WASTE HEAT RECOVERY POWER PLANT(2MW)– 100TPD

ORISSA SPONGE IRON CLUSTER

BEE, 2011

Detailed Project Report on Waste Heat Recovery

Power Plant (2MW)- 100 TPD

Sponge Iron SME Cluster, Orissa (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No.: **ORSA/SPONGE/WHP/10**

For more information

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We sincerely appreciate the efforts of industry, energy auditors, equipment manufacturers, technology providers, consultants and other experts in the area of energy conservation for joining hands with Bureau of Energy Efficiency (BEE), Ministry of Power, and Government of India for preparing the Detailed Project Report (DPR) under BEE SME Program in SMEs clusters. We appreciate the support of suppliers/vendors for providing the adoptable energy efficient equipments/technical details to the SMEs.

We have received very encouraging feedback for the BEE SME Program in various SME Clusters. Therefore, it was decided to bring out the DPR for the benefits of SMEs. We sincerely thank the officials of BEE, Executing Agencies and ISTSL for all the support and cooperation extended for preparation of the DPR. We gracefully acknowledge the diligent efforts and commitments of all those who have contributed in preparation of the DPR.

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Lists 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
MoSME	- Micro Small and Medium Enterprises
NPV	- Net Present Value
ROI	- Return On Investment
SIDBI	- Small Industrial Development Bank of India
SME	- Small and Medium Enterprises

EXECUTIVE SUMMARY

APITCO Ltd. is executing BEE-SME program in Orissa Sponge Iron Cluster, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in cluster units.

Rourkela and Sundargarh area is renowned for Sponge iron manufacturing business and is a big hub for sponge iron supply. There are about 107 sponge iron units in the cluster and majority of industries located in Sundargarh area engaged in production of sponge irons which further converted into billets through induction furnace for further use.

The major Energy consumption in sponge Iron cluster is of thermal energy derived from coal and electrical energy from grid electricity. Electricity is used for supplying energy for motor driven drives like kiln min drive, cooler main drive, crushers, bag filters, pumps, ESPs etc. and also for lighting purpose. If the percentage share of the total energy consumption is considered then the electrical is not more than 2% where as the remaining 98% is the thermal energy requirement. HSD is used as fuel in DG sets for generation of electricity during the power failure from Electricity board.

In the plant it is observed that a good amount of heat energy is expelled out of the kiln in the form of waste gases, more over an extra amount of electrical energy is given via forced draft fan to reduce the heat content of the flue gases for the environmental concern. The flue gases from the kiln's ore feeding end contains a good percentage of carbon monoxide which is further burnt in the ABC i.e. the After Burning Chamber which causes rise in the outlet flue gases temperature. The waste heat of the flue gases can be used for generating power which results in the power consumption.

The DPR highlights the details of study conducted for assessing the potential for reducing thermal energy consumption during operation by installing fuel economizer at the various units in the cluster, possible energy savings and its monetary benefit, availability of the technologies/design, local service providers, technical features and proposed equipment specifications, various barriers in implementation, environmental aspects, estimated GHG reductions, capital cost, financial analysis, and schedule of project Implementation.

Total investment required and financial indicators calculated such as debt equity ratio, monetary saving, IRR, NPV, DSCR and ROI etc for proposed technology is furnished in Table below:

S. No.	Particular	Unit	Value
1	Project cost	(in Lakh)	725
2	Power Savings	KW/annum	14256000
3	Monetary benefit	(in Lakh)	499
4	Simple payback period	Months	18
5	NPV	(in Lakh)	660.29
6	IRR	percentage	37.01
7	ROI	percentage	34.78
8	Average DSCR	Ratio	2.24

The projected profitability and cash flow statements indicate that the project implementation i.e. installation of waste heat power plant 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. Orissa Sponge Iron 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

The state of Orissa is located in the South –East coast of India in the banks of Bay of Bengal. The state capital is Bhubaneswar. It is renowned for the Sponge Iron business. They even export to various countries throughout the world.

There are about 107 sponge iron industries in the cluster and majority of industries are located in Orissa.

The major Energy consumption in Ice making cluster are thermal energy from coal and grid electricity. Electricity is used for driving the prime movers of installed in the plants i.e. Reduction Kiln main drive, Cooler Kiln main, air compressors, pumps, and other drives and even for lighting purpose. The majority of the energy share is by the thermal energy drawn by burning coal which comes out to be around 98% of the total energy consumption the remaining is by the electrical energy.

