											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Foundation & civil work	■	■										
2	Erection & commissioning of the turbine set			■	■	■	■	■	■				
3	Cabling & electrical panel fitting								■	■	■		
4	Testing and trial											■	
5	On site operator training												■

Annexure 1: Energy audit reports used for establishing

The results of 2, 3TPH boiler detail energy audit with efficiency is given below

Audit No. 1: Energy audit

Sr. No	Parameter	Unit	Value
1	Boiler Capacity	TPH	4
2	Feed water temperature (T1)	^{0}C	4000
3	Enthalpy of feed water(h2)	kcal/kg	60
4	Process steam pressure (P)	kg/cm^2	10.5
5	Inlet steam temperature (T2)	^{0}C	110
6	Steam Enthalpy at steam turbine inlet(h1)	kcal/kg	644
7	Mass Flow rate of fuel (mf)	kg/h	540
8	% Hydrogen in fuel	%	7.00
9	% Carbon in fuel	%	38.5
10	% Oxygen	%	28.5
11	% Nitrogen	%	0.5
12	% Sulphur	%	0
13	G.C.V	Kcal/kg ^{0}C	3600
14	Moisture in fuel	%	9
15	Ash in fuel	%	16
16	G.C.V of Bottom Ash	Kcal/kg ^{0}C	900
17	G.C.V of Fly Ash	Kcal/kg ^{0}C	650
18	Ratio of bottom Ash to Fly Ash		80:20
19	Percentage of oxygen in flue gas	%	9
20	Flue gas temperature	^{0}C	200
21	Ambient Temperature	^{0}C	30
22	Humidity of air	kg/kg of dry air	0.018

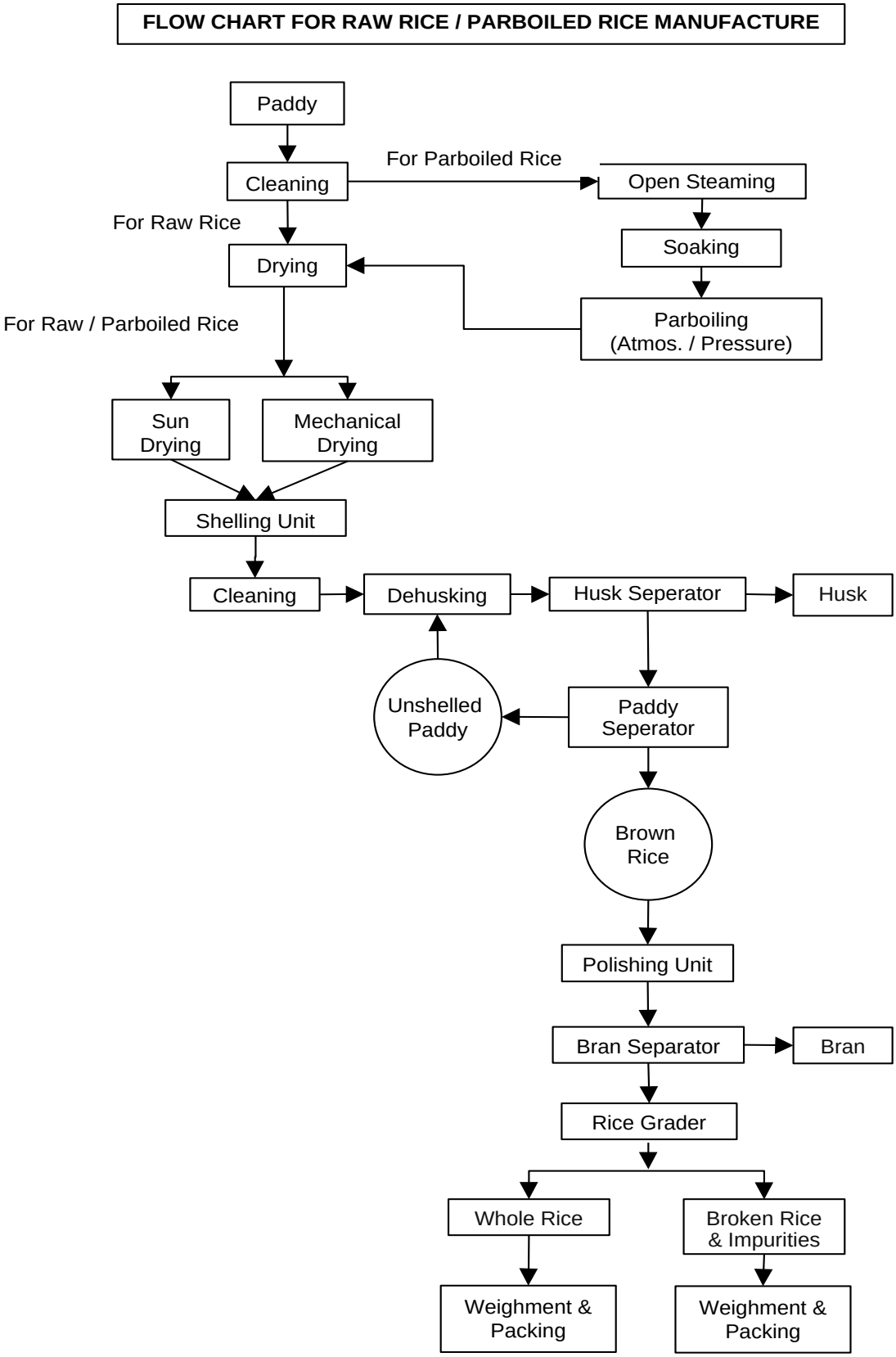
Efficiency of Boiler

Based on the measured data the boiler efficiency is calculated and presented below

EFFICIENCY CALCULATION			
S.NO	HEAT LOSS DESCRIPTION	GCV Based	
		kCal/kg	%
1	Loss due to heat in dry flue gases	1205	33.5
2	Loss due to physically bound moisture in fuel	59	2.00

3	Loss due to chemically bound moisture from burning of hydrogen	413	11.5
4	Loss due to un-burned carbon in ash	68	1.9
5	Loss due to formation of co	0.1	0.0
6	Loss due to radiation &convection (Unmeasured)	108	3.0
	Total Heat Loss	**1853**	**52**
	Efficiency	**48%**	

Annexure 2: Process flow diagram



Annexure 3: Detailed technology assessment report

Parameter	Unit	Existing System	Proposed CO GEN System
Process Steam Requirement (ms)	kg/h	4000	8000
Process Steam Pressure (P2) / Back Pressure	kg/cm^2	10.5	3.5
Steam Pressure (P1)	kg/cm^2	10.5	22
Steam temperature (T2)	^{0} C	110	212
Steam Enthalpy at steam turbine inlet(h1)/ Process	kcal/kg	644	671
Steam Enthalpy at extraction turbine (h2) ,	kcal/kg		639
Feed water temperature (T)	^{0} C	60	80
Enthalpy of feed water (h)	kcal/kg	60	80
Fuel Consumption with Rice Husk 3600 Kcal/kg	kg/h	1520.83	1801.83
Boiler efficiency (ηb)	%	48	82
Average Power generated (P)	KW		290
Extra Fuel Consumption for Power Generation	kg/h		281
Cost of Fuel per Kg	`/kg		1.8
Additional Fuel Cost per Day	`/day		12139
Power Produced per day	kWh/day		6960
No of days operation (assumption)	Days		350
Working hours per days	hours		24
Net Electricity produced per Annum	kWh/Year		2436000
Cost of APNPDCL power	`/kWh		1.74
Cost of generation of per unit electricity	`/kWh		3.75
Savings per unit of Electricity	`/kWh		2.01
Net Saving Potential per annum	`(in lakh)		48.87
Initial Investment	`(in lakh)		180.38
Simple Payback period	years		3.69

Annexure 4: Detailed financial analysis

Assumption

Name of the Technology	Cogeneration System		
Rated Capacity	**290 kW**		
Details	**Unit**	**Values**	**Basis**
Installed Capacity	kW	290	
No of working days	Days	350	
No of Operating Hours per day	Hrs./day	24	
Proposed Investment			
Cost of System(Boiler+System)	` in lakhs	119.37	
Erection & Commissioning	Lumpsum	5.00	
Civil work	Lumpsum	25.00	
Taxes	` in lakhs	17.42	
Misc .cost(including supervision)	` in lakhs	5.00	
Investment without EPC	` in lakhs	171.79	
EPC cost	` in lakhs	8.59	
Total Investment	` in lakhs	180.38	
Financing pattern			
Own Funds (Internal Accruals)	` in lakhs	45.09	
Loan Funds (Term Loan)	` in lakhs	135.28	
Loan Tenure	Years	5	
Moratorium Period	Months	6	
Repayment Period	Months	66	
Interest Rate	%	10.00%	SIDBI EE Lending rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	4.00%	
Annual Escalation	%	5.00%	
Estimation of Revenue			
Power generation	kW/Annum	2436000	
Saving per unit	`/kWh	2.006	
St. line Depn.	%	5.28%	Indian Companies Act
IT Depreciation	%	7.84%	Income Tax Rules
Income Tax	%	33.99%	Income Tax

Estimation of Interest on Term Loan **(`in lakh)**

Years	Opening Balance	Repayment	Closing Balance	Interest
1	135.28	7.50	127.78	15.67
2	127.78	15.00	112.78	12.10
3	112.78	16.20	96.58	10.54
4	96.58	18.00	78.58	8.84
5	78.58	21.00	57.58	6.92
6	57.58	21.40	36.18	4.79
7	36.18	24.00	12.18	2.53
8	12.18	12.18	0.00	0.36
		135.28		

WDV Depreciation (`in lakh)

Particulars / years	1	2	3	4	5	6	7	8	9	10
Plant and Machinery										
Cost	180.38	166.24	153.20	141.19	130.12	119.92	110.52	101.85	93.87	86.51
Depreciation	14.14	13.03	12.01	11.07	10.20	9.40	8.66	7.99	7.36	6.78
WDV	166.24	153.20	141.19	130.12	119.92	110.52	101.85	93.87	86.51	79.73