1.1.1 Production process

Non-coking coal and iron ore along with limestone in the required size range and quantity are continuously fed into the feed – end of the inclined rotary kiln through a feed pipe. The materials move along the length of the kiln due to its inclination and rotation. Air is blown in through required number of air tubes suitably located along the length of the kiln. At the feed-end of the kiln air is blown in through nozzles for drying and pre heating of the charge. Initial heating of the kiln is carried through a central oil burner located at the discharge feed end. As the charge moves through the kiln, it is heated by the hot gases, which flow in the opposite direction to the charge (i.e. counter current flow). The initial part of the kiln (about 30%) is called the pre heating zone, where moisture in the charge and volatiles in the coal are removed / burnt off as waste gases. The required heat in this zone is provided by the combustion of the feed coal. The remaining portion of the kiln is called as the reduction zone. In this zone, oxygen in the iron ore is removed leaving metallic iron as per the following chemical reaction.

$3FeO_3 + CO \leftarrow\text{----------}\rightarrow 2\ Fe_2O_4 + CO_2$

$Fe_2O_4 + CO \leftarrow\text{----------}\rightarrow 3FeO + CO_2$

$FeO + CO \leftarrow\text{----------}\rightarrow Fe + CO_2$

The CO is generated for the above reaction according to $CO_2 + C \rightarrow 2CO$, at temperature above 900 deg. C, carbon monoxide will combine with the oxygen in the iron ore forming carbon dioxide and thus reduce the ore to metallic state.

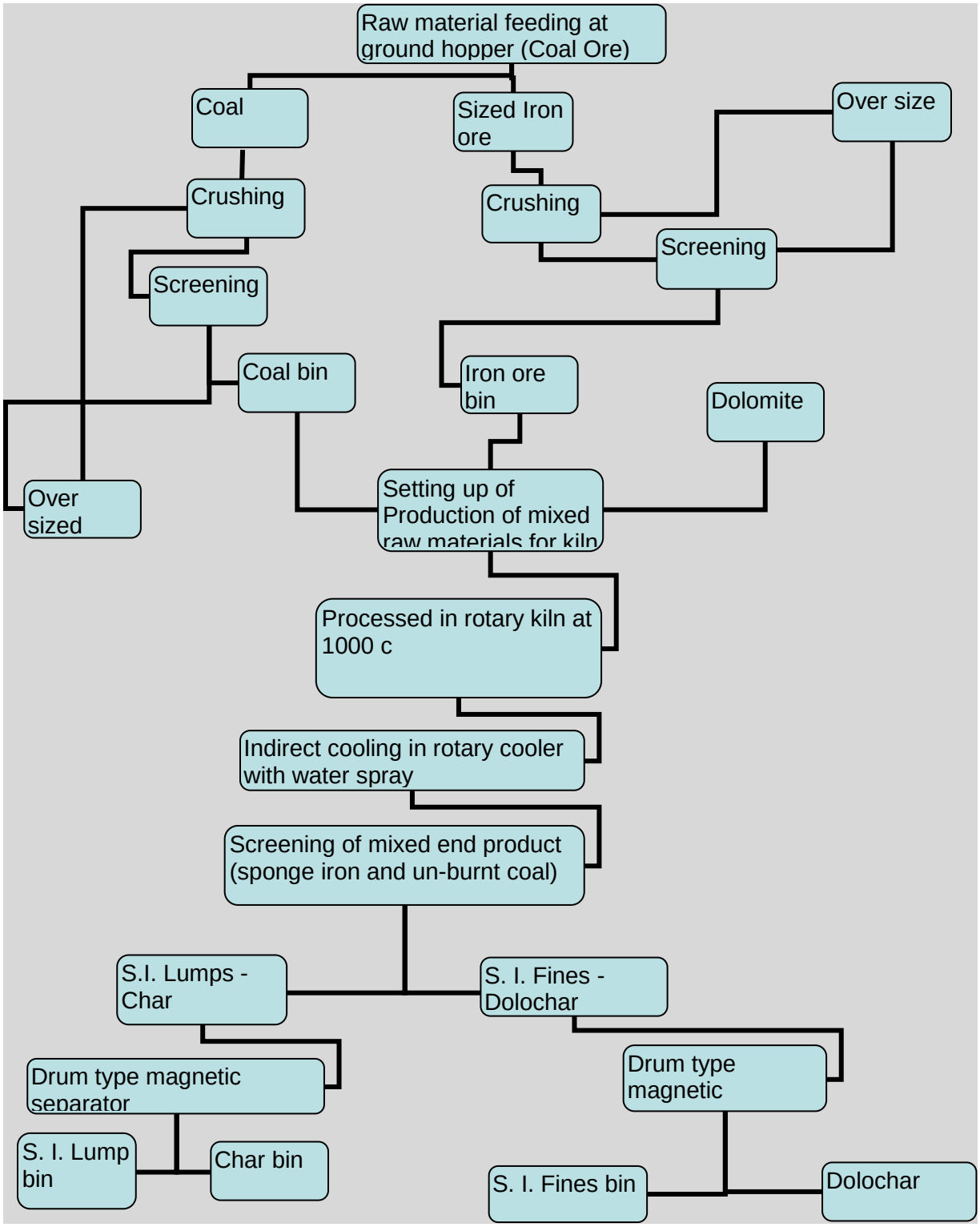
Higher the temperature, the faster would be the oxygen removal. After the removal of oxygen and grater is the metallization of sponge iron. Metallization levels can roughly be checked by density of the sponge iron. It can also be judged by the metallic luster if a sample is rubbed against a rough surface.

After the iron ore has been metallic to the desired level, sponge iron and residual char are discharged from the kiln into a rotary drum type cooler. In the cooler sponge iron is cooled to below 60 deg. C before the material is discharged on to a belt conveyor. If the sponge iron were exposed to air at high temperatures (about 150 deg. C) it would tend to re oxidize. It is therefore, necessary that the temperature of the product at the point of discharge from the cooler is as close as possible to the ambient temperature. The reduction process occurs in solid state. The crucial factor in this reduction process is the controlled combustion of coal and its conversion to carbon monoxide to remove oxygen from the iron ore.

The overall process extends to a period of 10 to 12 hours inside the kiln. During this time, iron ore is optimally reduced and the hot reduced sponge iron along with semi-burnt coal is discharged to a rotary cooler for indirect cooling to a temperature of around 120°C. Sponge iron being magnetic in nature, the discharge from cooler main drive consisting of sponge iron, chars & other contaminations are routed through electromagnetic separators, to separate other impurities from sponge iron. The product is then screened in size fractions of lump (+3mm) and fines (0-3 mm). Separate bins are installed to preserve its quality, reduce re oxidation and facilitate faster loading on to the trucks.

Detailed of process flow chart are finished in Figure 1.1 below:

Figure 1.1: General process flowchart of a typical Sponge Iron unit



1.2 Energy performance in existing situation

1.2.1 Fuel and electricity consumption of a typical unit in the cluster

The main energy used in a typical sponge iron industry is the thermal energy derived from coal and electrical energy from grid supply. Electricity is used for driving the prime movers like kiln drives, compressors, pumps, Bag filters, crushers, FD and ID fans etc. and even for lighting power consumption. The energy consumption details are given below in the Table 1.1 below:

Table 1.1: Energy consumption of typical units have 100 TPD kiln

S. No	Name of Industries	TPD	No. of 100 TPD Kiln	Annual Production	Annual Electricity consumption (millions of kWh)	Annual Coal Consumption (Tons/annum)
1	Govindam Projects P Ltd.	200	2	62415	4.99	108186
2	Jay Iron & Steel Pvt. Ltd.	200	2	59862	4.75	93119
3	Kalinga Sponge Iron Limited	200	2	58800	6.17	91467
4	Maa Shakamburi Sponge ltd.	100	1	29651	2.9	46124
5	Pooja Sponge Private Limited.	200	2	60000	4.7	93333
6	Shree Ganesh Metallics Ltd.	400	4	122000	9.8	199562
7	Singhal Enterprises Pvt. Limited	200	2	60500	6	95270
8	Sponge Udyog private limited	200	2	59700	4.8	92866
9	Sri Mahaveer Ferro Alloys Pvt. Limited	200	2	60366	5.99	93887
10	Sri Mangalam Ispat Limited	200	2	61000	5.2	94888
11	Surendra Mining (IND) P. Ltd	200	2	59000	4.11	92714
12	Vishal Metallic Limited	100	1	28000	4.1	44091

1.2.2 Average production by a typical unit in the cluster

The average productions in a sponge iron unit depend on the installed TPD for a single 100 TPD kilns it varies in between 28000 to 30000 tons per annum.

1.2.3 Specific Energy Consumption

For production of sponge iron both thermal and electrical energy are required. The major share of the energy is for the thermal energy which is around 98 % and the remaining is of the electrical energy. The over all specific energy consumption of the units is given below:

Table 1.2: Specific energy consumption for typical units with 100 TPD kilns

S. No.	Name of Industries	TPD	No. of 100 TPD Kiln	Annual Production	Over all Specific energy consumption (TOE/ Tons)
1	Govindam Projects P Ltd.	200	2	62415	0.53
2	Jay Iron & Steel Pvt. Ltd.	200	2	59862	0.47
3	Kalinga Sponge Iron Limited	200	2	58800	0.48
4	Maa Shakamburi Sponge ltd.	100	1	29651	0.48
5	Pooja Sponge Private Limited.	200	2	60000	0.47
6	Shree Ganesh Metallics Ltd.	400	4	122000	0.50
7	Singhal Enterprises Pvt. Limited	200	2	60500	0.48
8	Sponge Udyog private limited	200	2	59700	0.47
9	Sri Mahaveer Ferro Alloys Pvt. Limited	200	2	60366	0.48
10	Sri Mangalam Ispat Limited	200	2	61000	0.47
11	Surendra Mining (IND) P. Ltd	200	2	59000	0.48
12	Vishal Metallic Limited	100	1	28000	0.48

1.3 Existing technology/equipment

1.3.1 Description of existing technology

In the present condition there is no arrangement for the recovery of the waste heat which is expelling out of the kiln. The pre heating is of the ore is done in the 1st zone of the kiln where the temperature reaches to 700^{0}C, just before the reduction zone. And the heat contained in the flue gas is force fully reduced by the help of the FD fans or GCT arrangements just after the ABC chamber. The heat contained in the flue gas coming out of the kiln is made to increase more in ABC as because the unburned carbon monoxide is made to burn in the ABC for converting it completely to cordon dioxide. This hot expelled out gas is conditioned in the ESP and FD or GCT arrangements and then is released in the atmosphere.