Project Profitability (`in lakh)

Particulars / Years	1	2	3	4	5	6	7	8	9	10
Revenue through Savings										
Total Revenue (A)	48.87	48.87	48.87	48.87	48.87	48.87	48.87	48.87	48.87	48.87
Expenses										
O & M Expenses	7.22	7.58	7.95	8.35	8.77	9.21	9.67	10.15	10.66	11.19
Total Expenses (B)	7.22	7.58	7.95	8.35	8.77	9.21	9.67	10.15	10.66	11.19
PBDIT (A)-(B)	41.65	41.29	40.91	40.51	40.10	39.66	39.20	38.71	38.21	37.67
Interest	15.67	12.10	10.54	8.84	6.92	4.79	2.53	0.36	-	-
PBDT	25.98	29.20	30.37	31.68	33.18	34.87	36.67	38.35	38.21	37.67
Depreciation	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52
PBT	16.46	19.67	20.85	22.15	23.65	25.34	27.15	28.83	28.68	28.15
Income tax	4.02	5.49	6.24	7.00	7.81	8.66	9.52	10.32	10.48	10.50
Profit after tax (PAT)	12.43	14.18	14.61	15.15	15.84	16.69	17.63	18.51	18.20	17.65

Computation of Tax (`in lakh)

Particulars / Years	1	2	3	4	5	6	7	8	9	10
Profit before tax	16.46	19.67	20.85	22.15	23.65	25.34	27.15	28.83	28.68	28.15
Add: Book depreciation	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52
Less: WDV depreciation	14.14	13.03	12.01	11.07	10.20	9.40	8.66	7.99	7.36	6.78
Taxable profit	11.84	16.16	18.36	20.61	22.98	25.47	28.01	30.37	30.85	30.89
Income Tax	4.02	5.49	6.24	7.00	7.81	8.66	9.52	10.32	10.48	10.50

Project Balance Sheet (`in lakh)

Particulars / Years	1	2	3	4	5	6	7	8	9	10
Liabilities										
Share Capital (D)	45.09	45.09	45.09	45.09	45.09	45.09	45.09	45.09	45.09	45.09
Reserves & Surplus (E)	12.43	26.61	41.22	56.36	72.21	88.90	106.53	125.03	143.23	160.88
Term Loans (F)	127.78	112.78	96.58	78.58	57.58	36.18	12.18	0.00	0.00	0.00
Total Liabilities D)+(E)+(F)	185.31	184.49	182.89	180.04	174.89	170.17	163.80	170.13	188.33	205.98
Assets										
Gross Fixed Assets	180.38	180.38	180.38	180.38	180.38	180.38	180.38	180.38	180.38	180.38
Less: Accm. Depreciation	9.52	19.05	28.57	38.10	47.62	57.14	66.67	76.19	85.72	95.24
Net Fixed Assets	170.85	161.33	151.81	142.28	132.76	123.23	113.71	104.19	94.66	85.14
Cash & Bank Balance	14.46	23.16	31.09	37.76	42.13	46.94	50.09	65.94	93.66	120.84
Total Assets	185.31	184.49	182.89	180.04	174.89	170.17	163.80	170.13	188.33	205.98
Net Worth	57.53	71.70	86.31	101.46	117.30	133.99	151.62	170.13	188.32	205.97
Dept equity ratio	2.83	2.50	2.14	1.74	1.28	0.80	0.27	0.00	0.00	0.00

Project Cash Flow **(`in lakh)**

Particulars / Years	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Sources											
Share Capital	45.09	-	-	-	-	-	-	-	-	-	-
Term Loan	135.28										
Profit After tax		12.43	14.18	14.61	15.15	15.84	16.69	17.63	18.51	18.20	17.65
Depreciation		9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52
Total Sources	180.38	21.96	23.70	24.13	24.67	25.37	26.21	27.15	28.03	27.72	27.17
Application											
Capital Expenditure	180.38										
Repayment of Loan	-	7.50	15.00	16.20	18.00	21.00	21.40	24.00	12.18	-	-
Total Application	180.38	7.50	15.00	16.20	18.00	21.00	21.40	24.00	12.18	-	-
Net Surplus	-	14.46	8.70	7.93	6.67	4.37	4.81	3.15	15.85	27.72	27.17
Add: Opening Balance	-	-	14.46	23.16	31.09	37.76	42.13	46.94	50.09	65.94	93.66
Closing Balance	-	14.46	23.16	31.09	37.76	42.13	46.94	50.09	65.94	93.66	120.84

Calculation of Internal Rate of Return

Particulars / months	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Profit after Tax		12.43	14.18	14.61	15.15	15.84	16.69	17.63	18.51	18.20	17.65
Depreciation		9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52
Interest on Term Loan		15.67	12.10	10.54	8.84	6.92	4.79	2.53	0.36	-	-
Cash outflow	(180.38)	-	-	-	-	-	-	-	-	-	-
Net Cash flow	(180.38)	37.63	35.80	34.67	33.51	32.29	31.00	29.68	28.39	27.72	27.17
IRR	12.77%										
NPV	20.60										

Break Even Point **(`in lakh)**

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Variable Expenses										
Operation & Maintenance Exp (75%)	5.41	5.68	5.97	6.26	6.58	6.91	7.25	7.61	7.99	8.39
Sub Total (G)	5.41	5.68	5.97	6.26	6.58	6.91	7.25	7.61	7.99	8.39
Fixed Expenses										
Operation & Maintenance Exp (25%)	1.80	1.89	1.99	2.09	2.19	2.30	2.42	2.54	2.66	2.80
Interest on Term Loan	15.67	12.10	10.54	8.84	6.92	4.79	2.53	0.36	0.00	0.00
Depreciation *(H)*	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52
Sub Total (I)	27.00	23.51	22.05	20.45	18.63	16.62	14.47	12.42	12.19	12.32
Sales (J)	48.87	48.87	48.87	48.87	48.87	48.87	48.87	48.87	48.87	48.87
Contribution (K)	43.45	43.18	42.90	42.60	42.29	41.96	41.61	41.25	40.87	40.47
Break Even Point (L= G/I) (%)	62.13%	54.45%	51.41%	48.00%	44.06%	39.60%	34.76%	30.11%	29.82%	30.45%
Cash Break Even {(I)-(H)} (%)	40.21%	32.39%	29.21%	25.65%	21.54%	16.90%	11.88%	7.03%	6.52%	6.91%
Break Even Sales (J)*(L)	30.36	26.61	25.12	23.46	21.53	19.35	16.99	14.72	14.57	14.88

Return on Investment

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Total*
Cash Inflow											
Profit after Tax	16.46	19.67	20.85	22.15	23.65	25.34	27.15	28.83	28.68	28.15	240.93
Depreciation	57.53	71.70	86.31	101.46	117.30	133.99	151.62	170.13	188.32	205.97	1284.34
ROI	18.76%										

Debt Service Coverage Ratio

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Total*
Cash Inflow											
Profit after Tax	12.43	14.18	14.61	15.15	15.84	16.69	17.63	18.51	18.20	17.65	125.03
Depreciation	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	9.52	76.19
Interest on Term Loan	15.67	12.10	10.54	8.84	6.92	4.79	2.53	0.36	0.00	0.00	61.74
Total (M)	37.63	35.80	34.67	33.51	32.29	31.00	29.68	28.39	27.72	27.17	262.96

Debt

Interest on Term Loan	15.67	12.10	10.54	8.84	6.92	4.79	2.53	0.36	0.00	0.00	61.74
Repayment of Term Loan	7.50	15.00	16.20	18.00	21.00	21.40	24.00	12.18	0.00	0.00	135.28
Total (N)	23.17	27.10	26.74	26.84	27.92	26.19	26.53	12.54	0.00	0.00	197.02
Average DSCR (M/N)	1.33										

Annexure 5: Detailed of technology service providers

S.No	Name of Service Provider	Address	Contact Person and No
1	THERMAX LIMITED	6-3-649,NALANDA COMPLEX, SOMAJIGUDA,HYDERABAD-500082,INDIA TEL: (040) 23310254 Fax : (40) 23312335	Mr. G.Gokulakrishna E-mail :gkrishnan@thermaxindia.com Mobile: +91 970411141
2	CHEEMA BOILER LIMITED	Flat #301B,Naga Sai Nivas Sreenivasa Nagar (E) S.R. Nagar, Hyderabad-500 038,INDIA TEL: +91 (040) 66821160 Fax :+91 (40) 66821161	Mr. Narsimham Ganti E-mail :Cheemahyd@cheemaboilers.com Mobile: +91 9849695585
3	TurboTech Precision Engineering Private Limited	A-343, 9th Main Road, Peenya Industrial Estate, Peenya 2nd Stage Bangalore, Karnataka 560 058, INDIA Phone: +91-80-41277221, Fax: +91-80-41272767	Srivatsa P.A. Head - Marketing +919448992610 E Mail: marketing@turbotechindia.com Web Site: www.turbotechindia.com

Annexure 6: Quotations of Techno-commercial bids for new Technology/equipment

Ref: CBL/HYD/AIL/Q2/10-11 Dt: 18-02-2011

To,
Shri. D.Gopala Rao
M/s.APITCO LIMITED ,
8th Floor ,Parisharma Bhavan,
Hyderabad-500 004.

Dear Sir,

SUB: Your requirement of 10 TPH (F & A 212 Deg) 21 Kg/Cm² FBC Boiler, with Paddy Husk -reg.

At the outset, We thank you very much for the kind courtesy extended to the undersigned during the meeting with you to discuss regarding your requirement of the Boiler of above capacity.

As discussed, we enclose our techno-commercial offer for your kind perusal and further action.

Trust the offer is inline with your requirement. In case of further clarifications if any please feel free to contact us.