1.3.2 Its role in the whole process

As the system proposed is not replacing any of the existing technology thus to describe the role in the whole process is not applicable.

1.4 Establishing the baseline for the equipment

1.4.1 Design and operating parameters

The present energy consumption for the production of sponge iron is given in the Table 1.4. The coal consumption depends on the production per batch which can be considered to be 24 hours per day.

1.4.2 Coal consumption in existing system

The coal consumption in the process of sponge iron manufacturing the units having at least one 100 TPD kiln is given below with the specific coal consumption of the unit.

Table 1.4 Coal consumption of Sponge iron Cluster

S. No.	Name of Industries	TPD	No. of 100 TPD Kiln	Annual Production	Annual Electrical energy consumption (millions of kWh)	Annual Coal consumption (from coal of CV 3000 kcal/kg)	Specific Coal Consumption (tons of coal/ tons of Sponge iron)
1	Govindam Projects P Ltd.	200	2	62415	4.99	108186	1.73
2	Jay Iron & Steel Pvt. Ltd.	200	2	59862	4.75	93119	1.56
3	Kalinga Sponge Iron Limited	200	2	58800	6.17	91467	1.56
4	Maa Shakamburi Sponge ltd.	100	1	29651	2.9	46124	1.56
5	Pooja Sponge Private Limited.	200	2	60000	4.7	93333	1.56
6	Shree Ganesh Metallics Ltd.	400	4	122000	9.8	199562	1.64
7	Singhal Enterprises Pvt. Limited	200	2	60500	6	95270	1.57
8	Sponge Udyog private limited	200	2	59700	4.8	92866	1.56
9	Sri Mahaveer Ferro Alloys Pvt. Limited	200	2	60366	5.99	93887	1.56
10	Sri Mangalam Ispat Limited	200	2	61000	5.2	94888	1.56
11	Surendra Mining (IND) P. Ltd	200	2	59000	4.11	92714	1.57
12	Vishal Metallic Limited	100	1	28000	4.1	44091	1.57

1.4.3 Operating specific coal consumption of existing system.

The detailed energy audit studies had been undertaken in various units of the cluster to evaluate the specific coal consumption in the cluster. Based on the installed TPD the specific energy consumption varies from 1.56 to 1.73 tons of coal to tons of production. On installing the fuel economizer there is a reduction of coal consumption by 5% of that of the present coal consumption.

1.5 Barriers for adoption of new and energy efficient technology / equipment

1.5.1 Technological Barriers

The major technical barriers that prevented the implementation of the waste heat boiler in the cluster are:

- Lack of water availability.

1.5.2 Financial Barrier

Implementation of waste heat power plant requires high investment compare. Hence, many of the owners don't show interest due to high initial investment.

Energy Efficiency Financing Schemes such as 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 for implementing the fuel economizer.

1.5.3 Skilled manpower

Not applicable

1.5.4 Other barrier(s)

Information on energy efficient technologies is not available among cluster unit owners, though the suppliers are available in near by states to the sponge iron cluster. Such technology has a substantial potential to save power consumption in the cluster.

2. TECHNOLOGY/EQUIPMENT FOR ENERGY EFFICIENCY IMPROVEMENTS

2.1 Detailed description of technology/equipment selected

2.1.1 Description of equipment

The project activity is installing the waste heat power in the existing operation. This arrangement uses to recover the waste heat of the exhaust flue gas coming out from the ABC outlet is feed in the waste heat boiler for generating power. The flue gas contains the heat content which is considerable to recover by adopting the proper heat recovery system. The sensible heat of the flue gases can be recovered to an extent. Complete recovery of waste heat is neither theoretically possible nor economically viable and hence only optimum quantity of the heat is recovered during this process. The waste heat recovery power plant has following special features:

- The most effective feature implementation point of view is that it does not require any additional space for installation.
- It significantly reduces the effect the temperature of the flue gases expelling out in the atmosphere.

2.1.2 Technology /Equipment specifications

The detailed specification of the Waste Heat Recovery power plant suggested is furnished in table 2.1 below:

Table 2.1: Waste heat recovery power plant Specifications

Boiler: IBR 1950 with its latest amendments

S. No.	Specifications	UNIT	Data
1	Design Pressure	Kg/cm2	75
2	Design Temperature	oC	317
3	Hydro test Pressure	Kg/cm2	112.5
4	Type		Vertical
5	Type of tubes		Bare
6	Tube outer diameter	mm	50.8
7	Tube thickness	mm	4.47
8	Fin thickness	mm	5
9	MOC of tubes		BS 3059 Seamless
10	MOC of fins		IS 2002
11	MOC of headers		SA 106 Gr.B

Turbine: Multi stage, Horizontal Spindle, Bladed Design, Axial Flow, Impulse, Bleed cum Condensing Steam Turbine.

S. No.	Specifications	UNIT	Data
1	Make		KESSELS
2	Turbine Rating	MW	2
3	Inlet steam pressure	Kg/cm2	64
4	Inlet steam Temperature	oC	485
5	Inlet steam flow	TPH	18
6	Bleed Steam	TPH	1.75
7	Exhaust steam pressure	Bar	0.18
8	Steam flow to condenser	TPH	9.125
9	Power Generated (MAX)	MW	2

2.1.3 Justification of the technology selected & Suitability

The flue gas coming out of the reduction kiln is having a very high thermal energy which not been used for any of the process activity. Further the high temperature content of the gas is made to cool down by the force draft fan in waste gas treatment zone which is then fed to the ESP for the waste gas cleaning due to the environment concern. This technology is very useful for exchanging the heat of the waste flue gases for generating power.

2.1.4 Superiority over existing technology/equipment

In the present process condition extra amount of energy is required to reduce the waste heat of the exhaust flue gas. This is the energy required to run the FD fans for cooling the flue gas for the safety of the environment. With the installation of the waste heat recovery boiler good amount of heat is absorbed for per heating water and producing steam. Utilizes the waste energy of the flue gas which unused in the previous system.

- Reduces the environmental effect.

2.1.5 Availability of proposed technology/equipment

Such equipment suppliers are available and are already been installed in some of the sponge iron plants in Raipur. The detail of the supplier is provided in Annexure-6.

2.1.6 Source of technology/equipment for the project

The source of the technology is indigenous and is available.

2.1.7 Service/technology providers

A detail of supplier has been furnished in Annexure 6.

2.1.8 Terms of sales

No any specific terms and conditions

2.1.9 Process down time during implementation

The process down time for installation of waste heat recovery boiler is Zero due to no major changes required for installing this technology.

2.2 Life cycle assessment and risks analysis

The life of the waste heat recovery boiler system is considered for 15 years. There is no risk involved as the technology is installed in few plants and running successfully.

2.3 Suitable unit/plant size in terms of capacity/production

The Waste heat recovery power plants are categorized by the following plant sizes they are 100 TPD, 200 TPD & 300 TPD if they are installed side by side and the flue gas output can be merged together from the out let of ABC.

3. ECONOMIC BENEFITS FOR THE INSTALLATION OF WASTE HEAT RECOVERY BOILER

3.1 Technical benefits

3.1.1 Fuel savings per year

Waste Heat carried away by the flue gases is being recovered by the Waste Heat recovery Boilers and gainfully used for Steam and hence power generation.

Fuel: The fuels available for power generation are:

Off Gases from DR kiln after "After Burning Chamber (ABC)The waste Heat Boiler will be installed behind the ABC of DR kiln in bypass configuration. The flue gases after ABC will be taken to unfired furnace chamber and them flow over banks of super heater, convective evaporator and economizer before being discharged to atmosphere through ESP, ID Fan and chimney of DR Kiln. In case of outage of Waste Heat Boiler, Flue gases will pass through GCT- ESP ID Fan and Chimney. The flue gases will pass over various heat transfer surfaces to ESP and then finally discharges in to chimney by ID Fans. The boiler will have its own ESP, ID fans and Chimney.

3.1.2 Electricity savings per year

The power savings due to installation of WHR boiler and turbine is 14256000 kWh per annum.

3.1.3 Improvement in product quality

There is no significant impact on the product quality.

3.1.4 Increase in production

There is no increase of production capacity.

3.1.5 Reduction in raw material consumption

Not Applicable

3.1.6 Reduction in other losses

Not Applicable

3.2 Monetary benefits

The monetary benefit due to installation of waste recovery power plant for 100 TPD kiln is Rs. 499 lakhs per annum due to the generation of power. A detail of the saving is given in Table 3.1 below:

Table 3.1: Energy and monetary benefits

S. No.	Parameter	Unit	Value
1	Power generation	kwh/day	48000
2	Auxilary power consumption	kwh/day	4800
3	Power available for grid	kwh/day	43200
4	Power available for grid	kwh/year	14256000
5	Power Cost	Rs./kWh	3.3
06	Energy cost due to power generation using flue	Rs.lakhs/year	499

3.3 Social benefits

3.3.1 Improvement in working environment in the plant

There is no such benefit achieved by waste heat recovery boiler..

3.3.2 Improvement in skill set of workers

The technology selected for implementation is waste heat recovery power plant will create the awareness among the workforce on advancement of the waste heat recovery system and how it will reduce the total energy consumption by existing process.