Kindly go through our offer and let us know as to when we should call on you for further discussion

Thanking you and assuring you of our best attention and services at all times, we remain,

Yours faithfully,

For **CHEEMA BOILERS LIMITED,**

NARASIMHAM GANTI
GENERAL MANAGER
098496-95585

Annexure – I

Boiler features & About furnace

In fluidized bed combustion system, solid together with the bed material for example Badarpur sand/ refractory granules are kept suspended with the action of Primary air distributed through air nozzles.

When air is passed through an inert bed of solid particles such as sand supported on a fine mesh or grid, the air initially will seek a path of least resistance and pass upward through the sand. With further increase in the velocity, the air bubbles through the bed and the particles attain a state of high turbulence. Under such conditions, the bed assumes the appearance of a fluid and exhibits the properties associated with a fluid and hence the name 'FLUIDISED BED'.

When the sand in a fluidized state is heated to the ignition temperature of the fuel and the fuel is sprayed continuously on the bed, the fuel will burn rapidly and the bed attains a uniform temperature due to effective mixing. This, in short, is fluidized bed combustion.

While it is essential that temperature of bed should be at least equal to ignition temperature of fuel and it should never be allowed to approach ash fusion temperature to avoid melting of ash. This is achieved by extracting heat from the bed by tubes immersed in the bed or by furnace design. The immersed bed tubes are must for high calorific value fuel such as coal to extract heat from the bubbling Fluidized bed to maintain the bed temperature, but it is not necessary in case of low calorific value fuels such as rice husk.

THE BOILER FEATURES

Boiler design:

The boiler offered to you is water cum smoke tube design to utilize the benefits of water tube & smoke tube boiler. This boiler is very compact and rugged.

About furnace:

The furnace is water cooled and leak proof. Ample space is provided to provide longer residence time for complete combustion of volatiles and fines. The evaporative tubes are vertical in configuration for better circulation and widely spaced. Furnace required minimum quantity of refractory bricks and material.

Refractory and insulation:

The water wall tubes of membrane panel a Boiler Quality strip is welded in between the tubes. Therefore no refractory is required on the outer side of these panels. The life of refractory in this is more due to paneled water walls as compared to other extended furnace boilers. Only 4" mineral wool insulation will serve the purpose.

Flexibility of fuels:

The boiler is a Multi fuel boiler and can be used for Husk, coal or any bio mass fuel (sized) in this boiler without any alteration.

Larger steam – water interface area :

The ample diameter and length gives large steam – water interface area which gives the better steam quality.

Accessories:

Boiler is equipped with fluidized bed furnace, latest air pollution control equipment and heat recovery unit. The FD and ID fans are designed to consume minimum power and for lower RPM operation thus less wear & tear and long life of the fans. All valves such as Main steam stop valves, Safety valves, Check valves, Blow down valve etc. are of leader/equivalent make and Feed water pumps are of KSB make.

Automization :

The boiler is provided with pressure switch to operate between the set pressure i.e. boiler will automatically start when the pressure comes down to the lower set pressure and automatically stop when pressure reaches higher set pressure. To maintain the water level in the boiler mobrey water level controller is provided. It automatically On / Off the feed water pump according to the water level in the drum.

Instrumentation & Control panel:

The Instrument cum electric control panel is mounted with all electricals, relays, switches etc. Apart from these all the instruments like Steam pressure gauge, Temperature gauges for furnace, hot air and flue gas temperature at various points are provided to monitor all the parameters and operate the boiler efficiently.

Thermal efficiency:

The precise air & fuel controls with help of Variable frequency drive to ensure the maximum efficiency i.e. 82 % +/- 2% on Paddy husk.

Boiler installation:

This boiler is a single piece unit, thus making it ready to install. And minimal site work during installation of boiler.

Maintenance & shut down :

The flue gas velocity is so designed that it does not allow any ash deposition anywhere inside the boiler thus no tube cleaning is required at all.

TECHNICAL SPEICIFICATIONS –10 TPH, 21.0 KG/CM2 (G).

A.PERFORMANCE.

MAX. STEAM OUTPUT F & A 100 DEG C	: 10 TPH
PRESSURE	: 21 KG/CM^2
DRYNESS FRACTION	: 0.98
THERMAL EFFICIENCY	: 82% ON HUSK AND 83% ON COAL
FLUE GAS TEMPERATURE AFTER THE BOILER/H R U	: 250/160

B.DESIGN DATA.

DESIGN CODE FOLLOWED AMENDMENTS		: IBR 1950 WITH LATEST
DESIGN PRESSURE		: 21 KG/CM^2
MATERIAL OF CONSTRUCTION	SHELL	: ASTM A 516/515 GRADE 70 OR EQUIVALENT
	MEMBRANE PANEL	: BS 3059 PART-1 ERW-320 OR EQU
	IN BED HEADER	: **BS 3059 PART-II SEAMLESS**
HEATING SURFACE AREAS	SHELL	: 300 SQ.METERS
	MEMBRANE PANEL(EPRS)	: 38 SQ.METERS
	INBED HEADER	: 22 SQ.METER
STEAM HOLDING CAPACITY – SHELL		: 2.2 M^3
WATER HOLDING CAPCITTY - SHELL		: 12.8 M^3
STEAM TO WATER INTERFACE AREA		: 7.2 M^2

C.COMPONENT DATA

DIAMETER OF THE SHELL	: 2800 MM
LENGTH OF THE SHELL	: 3500 MM
SHELL THICKNESS	: After Detail Engineering
TUBE PLATE THICKNESS	: After Detail Engineering
SHELL TUBE DIA/THICKNESS	: 76.2/3.66
SHELL TUBE LENGTH	: 3500 MM
QTY IN I PASS/II PASS	: 214/146
MEMBRANE PANEL TUBE DIA/THK	: 63.5/3.66
LENGTH & QTY	: 3500 MM & 90 NOS.
IN BED HEADER DIA/THK	: 63.5/6.35THK
QUANTITY	: 34 NOS
TOTAL NO.OF NOZZLES (APPROX)	: 723

D. CONNECTIONS AND FITTINGS

MAIN STEAM STOP VALVE	: 200 MM
STEAM SAFETY VALVE (ONE EACH)	: 80X100

BLOWDOWN VALVE

• MEMBRANE PANEL MM/NO	: 25/2
• I B H	: 25/1
• SHELL	: 40/1

STOP VALVE IN THE FEED LINE MM/NO	: 50/3
N R V IN THE FEED LINE	: 50/3
AIR VENT VALVE	: 25/1

E. FEED WATER PUMP.

QUANTITY	: 2 NOS
CAPACITY M3/HR	: 14
PRESSURE HEAD MM WATER COLUMN	: After Detail Engineering
MOTOR	: 20 HP
SPEED	: 2900 R P M

F. FORCED DRAUGHT FAN.

QUANTITY	: 2 NO-(TWIN COMPARTMENT)
CAPACITY M3/MIN	: 150
PRESSURE HEAD AT 40 DEG C MM WC	: 400/625
MOTOR HP/RPM	: 25/30 HP – 1440 RPM

G. INDUCED DRAUGHT FAN.

QUANTITY	: 1 NO
CAPACITY M3/MIN	: 600
PRESSURE HEAD AT 180 DEC MM WC	: 250
MOTOR HP/RPM	: 50/1440.

H. HEAT RECOVERY UNIT-APH.

NO. OF TUBES	: 330
SIZE OF THE TUBES	: 60.3
HEATING SURFACE AREA	: 185 M2

T-CYCLONE

DIA OF THE BOTTLE	: 1000 MM
NO OF BOTTTLES	: 4 ANY
ROTARY AIR LOCK VALVES	: 5 NOS, EACH 1 HP
SCREW FEEDER	: 2 NOS, EACH 1 HP

Annexure- iii

Scope of Work

DESIGNING & ENGINEERING

- Complete designing of boiler layout at your site in consent with your engineering staff.
- Designing of boiler, fluidized bed combustion system, and other accessories for
  the boiler.
- Preparation of all relative drawings.
- Fabrication & supply of boiler, fluidized bed combustion system, HRU, Pollution control equipment and other accessories for the boiler.
- Supervision of commissioning of boiler.

Annexure iv

Scope of Supply

A. Pressure parts Consists of

- Steam drum
  - The boiler is provided with steam shell and is of fusion – welded construction.
  - The shell is provided with end plates fitted with stay tubes and plain tubes.
  - Two man hole doors (One on top and one at bottom) are fitted with cross bars, studs and nuts.
  - The shell is complete with required stubs for mounting valves and fittings.
- Down comers & Risers
  - Two numbers of down comers and one riser are provided to connect the
    steam drum and membrane furnace water walls.
- Furnace tubes
  - One set of bent tubes to form radiation zone and convection zone of boiler complete with inter connecting headers.
  - The furnace is a membrane water wall construction with Boiler quality strip is welded in between the tubes.
  - One set of bed coils to control the bed temperature.
- Feed water piping
  - One set of feed water piping with required vales between the boiler feed water pumps and boiler shell.
- Mountings and fittings
  - Main steam stop valve : 1 No.
  - Auxiliary steam stop valve 1 No.
  - Safety valve 2 Nos.
  - Main blow down valves : 1 No.

- Header blow down valves 4 Nos.
- Drum internal consist of baffle plates, perforated plate, dry box, tray and chevron type steam separator: 1 Set.
- Non return valve on water inlet line : 1 No.
- Gauge glass with drain valve : 2 Nos.
- Feed stop valve on water line : 1 No.
- Air vent valve : 1 No.
- Non return valve on pump outlet line : 1 No.
- Header air vent valve : 2 Nos.

B. Feed water system

- Boiler feed water system consisting of Two numbers of multi stage feed water pumps.

C. **Fluidized bed furnace: Twin Compartment Furnace.**

- Plannum chamber (Made out of 10 mm thick top plates, 6 mm thick bottom and side plates duly drilled to accommodate air nozzles for proper fluidization).
- Bed discharge system (With rotary air lock valve).
- Fluidized nozzles of graded Cast Iron.
- Doors (4 Nos.).
- Air connections (1 No.).