3.4 Environmental benefits

3.4.1 Reduction in effluent generation

None

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

The major GHG emission reduction source is CO_2. The technology will reduce coal consumption and emission.

3.4.3 Reduction in other emissions like SOx

No significant impact on SOx emissions.

4. INSTALLATION OF WASTE HEAT RECOVERY POWER PLANT

4.1 Cost of technology/equipment implementation

4.1.1 Cost of technology/equipments

The total cost of waste heat recovery power plant is estimated to be Rs. 746 lakhs, which includes all the required equipment and man power for the installation of the waste heat recovery power plant. Other details are mentioned in the quotation attached in Annexure 7.

4.1.2 Other costs

Other charges include cabling and panel modification. Project cost details are furnished in Table 4.1 below:

Table 4.1: Project detail cost

S. No.	Particular	Unit	Value
1	Cost of Boiler	Rs. in lakhs	373.50
2	Cost of System	Rs. in lakhs	210.00
3	Erection & Commissioning	Lump sum	25.00
4	Civil work	Lump sum	50.00
5	Taxes	Rs. in lakhs	42.00
6	Other Misc. cost(supervision, other cost)	Rs. in lakhs	10.00
7	Total cost excluding EPC	Rs. in lakhs	710.50
8	EPC cost	Rs. in lakhs	35.53
9	Total Investment	Rs. in lakhs	746.03

4.2 Arrangement of funds

4.2.1 Entrepreneur's contribution

The entrepreneur's contribution is 25% of total project cost, which works out at Rs. 186 lakhs.

4.2.2 Loan amount

The term loan is 75% of the total project, which is Rs. 560 lakhs.

4.2.3 Terms & conditions of loan

The interest rate is considered at 10% which is prevailing interest rate of SIDBI for energy efficiency related projects. The loan tenure is 5 years and the moratorium period is 6 months.

4.3 Financial indicators

4.3.1 Cash flow analysis

Considering the above discussed assumptions, the net cash accruals starting with 255.68 lakh in the first year operation and increases to 12225 at the end of fifth year.

4.3.2 Simple payback period

The total project cost of the proposed technology is Rs. 746 lakh and monetary savings due to generation of power is Rs.499 lakh and the simple payback period works out to be 18 months.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10% interest rate works out to be Rs.1194.06 lakh.

4.3.4 Internal rate of return (IRR)

The after tax Internal Rate of Return of the project works out to be 42.03 %. 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 24.33%. The average DSCR is 2.09.

4.4 Sensitivity analysis in realistic, pessimistic and optimistic scenarios

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

- Increase in power savings by 5%
- Decrease in power savings by 5%

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

Table 4.2: Sensitivity analysis

Particulars	IRR	NPV	ROI	DSCR
Normal	37.01	660.29	34.78	2.24
5% increase in power savings	41.97	795.54	35.61	2.45
5% decrease in power savings	31.91	525.04	33.74	2.02