D. Variable frequency drive

- Electronic variable frequency drive with screw feeder and gear box for fuel feeding and control of feed.

E. Forced draught fan

- Heavyduty fan complete with air control damper made out of heavy gauge MS body with dynamically balanced impeller, heavy grade Cast Iron bearing brackets complete with MS hub, spherical roller bearings, pulleys and motor base frame suitable to handle air at ambient temperature.

F. Secondary Air System

- Made out of 3" dia MS 'C' class pipes with C.I. mouths (for long life of nozzles) fitted with high velocity air swirling nozzles.

G. Induced draught fan

- Induced draft fan complete with suction damper, expansion joint suitable to handle flue gases at high temperature.

H. Motor control center:

Central control panel for central indication / control shall be fabricated out of heavy gauge MS paltes.

I Heat Recovery Unit (Air Pre heater)

- Multipass counter current flow shell & tube type made out of 50 NB MS 'B' Class tubes and 5 mm thick MS body plate to pre-heat the water/air by drawing heat from flue gases for optimum efficiency of boiler complete with plate valve for ash removal.

J. Air Pollution control system

- 'C' Cyclone (Trema Type) with rotary air lock valve for continuous ash discharge.

Exclusions from scope of supply

A. Civil works

- Foundations for boiler, furnace and boiler accessories and boiler house.
- Supply of refractory bricks, insulation bricks, refractory material and furnace and sand required for the construction of furnace
- Civil supports for ducting or piping any etc.,
- Boiler house.

B. Mechanical

- Suitable chimney and its erection.
- Air & flue gas ducting, Structure, Platform and ladder
- Fuel preparation and conveying system (Vibratory Screen with Bucket Elevator)
- Fuel bunker Storage and feed water tanks.
- Base Plates and Foundation Bolts.
- Feed Water and Storage Tanks.

C. Piping

- Feed water piping up to suction inlet of feed water pumps.
- Steam piping from outlet of Main steam stop valve.
- Blow down / Drain / vent piping from respective valves.

D. Water treatment plant.

- Suitable water treatment plant based on the characteristics of raw water at site.

E. Electrical

- All Electrical and control cables for individual motors supplied by Cheema boilers limited.
- Earthing for motors supplied by CBL.

F. General

- Transportation and transit insurance.
- Additional pollution control equipment if any other than C-cyclone.
- Unloading of boiler and accessories at site and erection.
- I B R inspection and registration
- Boarding and lodging for Cheema's site engineers / Supervisors.
- Any other items specifically not mentioned in these exclusions.
- Any other Pollution devise other than C Cyclone.
- Thermal Insulation with Aluminum Cladding

Annexure – vi

Terminal Points

Water	:	Suction flanges of feed water pumps strainer.
		Inlet & outlet flanges of HRU in case of water pre heater.
Steam	:	Outlet flange of main steam valve on the boiler.
Fuel Paddy husk	:	Inlet of fuel feeders.
Ash	:	Outlet of
		- Bed drain pipes.
		- Ash drain gate at the bottom of HRU.
		- Rotary airlock feeder at the bottom of MDC ash chute.
Flue gas &	:	Outlet of Boiler / inlet & outlet of HRU or APH / inlet
		outlet of ID fan
Drains and vents	:	Outlet flange of
		- Blowdown valve from steam drum.
		- Furnace tube header drain valve.
		- Main header blowdown valve
		- Water level gauges drain cock.
		- Liquid level limiter drain valve.
		- Safety valve discharge flange.
		- Air vent valve.
Electricals	:	
LT		- Inlet & outlet terminals of boiler MCC.
Motors		- Terminal points of individual motor.

Annexure vii

Performance Parmeters

EFFICIENCY : on Paddy Husk 82 +/- 2% on GCV basis

PERFORMANCE CRITERIA :

FUEL

The output and other performance parameters of the boiler specified in this offer hold good only if fuel of the following characteristics is charged to the boiler. Any variation in the characteristics of fuel will alter the performance.

Rice husk

Gross calorific value of husk Kcals/kg. (min.)	:	3300
Moisture (Inherent)	:	Less than 10%

WATER

The performance of the boiler under this offer is based on filtered and treated water of the following quantity being available.

Specifications of feed water to boiler

Residual Hardness as $CaCO_3$	mg/ltr.	5 max.
pH value		8.5 to 9.5
Oil Content	ppm	Nil
Free CO_2	ppm	Nil
Bound CO_2	ppm	5 Max.
TDS	ppm	200 Max.

Specifications of water in boiler

Total Hardness	ppm	5 Max.
Alkalinity	ppm	15-20% of TDS
pH value	ppm	10.5 - 11
Sodium Sulphite Na_2S0_3	ppm	30-50 Max.
P_2O_5	ppm	15 to 30
Oxygen O_2	ppm	Nil
TDS	ppm	Less than 3500

Commercial Terms & Conditions

Basic price for supply of boiler 10 TPH Boiler(F & A 100 Deg C) ,21 Kg/Cm2 along with Air Pre Heater and Dust Collecting Equipment(C Cyclone) as per Annexure-iv is **Rs.69,50,000/-Ex-Works- Kurali, Punjab.**

Packing & forwarding is extra on basic price @ 2.5%

Taxes & Duties are extra as applicable at the time of dispatch or invoicing. The taxes applicable at present are

- Central Excise duty is exempted on Husk Fired Boilers and the same is 10.30% for Coal Firing Units
- Central Sales Tax 2% against Form C.

Transportation & transit insurance: At Actuals.

Unloading & erection is extra at actuals(Pl refer to Annexure V of Page 12)

Supervision of erection & commissioning is extra @ Rs.1500/- per day.

Delivery 4 Months from the date of Purchase Order along with the advance and steaming is 6 Months from the date of Purchase Order.

Payment terms are 40% advance along with Purchase Order and balance along with applicable taxes & duties against submission of Pro forma invoice before dispatch.

This offer is **valid** for 30 days from its date and there on wards subject to confirmation from our office.

Terms & Conditions of Sale

Warrantee

The boiler is warranted against malfunction arising out of faulty design, material and / or workmanship for a period of 12 months from the date of commissioning or 18 months from the date of Invoice, whichever is earlier. This clause will be applicable if the Purchaser strictly adheres to manufacturer's recommendations on feed water and fuel quality.

Boughtout items

The purchaser shall indemnify the manufacture for any delay arising from delay in supply of specific make of sub delivery insisted upon the purchaser where the manufacturer has no control over the delivery of that sub delivery.

Handing over of the boiler

The boiler shall be deemed to have been delivered and commissioned as per manufacturer scope and the purchaser shall issue a certificate to that effect. On achieving the rated steam parameters at the time of commissioning, it shall be deemed that the manufacturer has completed the performance tests. Manufacturer stands no guarantee if the boiler is put to commercial use without the authorisation of the manufacturer.

Boiler Registration

The boiler is manufactured as per Indian Boiler Regulations with latest amendments / ISO. One set of relevant documents and certificates signed by the Director of Boiler, Punjab will be forwarded to the customer. The purchaser at his cost shall complete subsequent formalities for registration of the boiler with boiler inspectorate of the state concerned.

Warehousing clause

If payment is not made within 15 days of date of proforma invoice, we reserve the right to divert the ordered material. We will give a fresh delivery period and price at the time of diversion which will be binding on the purchaser and the contract can not be rendered void on this account. If the goods cannot be diverted, change will be applicable for storage, insurance and interest at the rate of 1% of the invoice value for each week or part thereof commencing 15 days from the date of proforma invoice. Warehousing charge is subject to a maximum of 5%.

Place of Jurisdiction

In the event of any dispute of arising as result of contracting to supply against this offer and quotation, the place of Jurisdiction will be Ropar (Punjab) and not any other place.

Force Majeure

All our offer are subject to force majeure by which is meant causes beyond of our control such as war, invasion, civil disobedience, govt. orders, directives or restrictions, strikes, lockouts, riots, fire earthquakes, floods, accident delay or inability to obtain labour, raw material, railway wagon, shipping space or any such and similar causes what so ever.

General

On receipt of the purchase order the terms and conditions specified in our offer shall be deemed to have been accepted by the purchaser except in cases when the purchase order specifies otherwise.

Special Note

Please note that this offer is made strictly on the basis of divisible contract. The property in the goods shall pass to the buyer on the goods being handed over to the carrier for onward despatch to site endorsement and waybills in your favour.

Excess Materials

The excess materials send to site along with components for contingency and safe transportation purpose will be reused upto the maximum extent possible (or) taken back by CBL.

for **CHEEMA BOILERS LIMITED,**

NARASIMHAM GANTI.

LIST OF BOUGHT OUT ITEMS

NOTE: THE BELOW MENTIONED LIST IS APPLICABLE FOR THE EQUIPMENTS WHICH WILL BE UNDER CBL SCOPE AND DOES NOT IMPLY THAT THE EQUIPMENTS AND ITS SUB VENDORS SO LISTED ARE IN CBL SCOPE OF SUPPLY.

A.	MECHANICAL	
1.	FANS	CBL
2.	FEED PUMP	KSB / JOHNSON
3.	GEARBOX	RADICON / GREAVES
4.	COUPLINGS	RATHI
5.	BEARING	SKF / FAG / ZKL
6.	DIRECT WATER LEVEL GAUGE	
-	TUBULAR TYPE	LEVCON / SHARP
-	TRANSPARENT	LEVCON
7.	METALLIC BELLOWS	CBL
8.	AIR & FLUE GAS DAMPERS	CBL
9.	ERW TUBES	TATA / TPI
10.	BOILER SHELL PLATE	SAIL/ IMPORTED
11.	AIR NOZZLES	CBL
B.	**VALVES**	
1.	IBR VALVES	21 KG / CM^2 (LEADER / SHARP)
2.	SAFETY VALVES	FAINGER / DARLING
3.	BLOW DOWN VALVES	SHARP / LEVCON
4.	NON – IBR VALVES	SHARP / FLUIDLINE
C.	**CASTINGS**	
1.	MANHOLE DOOR	CBL
2.	OTHER CASTINGS	CBL

D. ELECTRICALS

1.	MOTORS	ABB / CROMPTON
2.	ACTUATORS	ROTARK / AUMA
3.	MCC / CONTROL PANEL	CBL
4.	LOCAL PUSH BUTTON STATION	CBL
5.	AIR CIRCUIT BREAKER	SIEMENS / L & T
6.	FUSE	SIEMENS / L & T
7.	SWITCHES	SIEMENS / L & T
8.	SWITCH / FUSE UNIT	SIEMENS / L & T
9.	THERMAL OVERLOAD RELAY	SIEMENS / L & T / SPRECHER SCHUH
10.	CONTACTORS	SIEMENS / L & T/ SPRECHER SCHUH
11.	AMMETER / VOLT METER	MECO / AE / RISHAB
12.	PUSH BUTTONS	ESBEE / SIEMENS
13.	SELECTOR SWITCH	SULZER / SIEMENS
14.	INDICATING LAMPS	ESBEE / SIEMENS
15.	MCB	SIEMENS / L & T / SPRECHER SCHUH
16.	TERMINAL BLOCKS	PHOENIX / ELMEX
17.	MCCB	SIEMENS / L & T / SPRECHER SCHUH
18.	TIMER	L& T / EAPL / SPRECHER SCHUH / GIC
19.	CABLES	GEMSCAB / ECKO
20.	VFD	ABB/ ALLEN BRADLEY

E. INSTRUMENTS

1.	TEMP. GAUGES	CBL / GIC / FORBES
2.	PRESSURE GAUGES	CBL / GIC / FORBES
3.	THERMOCOUPLES	TEMPSON/ TEMPEX
4.	PRESSURE SWITCH	INDFOS
5.	TEMP. SWITCH	INDFOS
6.	LEVEL SWITCH	MALHOTRA
7.	LIMIT SWITCH	CUTLERS HAMMER
8.	DRAUGHT GAUGE	CBL
9.	INDICATOR / 6 POINT TEMP. SCANNER	TEMPEX

TURBOTECH

TurboTech Precision Engineering Pvt. Ltd.
A-343, 9th Main, 2nd Stage, Peenya Industrial Estate,
Bengaluru - 560 058 INDIA
Phone (+91) 80 4122 7224 / 25 ***Fax*** (+91) 80 4127 2767
www.turbotechindia.com

TT/MKTG/APITCO/Q-5118/10-11

02nd February 2011

M/s APITCO Limited
8th floor, Parisrama Bhavan,
Basheerbagh, Hyderabad.
AP – 500 004

Subject: **ECT™ Steam Turbine System, Capacity: 290 KW**

Reference1: Your Enquiry Email Dated 25th January 2011
Reference2: TT/EQ-1888 Dated 25th January 2011

Kind Attn: Mr. D.Gopala Rao

Dear Sir:

With reference to the above:

We are in the receipt of your enquiry and thank you for the same, Further please find enclosed the Techno-Commercial Proposal for our ECT™ Steam Turbine System which addresses your requirements.

The ECT™ Steam Turbine Systems have the following unique advanced features, which make them ideal for your application:

- *Custom-optimized turbine blades, designed specially to suit process steam conditions, ensuring 10-15% greater efficiency*
- *One-piece turbine wheel CNC-milled from a single hardened Stainless Steel forging, for maximum accuracy, strength and life*
- *Integrated gear-box, eliminating bearings, seals and high-speed couplings, for maximum reliability and simplicity*
- *Compact packaging, minimizing floor-space and foundation requirements*
- *Minimum weight design, for ease of handling and installation*
- *Special design features to accommodate saturated steam*

We hope this offer meets your requirements. Please call us for any clarifications.

Yours Truly
For TurboTech Precision Engineering Private Limited

(Srivatsa P.A.)
Head - Marketing
+919448992610

TURBOTECH

Techno-Commercial Proposal

ECT™

Steam Turbine Generator System

Offer Reference: *TT/MKTG/APITCO/Q-5118/10-11*

TurboTech Precision Engineering Private Limited
A-343, 9th Main Road, Peenya Industrial Estate, Peenya 2nd Stage
Bangalore, Karnataka 560 058, INDIA
Phone: +91-80-41277221, Fax: +91-80-41272767
E Mail: marketing@turbotechindia.com
Web Site: www.turbotechindia.com

TURBOTECH

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TURBOTECH

1.0 SYSTEM CONTRACTUAL GUARANTEE

The Generator system will generate a power of 290**±3%**kW at the generator terminal with the following parameters as specified in Table 1.

Table 1: Constituents

DESCRIPTION	UNITS	DESIGN POINT
Steam Pressure at Turbine Inlet (At the Turbine Main Inlet Valve)	Kg/cm2 (g)	21.0
Steam Temperature at Turbine Inlet (At the Turbine Main Inlet Valve)	°C	212.0*
Steam Flow at Turbine Inlet (At the Turbine Main Inlet Valve)	TPH	8.0
Steam Pressure at Turbine Outlet (At the Turbine Exhaust Flange)	Kg/cm2 (g)	3.5
Steam Temperature at Turbine Outlet (At the Turbine Exhaust Flange)	°C	147.0
Power Output at the Generator Terminals	KW	**290 ±3%**

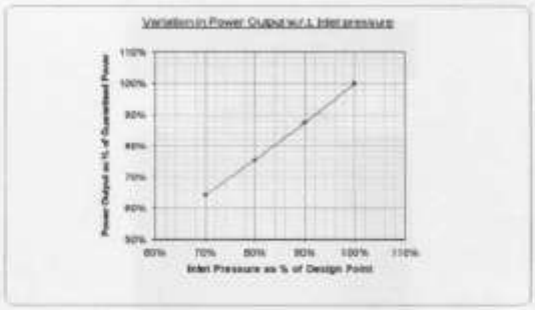
***Considering 100% Dry Saturated Steam**

Note:

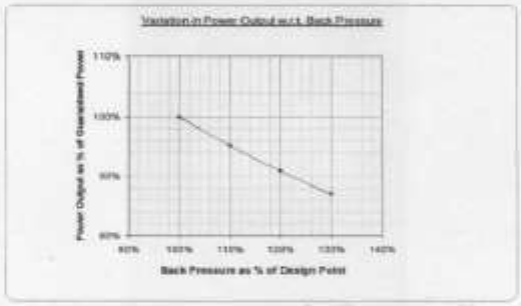
1. The flow and power output data apply at steady state and nominal inlet steam conditions at turbine inlet flange, with the control valve fully opened, deposit free blading and design point performance of Balance of plant equipments.
2. This steam condition consumption does not include the power requirements of any Auxiliary equipments.
3. Instrumentation tolerance of ±2.5% is allowed as per international testing practices
4. Steam quality and quantity should be maintained at the inlet point for guarantee point as shown in Annexure.
5. Performance under off-design conditions will depend on appropriate nozzle tuning / replacing for various flow conditions keeping Inlet Pressure and Temperature constant as per design.
6. Performance under off-design conditions will depend on appropriate nozzle tuning / replacing for various flow conditions keeping Inlet Parameters as per design.
7. Water and Steam quality should be maintained as per Annexure 1. Power Output Guaranteed is in correlation to the required minimum steam quality at Turbine Inlet as detailed in Annexure.

TURBOTECH

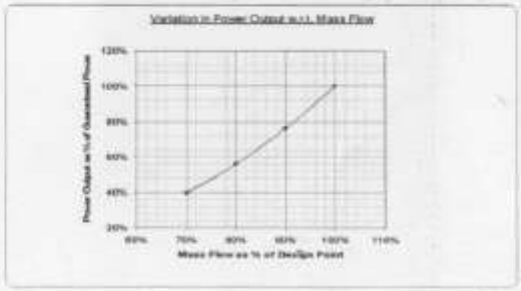
TURBINE PERFORMANCE CURVE WITH VARIABLE INLET PRESSURE& TEMPERATURES
(KEEPING FLOW & EXIT PRESSURE CONSTANT)



TURBINE PERFORMANCE CURVE WITH VARIABLE EXIT PRESSURE & TEMPERATURE
(KEEPING FLOW & INLET PRESSURE & TEMPERATURES CONSTANT)



TURBINE PERFORMANCE CURVE WITH VARIABLE FLOW
(KEEPING INLET & EXIT PRESSURE, TEMPERATURES CONSTANT FLOW & INLET PRESSURE CONSTANT)



TURBOTECH

2.0 SCOPE OF SUPPLY

Ref. Para.	Item	Qty
2.1	Turbine Module	1
2.2	Gearbox with integral oil tank	1
2.3	Coupling between Gear box and Generator	1
2.4	Lubrication System (including AOP, MOP and Accessories)	1
2.5	Turbine Governing Panel (PLC panel including Allen Bradley PLC, Micrologix 1500 Series with HMI).	1
2.6	Electrical Control Panel (Breaker Panel – 415 VAC)	1
2.7	Induction Generator (Rating 315KW, 415 V 50 Hz 0.8 PF, 1500 RPM)	1
2.8	Throttle Valve (Main turbine inlet valve- Pneumatically) operated	1
2.9	Unitary Mounting skid with AVMs	1
	Other Accessories Included are 1. Vibration Monitoring Probe - 1 No. 2. Speed Redundant - 2 Nos.	

TURBOTECH

TECHNICAL SPECIFICATIONS:

2.1 TURBINE MODULE

The turbine module contains the aerodynamic bladed components of the turbine, namely the nozzle and the rotor. The turbine module consists chiefly of the following:

a. Inlet manifold: Machined from high quality cast steel (ASTM A216 GR WCB) casting, conducts the inlet steam to the nozzle
b. Nozzle: Aerodynamic blading, 4-Axis CNC milled onto the periphery of a forged SS ring
c. Rotor disk: Aerodynamic blading, 4-Axis CNC milled onto the periphery of a forged SS disk

The turbine module does not contain bearings or seals, as the turbine wheel are directly mounted on the gearbox input shaft. This also eliminates the high-speed coupling.