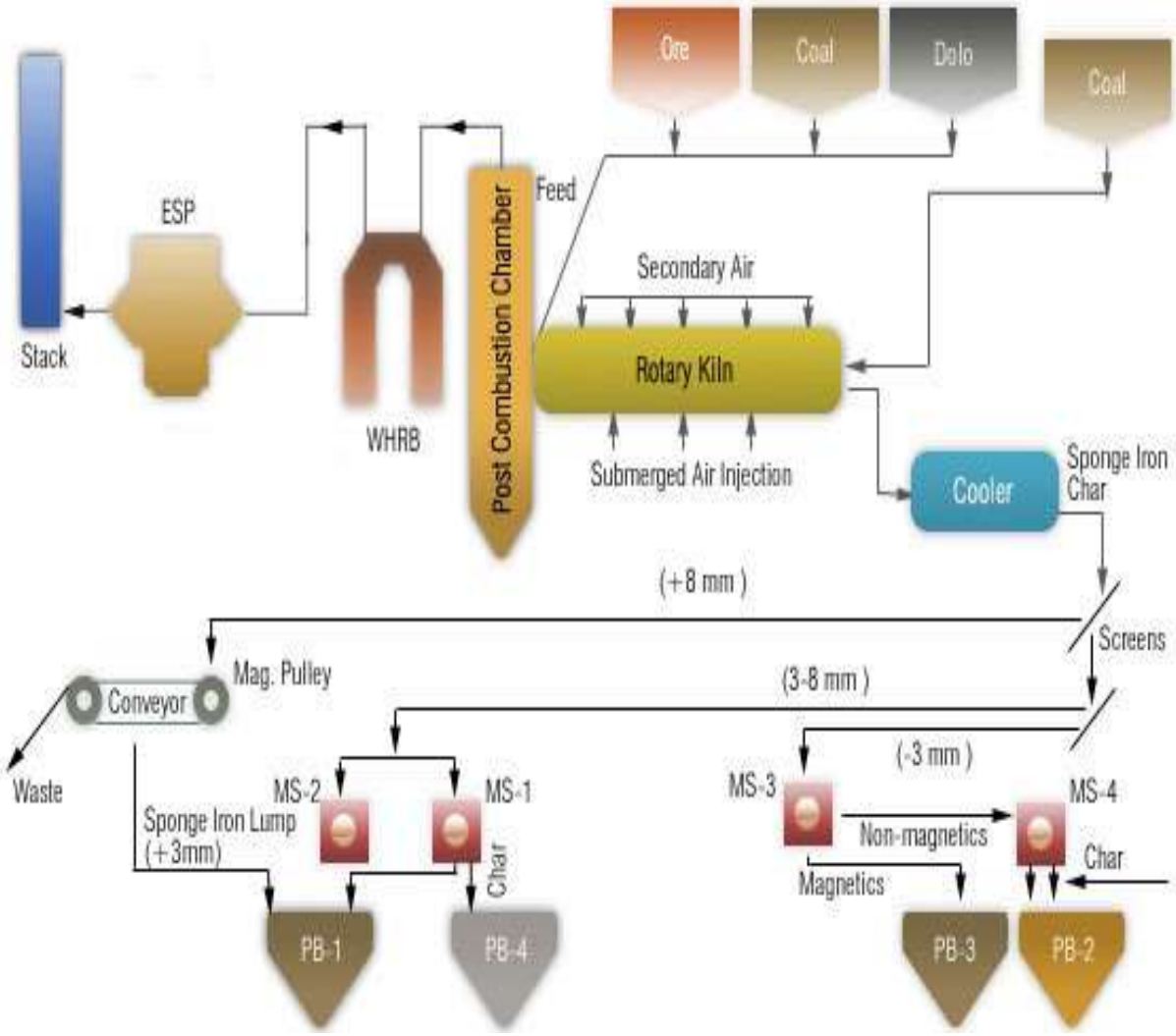
4.5 Procurement and implementation schedule

The project is expected to be completed in 10 Months from the date of release of purchase order. The detailed schedule of project implementation is furnished in Annexure 5.

ANNEXURE

Annexure 1: Process Flow Diagram

Process flow diagram will remain the same after implementation of proposed waste heat recovery power plant.



Annexure 2: Detailed technology assessment report –Waste heat recovery boiler for 100 TPD

S.No	Parameter	Unit	Existing System	Proposed WHR Power Generation
1	Rotary kiln Capacity	TPD	100	100
2	No of kilns in the plant	No	2	2
3	Total Installed Capacity	TPD	200	200
4	Iron ore Consumption	Tons/hr	10.89	10.89
5	Iron ore Consumption	TPD	2178	2178
6	Coal Calarific Value	kcal/kg	3000	3000
7	Lump coal consumption	Tons/hr	6.75	6.75
8	fine coal consumption	Tons/hr	4.14	4.14
9	Total Coal Consumption	Tons/hr	10.89	10.89
10	Total Coal Consumption	TPD	2177.78	2177.78
11	Dolamite Consumption	Tons/hr	0.28	0.28
12	Flue gas generated by kiln	nm3/hr	24000	24000
13	Total flue gas generated at installed capacity	nm3/hr	48000	48000
14	Density of flue gas	kg/m3	1.3	1.3
15	Actual gas flow	kg/hr	62400	62400
16	Flue Gas Temperature at out let of kiln	C	1005	1005
17	Enthalphy of flue gas at kiln out let @ 950C	kcal/kg	290	290
18	Enthalphy of gas at Boiler out let @ 170 C	kcal/kg	39.15	
19	Flue gas temperature at inlet of ESP	C	170	
20	Heat value available in flue gas	kcal/hr	15653040	
21	Radiation heat loss(1%)	kcal/hr	156530	
22	Blow down loss(2%)	kcal/hr	313061	
23	Actual heat available after loss	kcal/hr	15183449	
24	Steam enthalphy or total heat at 66kg/cm2, 490C	kcal/kg	800	
25	Feed water temperature	oC	126	
26	Enthaly of feed water	kcal/kg	127	
27	Generated steam @66 kg/cm2, 485 C	kg/hr	22561	
28	Power generation by generated steam	MW	2	
29	Power generation	kwh/day	48000	
30	Auxilary power consumption	kwh/day	4800	
31	Power availale for grid	kwh/day	43200	
32	Power availale for grid	kwh/year	14256000	
33	Power Cost	Rs./kWh	3.3	
34	Energy cost due to power generation using flue gases	Rs.lakhs/year	499	
35	Investment cost of power plant	Rs. Lakhs	625	
36	O& M cost	Rs. Lakhs	12.5	
37	Manpower Cost	Rs. Lakhs	43.2	
38	Total investment Cost including O&M, Manpower	Rs. Lakhs	681	
39	Payback period	years	1.36	