TECHNICAL SPECIFICATIONS	TURBINE MODULE		
No.	Design-Point Parameters	Value	Unit
1	Turbine Type	Curtis , Single stage	
2	Casing Type	Non-Split one-piece	
3	Working Fluid	100% Dry Saturated Steam	
4	Inlet Pressure	21.0	Kg/cm2 (g)
5	Inlet Temperature	212.0	°C
6	Exhaust Pressure	3.5	Kg/cm2 (g)
7	Exhaust Temperature	147.0	°C
8	Steam Flow rate	8,000	Kgs/hr
9	Speed	12,000	RPM
10	Material of Construction, Casings	Suitable material to withstand the operating pressure & Temperature	
11	Material of Construction, Nozzle	AISI 304	SS Forging
12	Material of Construction, Turbine Wheel	17-4 PH	SS Forging
13	Manufacturer	**TurboTech**	

TURBOTECH

2.2 GEARBOX

The turbine module is mounted on the gearbox face, with the turbine wheel mounted directly on the input shaft flange in an overhung manner. The gearbox reduces the high speed of the turbine shaft to the lower generator speed. The mounting face of the gearbox is provided with a combination air-cum-oil shaft seal. The gearbox consists mainly of the following:

a. Housing (top & bottom halves): Precision machined carbon-steel fabrication.
b. High-speed shaft: Precision machined from a alloy steel forging, with integral helical pinion gear
c. Bull-gear: Precision machined from an alloy steel forging, helical gear
d. Output Shaft: Precision machined from alloy-steel forging, provided with a drive spline on coupling end
e. Oil Reservoir: Built into gearbox (wet sump construction, with air-oil separation features)
f. Seal: This consists of an air-buffered carbon ring labyrinth, consisting of multiple segmented graphite rings (controlled leak off type) contained in horizontally-split seal housing.

TECHNICAL SPECIFICATIONS	GEARBOX		
No.	Design-Point Parameters	Value	Unit
1	Input Speed	12,000	RPM
2	Gear Ratio	8:1	
3	Output Speed	1500	RPM
4	Gear-box Type	Parallel axis, single Reduction	
5	Gearing Type	Helical, case-hardened & Ground	
6	Gearing Accuracy	AGMA	
7	Gearbox Rating	315	kW
8	Bearings, high-speed	Multi Lobe Journal Babbitt Steel	
9	Bearings, low-speed	Taper-roller bearings, pre-Loaded	
10	Gearbox Efficiency	98.5%	
11	Lubrication	Jetted pressurized oil	
12	Lubrication Oil rating	ISO-VG 32	
13	Manufacturer	**TurboTech**	

TURBOTECH

2.3 COUPLING

The unit is a flexible shim-pack tube coupling, which is laterally flexible and torsionally rigid. It requires no lubrication. The coupling hubs and center tube are made from carbon steel forgings, and the shim-pack is of stainless steel AISI 301, hardened by cold- working. The carbon steel components of the coupling are protected by two-part epoxy paint.

TECHNICAL SPECIFICATIONS	COUPLING		
No.	Design-Point Parameters	Value	Unit
1	Maximum Speed	1,500	RPM
2	Design speed	1,500	RPM
3	Manufacturer	TurboTech	

TURBOTECH

2.4 LUBRICATION SYSTEM

The gearbox is provided with a pressurized re-circulating type lubrication system, consisting of:

1. Gearbox-driven Main oil pump (MOP)
2. Electric-motor driven Auxiliary oil pump (AOP)
3. Oil strainer
4. Duplex Oil filter (2 x 100%)
5. Plate type heat exchanger (Oil cooler)
6. Pressure regulation valves
7. Check valves
8. Oil distribution manifold
9. Oil jets
10. Interconnecting piping

For normal operation, the gearbox mounted Main Oil pump will provide pressurization. During starts and stops, the Auxiliary Oil Pump provides pre-and post- lubrication. Changeover from AOP to the MOP is automatic, and is by means of an oil-pressure switch signaling the PLC.

TECHNICAL SPECIFICATIONS	LUBRICATION SYSTEM		
No.	Design-Point Parameters	Value	Unit
1	Oil Viscosity rating	ISO-VG-32	
2	Oil type	Straight mineral	
3	Flow rate, main oil pump	54	Lpm
4	Flow rate, auxiliary oil pump	54	Lpm
5	Oil pump type (main & auxiliary)	Gear	
6	Oil Filter type	Duplex, on-line change-over	
7	Cartridge Type, Oil Filter	Paper cartridge, disposable	
8	Filtration rating	10	Micron
9	Instrumentation	As required	
10	Manufacturer	**TurboTech**	

TURBOTECH

2.5 TURBINE CONTROL PANEL (PLC PANEL)

The ECT system is controlled using a digital PLC, running a proprietary control algorithm. The PLC controls all aspects of the ECT system's operations, including START, RUN, STOP, TRIP and health-monitoring. Further, the PLC program can be customized (optional) to accept digital and analog inputs from the plant operator, both locally and remotely.

The PLC along with its attendant power supply and input cards is mounted in the Turbine Control Panel (TCP). The TCP contains only instrumentation and HMI's / displays, and is isolated from the high-power electrical switch-gear and bus-bars.

TECHNICAL SPECIFICATIONS	TURBINE CONTROL PANEL		
No.	Design-Point Parameters	Value	Unit
1	Type	Console type, dead rear end, front access	
2	Material of Construction	16swg CRCA steel sheet	
3	Digital Energy-Meter	V, A, Hz, KVA, pf, kW, kW-h	
4	PLC with HMI	Manufacturer:	Allen Bradley
5	Alarm and Trip annunciation	PLC HMI	
6	START / STOP Control	Key-switch	
7	EMERGENCY STOP (Mushroom button, latching)	Directly shuts-off Control Valve	
8	Mech. Trip: Over-speed	PLC Logic, Programmable	
9	Mech. Trip: Under-speed	PLC Logic, Programmable	
10	Mech. Trip: Low oil pressure (Pres. Switch)	PLC Logic, Programmable	
11	Mech. Trip: High bearing temp.	PLC Logic, Programmable	
12	Mech. Trip: Low Instr. Air Pressure (Pres. Switch)	PLC Logic, Programmable	
13	**From switch gear panel one signal will be taken to PLC For the following Electrical trip**		
	Elec. Trip: Earth fault (Relay, signaling PLC)	PLC Logic, Programmable	
	Elec. Trip: Over load (ACB, signaling PLC)	PLC Logic, Programmable	
	Elec. Trip: Over Current (Relay, signaling PLC)	PLC Logic, Programmable	
	Elec. Trip: Over Voltage (Relay, signaling PLC)	PLC Logic, Programmable	
	Elec. Trip: Under Voltage (Relay, signaling PLC)	PLC Logic, Programmable	
	Elec. Trip: Over Frequency (Relay, signaling PLC)	PLC Logic, Programmable	
	Elec. Trip: Under Frequency (Relay, signaling PLC)	PLC Logic, Programmable	
	Manufacturer	Turbo Tech	

TURBOTECH

2.6. ELECTRICAL CONTROL PANEL (BREAKER PANEL)

Electrical control panel description and parameters:

Make	TurboTech make
Type	Floor mounted cubicle type, free Standing and dead rear end and Front access
Material of Construction	16swg CRCA steel sheet.
RELAYS	
Type	Electro-mechanical type
Make	Alstom / Any Reputed make
Meters	Analog / Digital
System	3 phase, unbalanced load
Reference standard	IS-1248
Ammeter with selector switch	Supplied with suitable rating
Voltmeter with selector switch	0 – 600V
MDM(Multi Digital Meter) with IE option	Indicates V, A, HZ, KWA, KVA, KVAH, PF Etc...
CURRENT TRANSFORMERS	
Type	Tape Wound Type
Rating	Supplied with suitable rating
PROTECTION CTs	
Ratio	/ 5 A
Class	5P10
Burden	15VA
Quantity	3 Nos
METERING CTs	
Ratio	/ 5 A
Class	1
Burden	15 VA
Quantity	3 Nos
BUSBARS MATERIALS	Aluminum EC-91E grade/ Copper
INDICATING LAMPS	
Breaker on/off positions	3 Nos (on- off- trip)
Incoming busbar live	3 Nos
Outgoing busbar live	3 Nos
Aux. AC supply on	1 No
Emergency stop	Yes

ENVIRONMENT TURBOTECH ENERGY

SAFETY TRIPS PROVIDED

Over Speed Trip
Under Speed Trip
Over Voltage Trip
Under Voltage Trip
Over Load Trip
Over Current Trip
Earth Leakage Trip
Over Frequency Trip
Emergency Trip
Lube Oil Low Pressure Trip
Lube Oil Over Temperature Trip
Low Air Pressure Trip
Turbine Front Bearing Trip
Turbine Rear Bearing Trip
Pressure Transducer Faulty Trip
Low Pressure Steam Trip

Note: The above mentioned Specification/Rating and make may be subjected to change during detailed Engineering

TURBOTECH

2.7 INDUCTION GENERATOR.

Type	**INDUCTION GENERATOR**
Make	Marathon(Formerly known as Alstom)/Equivalent
Rating	315 KW
Speed	1500 RPM
Voltage	415V ±10%
Frequency	50Hz ± 3%
Protection	IP 23
Cooling	IC 01
Duty	S1
Insulation	Class F Temperature Rise Limited to Class B
Ambient Temperature	40 °C
Efficiency	
Full Load	During Detailed Engineering
3/4 Load	During Detailed Engineering
1/2 Load	During Detailed Engineering
Position of Terminal Box	Top
Applicable Standards	IS 325
Mounting Reference	As per IS 4691

Note: The above mentioned Specification/Rating and make may be subjected to change during detailed Engineering

TURBOTECH

2.8 THROTTLE VALVE

The turbine will be provided with a pneumatically-operated throttle valve. The valve is provided with a servo-positioner, controlled via the PLC. The valve is power-to-open, with a spring- actuated quick-shutoff trip action. It features a fail-safe quick-shutoff solenoid to "dump" the air pressure in the actuator in case of a trip. The valve will be fully compliant with Customer specifications.

TECHNICAL SPECIFICATIONS	THROTTLE VALVE		
No.	Design-Point Parameters	Value	Unit
1	Type	Globe type, single seat	
2	Material of Construction- Body	Cast steel Casting	
3	Nominal Size	**	Inch
4	Pressure Rating	**	ASA
5	Actuator Type	Piston	
6	Servo-Positioner	Smart Positioner	
7	Instrumentation Air Requirement	4.0 bar(g)	
8	Electrical power	24 V, DC	
9	Manufacturer	Flowserve / Equivalent make	

** will be provided during detailed engineering

TURBOTECH

2.9 MOUNTING SKID ASSEMBLY

The ECT system and the lubrication system will be mounted on a common skid. The skid is fabricated using carbon steel sections and plates, stress- relieved and machined from accuracy and long-term stability. The skid is provided with a stool for the generator. The entire skid assembly is supported anti-vibration mounts, to isolate the floor from the machine vibrations. This obviates the need to grout the assembly onto the floor, and consequently an ordinary industrial concrete floor capable of supporting normal industrial loads is sufficient.

TURBOTECH

3.0 LIMIT OF TENDER AND LIST OF EXCLUSIONS

LIMIT OF TENDER

This order is complete within the following limits beyond which purchaser shall arrange any and all equipment

- Inlet flange of the turbine the critical equipments which will be supplied loose along with the turbine (like inlet control valve)
- Exhaust flange of the turbine
- Inlet and outlet flanges of the cooling water connections of the oil cooler
- Inlet/outlet flanges of BOP equipments and default inter connecting pipes
- Tube drains with drain plugs terminated at the base plate
- Instruments, air connection ports wherever applicable
- Utility/auxiliary power at the control panel terminals
- Incoming terminal of Generator
- Incoming terminals to each motors

EXCLUSIONS

Following are excluded from Turbo Tech's scope of supply and also scope of work

- Any statutory approvals and local licenses
- Turbine Bypass System, including lines, valves and instruments
- Any civil Design/structural design/engineering/construction
- Crane and gantry in Power House.
- All steam, air and water Piping, Design/Supply/erection
- Cooling Water, accessories.
- **Moisture Separator – Strongly Recommended**
- **Steam Flow Meter - Strongly Recommended**
- **Y Strainer (IBR) – Strongly Recommended**
- **DoFs (to arrest the Forces & Moments coming to the Turbine) – Strongly Recommended**
- Gate valves & Isolation Valves.
- Capacitor Bank Panel with suitable capacitors for Power Factor Correction.
- Earthing for equipments and Earth Pits
- Bus bars and trucking
- All Power, control, Instrumentation with cables trays and trenches with end termination
- Electrical distribution system
- Erection and Commissioning
- Any item not specifically mentioned in "Scope of Supply".

TURBOTECH

4.0 DRAWING AND DOCUMENTATION SCHEDULE

The following documents form the Standard Documentation Package:

1. Dimensioned Installation Drawing
2. Piping and Instrumentation Diagram (P&ID) of the turbine installation, including Instrumentation Air and Cooling Water circuits
3. Single-Line Diagram of Electrical Panel
4. Bill of Materials

This will be submitted for information / approval within 4 weeks from date of receipt of technically & commercially clear purchase order. If there is no adverse customer comment with in 7 days of receipt of documents, we will presume that the same is in order and it will be released for manufacture.

All other documents requested by the customer will be charged on a mutually agreed basis.

Final drawings and documents shall be submitted along with supply.

TURBOTECH

5.0 PRICE SCHEDULE:

No.	Description	Unit Price Rs. Lakhs
1	**Standard ECT™ System – 290 kW Back pressure Steam Turbine** Design, Engineering, Manufacture and Supply of TurboTech make ECT™ Steam Turbine Generator System as per the technical details and scope enclosed	**49.87**
Rupees:	**Forty Nine Lakhs and Eighty Seven Thousand Only**	

Note:

BASIS OF OFFER:

The prices quoted by us are ex-works, Bangalore. Taxes & duties are extra and shall be charged at actual at the rates prevailing at the time of dispatch of equipment.

The present rates are as follows.

a.	Excise duty	: 10.30 % (presently)
b.	CST	: 2 % against form 'C' (presently)
c.	Packing & Forwarding	: Extra @ 2% on Basic value
d.	Freight & Insurance	: Extra to customers account
e.	Octroi & Entry tax	: Extra @ actual if applicable

CHARGES TOWARDS SUPERVISION FOR ERECTION & COMMISSIONING:

Charges towards supervision of erection and commissioning	**2.5 LACS**
Service Tax on E & C (presently)	10.30%
In addition to above, you shall also provide To & Fro charges, local Transportation, Lodging & boarding & First Aid facilities (if required) at site.	

TURBOTECH

- **PAYMENT TERMS:**

Payment terms and Conditions for Supply

- 30% advance along with the order.
- 20% on submission of drawings.
- 40% of the order value along with all taxes, Duties & packing and forwarding charges etc... against Pro-forma invoice and readiness of the Equipment prior to dispatch
- Balance 10% against PBG (Performance Bank Guarantee) valid for 12 months from the date of commissioning or 18 months from the date of supply, whichever is earlier.

Payment terms and Conditions for Supervision of Erection

- 50% as advance before arrival of our Service Engineer to site.
- 50% immediately after commissioning.

- **DELIVERY SCHEDULE:**
  4.5 months from the date of receipt of clear purchase order together with Advance.

- **VALIDITY:**
  This offer is valid for 60 days from the date and subject to re confirmation thereafter.

- **WARRANTY:**
  12 Months from the Date of commissioning or 18 Months from the date of supply, whichever is earlier. In this context, we reserve the right to qualify the defects and decide either to rectify the Turbine /components or to replace the same. The guarantee is applicable only for Turbine and not for spares and accessories.

Yours Truly
For TurboTech Precision Engineering Private Limited

(Srivatsa P.A.)
Head - Marketing
+919448992610

TURBOTECH

6.0 TERMS AND CONDITION OF SALE

1. **PRICE :**

The prices quoted are Ex-works, Bangalore **exclusive** of the following, which will be charges extra at actual as applicable at the time of delivery. The prices have been arrived at after considering the MODVAT benefits in the cost of inputs.

- Central Excise duty: Presently 10.30%
- Sales Tax (wherever applicable)-Central Sales tax: Presently 2% against Form "C"
- Freight charges **Extra** at actuals.
- Transit insurance @ 1.0% if to be arranged by us
- Octroi charges entry fees if applicable **Extra** at actuals
- Packing and forwarding charges 2% at the time of supply
- Any other statutory levies, at actual, as applicable at the time of supply
- Third party inspection **Extra** at actual, if any

2. **DELIVERY :**

All the items will be delivered 4.5 months from the receipt of your technically and commercially clear order & advance whichever is later. The delivery period is EX WORKS, BANGALORE subject to Force Majeure conditions. Early deliveries, part dispatch and part payment thereof should be acceptable to you.

3. **PAYMENT :**

Payment Terms and Conditions for Supply

- 30% advance along with the order.
- 20% on submission of drawings.
- 40% of the order value along with all taxes, Duties & packing and forwarding charges etc... against Pro-forma invoice and readiness of the Equipment prior to dispatch
- Balance 10% against PBG (Performance Bank Guarantee) valid for 12 months from the date of commissioning or 18 months from the date of supply, whichever is earlier.

Payment Terms and Conditions for Supervision of Erection & Commissioning

- 50% as advance before arrival of our Service Engineer to site.
- 50% immediately after commissioning.

TURBOTECH

4. **DRAWING APPROVAL :**

You are requested to specify clearly in the order whether drawings for items offered are required to be approved by you priory to manufacture. If so, we will submit drawing for your approval within 4 to 5 weeks upon receipt of technically clear order and you are requested to send us the drawings duly approved within two weeks after receipt at your end. Any delay in getting approved drawings at our end will protract delivery period accordingly. Generally drawing approval is not necessary. Hence, no drawing will be offered for approval. However it will be submitted for information only.

5. **INSPECTION :**

We will offer the Turbine and accessories for your inspection at our works prior to dispatch. Seven days advance intimation will be given to you. In case we do not hear from you, we will arrange to dispatch the items after testing at our works which is deemed to have been carried out in the presence of your representative and submit the test and guarantee certificates to you. If you insist on witnessing the test, interest at prevailing bank rate after seven days from the date of intimation for inspection will be charged to you. Your letter of intent and purchase order should clearly specify the name of inspection authorities for the Turbine.

6. **INTEREST ON FINSHED GOODS:**

After inspecting the material if you don't release dispatch clearance within seven days, then we will be charging interest at prevailing bank rate on the finished goods.

7. **VALIDITY:**

We will keep our offer valid up to 30 days from the scheduled date to this tender opening / date of this offer.

8. **DISPATCH:**

All items will be dispatched on SELF freight TO-PAY basis through our bank approved road transporters only. You are requested to furnish road permit form, if any, along with your order. Please note any demurrage due to delay in retiring the documents and handling over the consignee copy of L.R. to the transporter will be to your account. Dispatch instructions / details must be furnished in your order.

TURBOTECH

9. **INSURANCE:**

We will cover insurance with our underwriters, M/s New India Assurance Company Ltd., Mumbai. In case of any discrepancy damage observed on items at the time of receipt at your end, following is required to be taken by you:-

a. The damage / discrepancies should be notified to us telegraphically within 7 days of receipt / collection.
b. The open delivery certificate from the carriers should be sent to us.
c. The letter of authority from consignee for our claiming the equivalent amount for the damage / discrepancy observed should be sent to us.
d. Damaged items / discrepancy on these items should be shown to the surveyor from the nearest branch office of M/s New India Assurance Company Ltd. for obtaining survey report.

10. **WARRANTY:**

All our equipment is tested before dispatch and therefore can be depended upon for long trouble free service. We undertake to make good by replacement or repair, defects arising out of faulty design, material or workmanship, within eighteen months of the date of dispatch or twelve months from the date of commissioning, whichever is earlier. Providing that if we so require, the parts in respect of which complaint is made, must be sent at Purchaser's expense to our works before liability can be entertained.

Electrical components such as instruments such as pressure gauges, thermometers, RTDs, etc., are not covered under this warranty.

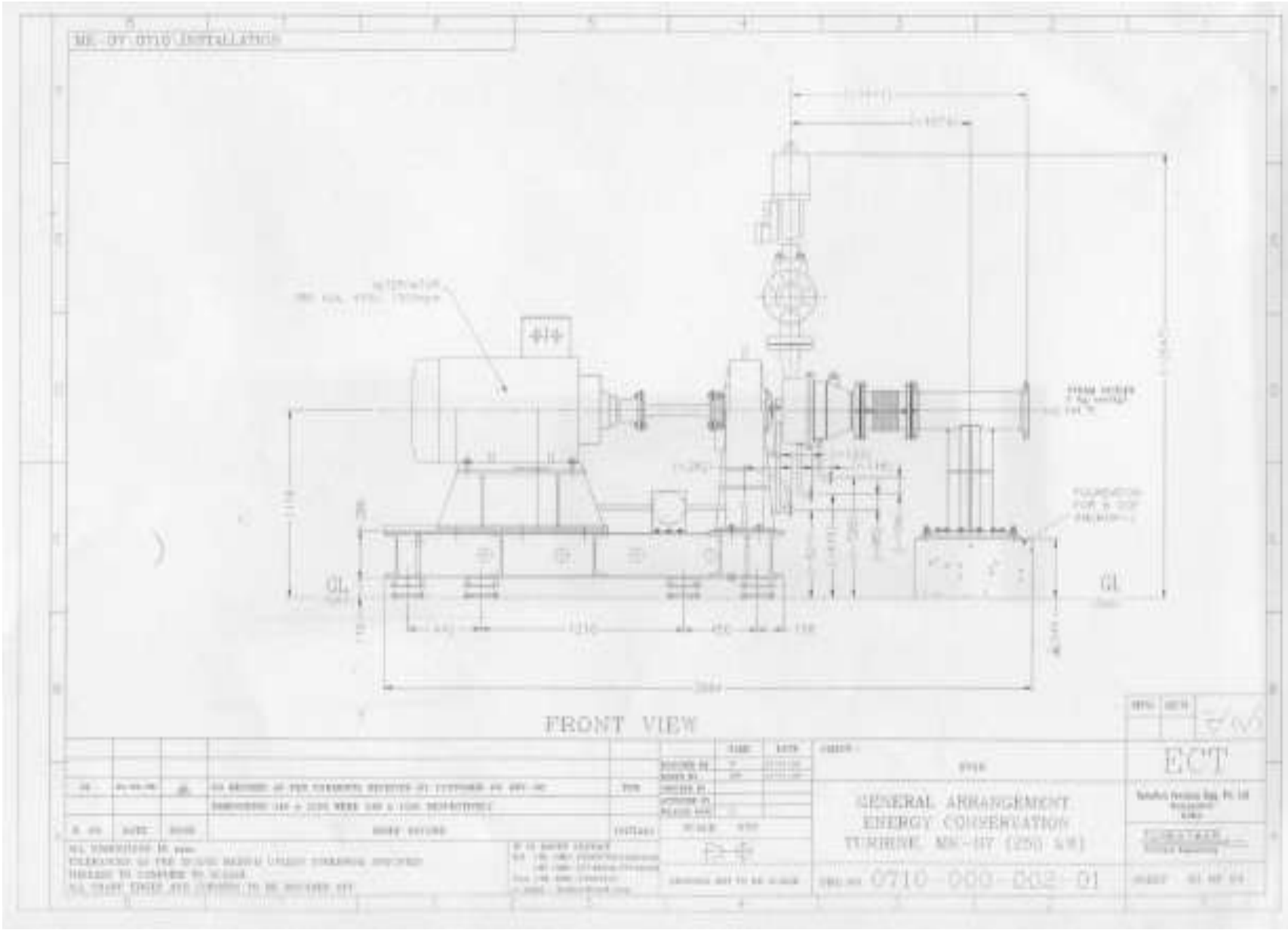
Bought out components other than those falling in the categories mentioned above are guaranteed by us only to the extent of guarantees given to us by our suppliers.

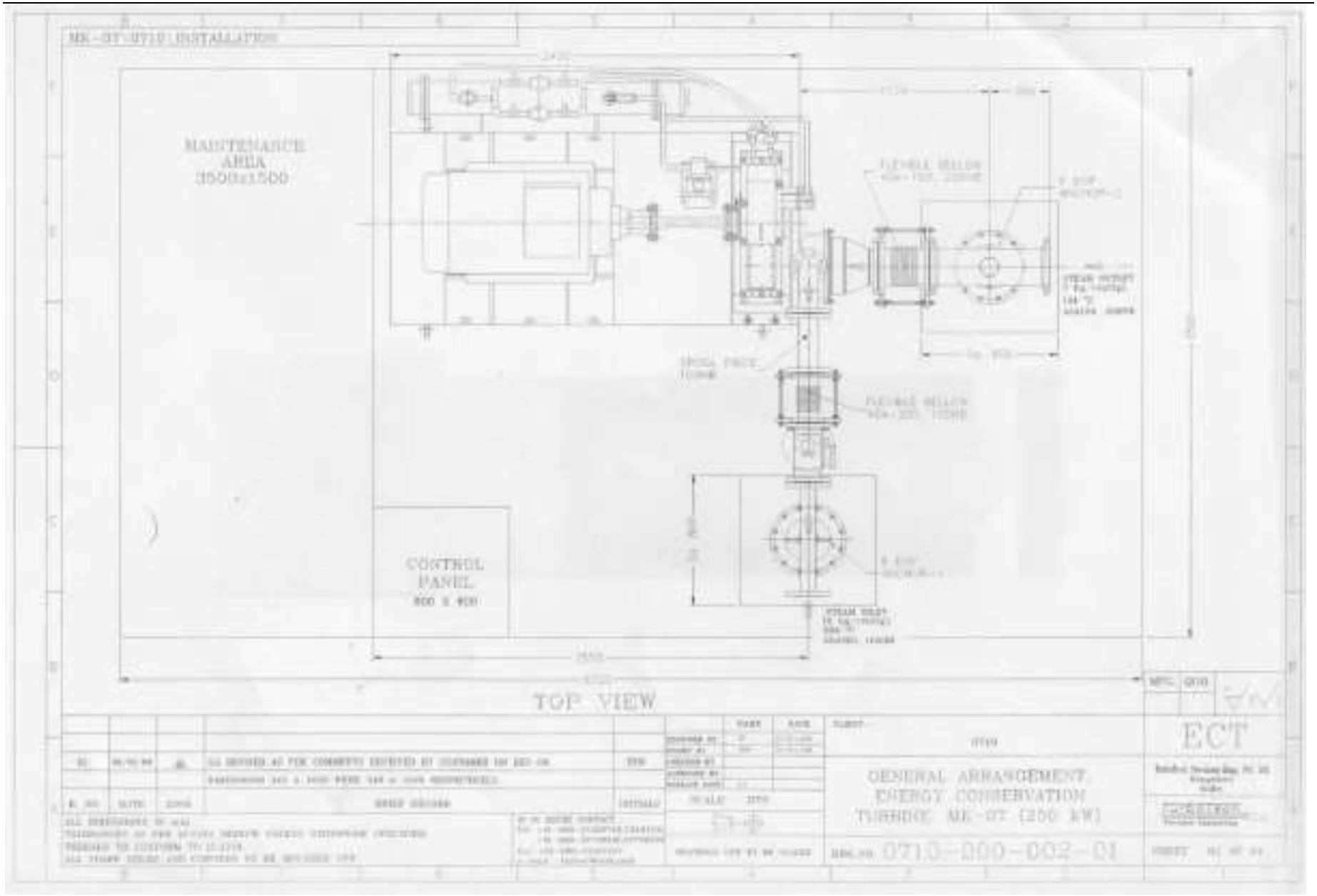
This warranty will be valid subject to:

1. Installation having been completed within 3 months of dispatch of the equipment or alternatively stored with care without damage.
2. The equipment or part thereof not being subject to accident alteration, abuse or misuse.
3. Installation has been made in a proper manner as per our Installation Manual.
4. The equipment being operated and maintained as per our Operation and Maintenance Manual and other operating instructions.

11. **ORDER CANCELLATION:**

Modification or cancellation of order cannot be accepted and is subject to our written consent. The purchaser will be liable to pay for all materials, overhead expenses and time spent on work already carried out prior to such modification or cancellation.


FRONT VIEW
GENERAL ARRANGEMENT
ENERGY CONSERVATION
TURBINE MS-07 (250 kW)
0710-000-002-01
ECT


MAINTENANCE
AREA
3500x1500
CONTROL
PANEL
TOP VIEW
GENERAL ARRANGEMENT
ENERGY CONSERVATION
TURBINE ME-ST (200 kW)
ECT

Bureau of Energy Efficiency (BEE)
(Ministry of Power, Government of India)
4th Floor, Sewa Bhawan, R. K. Puram, New Delhi – 110066
Ph.: +91 – 11 – 26179699 (5 Lines), Fax: +91 – 11 – 26178352
Websites: www.bee-india.nic.in, www.energymanagertraining.com

APITCO Limited
8th FLOOR, PARISRAMA BHAVAN,
BASHEERBAGH, HYDERABAD 500 004
Phones: +91- 040-23237333, 23237981,
Fax: +91-40-23298945
e-mail: hyd1_apitco@bsnl.in
Website: www.apitco.org