Annexure 4: Detailed financial calculations & analysis

Assumptions

Name of the Technology	WASTE HEAT RECOVERY BOILER		
Rated Capacity	2 MW		
Details	Unit	Values	Basis
No of working days	Days	330	
No of Shifts per day	Shifts	3	
Capacity Utilization Factor	%		
Proposed Investment			
Proposed Investment			
Cost of Boiler	Rs. in lakhs	373.50	
Cost of System	Rs. in lakhs	210.00	
Erection & Comissioning	Lumpsum	25.00	
Civil work	Lumpsum	50.00	
Taxes	Rs. in lakhs	42.00	
Other Misc. cost(supervision, other cost)	Rs. in lakhs	10.00	
Total cost excluding EPC	Rs. in lakhs	710.50	
EPC cost	Rs. in lakhs	35.53	
Total Investment	Rs. in lakhs	746.03	
Financing pattern			
Own Funds (Internal Accruals)	Rs. in lakhs	186.51	Feasibility Study
Loan Funds (Term Loan)	Rs. in lakhs	559.52	Feasibility Study
Loan Tenure	Years	5	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	66	Assumed
Interest Rate	%	10	SIDBI Lending Rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	4	Feasibility Study
Annual Escalation	%	5	Feasibility Study
Estimation of Revenue			
Power generation	kW/Annum	14256000	
Savings per unit	Rs./kWh	3.30	Detailed calculations enclosed in DPR
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 **Rs. (in lakh)**

Years	Opening Balance	Repayment	Closing Balance	Interest
1	559.52	83.93	475.59	65.21
2	475.59	111.90	363.69	53.66
3	363.69	111.90	251.78	51.12
4	251.78	111.90	139.88	48.23
5	139.88	111.90	27.98	45.04
6	27.98	27.98	0.00	41.16
	Total	559.52		

WDV Depreciation **Rs. (in lakh)**

Particulars / years	1	2	3	4	5	6
Plant and Machinery						
- Cost	746.03	687.54	633.63	583.96	538.17	495.98
- Depreciation	58.49	53.90	49.68	45.78	42.19	38.88
- WDV	687.54	633.63	583.96	538.17	495.98	457.10

Projected Profitability **Rs. (in lakh)**

Particulars / Years	1	2	3	4	5	6	Total
Revenue through Savings							
savings in Coal	470.45	470.45	470.45	470.45	470.45	470.45	**2822.69**
Total Revenue(A)	**470.45**	**470.45**	**470.45**	**470.45**	**470.45**	**470.45**	**2822.69**
EXPENSES							
O & M Expenses	29.84	31.33	32.90	34.54	36.27	38.09	**202.98**
Total Expenses(B)	**29.84**	**31.33**	**32.90**	**34.54**	**36.27**	**38.09**	**202.98**
PBDIT(A)-(B)	**440.61**	**439.11**	**437.55**	**435.90**	**434.18**	**432.36**	**2619.71**
Interest	65.21	53.66	51.12	48.23	45.04	41.16	**304.42**
PBDT	**375.40**	**385.46**	**386.43**	**387.68**	**389.13**	**391.20**	**2315.29**
Depreciation	39.39	39.39	39.39	39.39	39.39	39.39	**236.34**
PBT	336.01	346.07	347.04	348.29	349.74	351.81	**2078.95**
Income tax	107.72	112.69	114.46	116.21	117.92	119.75	**688.76**
Profit after tax (PAT)	**228.29**	**233.37**	**232.57**	**232.08**	**231.82**	**232.06**	**1390.19**

Computation of Tax **Rs. (in lakh)**

Particulars / Years	1	2	3	4	5	6
Profit before tax	336.01	346.07	347.04	348.29	349.74	351.81
Add: Book depreciation	39.39	39.39	39.39	39.39	39.39	39.39
Less: WDV depreciation	58.49	53.90	49.68	45.78	42.19	38.88
Taxable profit	316.91	331.55	336.75	341.89	346.94	352.31
Income Tax	107.72	112.69	114.46	116.21	117.92	119.75

Projected Balance Sheet **Rs. (in lakh)**

Particulars / Years	1	2	3	4	5	6
LIABILITIES						
Share Capital	186.51	186.51	186.51	186.51	186.51	186.51
Reserves & Surplus	228.29	461.66	694.24	926.31	1158.13	1390.19
Term Loans	475.59	363.69	251.78	139.88	27.98	0.00
TOTAL LIABILITIES	**890.39**	**1011.86**	**1132.53**	**1252.70**	**1372.61**	**1576.69**
ASSETS						
Gross Fixed Assets	746.03	746.03	746.03	746.03	746.03	746.03
Less: Accm. depreciation	39.39	78.78	118.17	157.56	196.95	236.34
Net Fixed Assets	706.63	667.24	627.85	588.46	549.07	509.68
Cash & Bank Balance	183.75	344.61	504.67	664.23	823.54	1067.01
TOTAL ASSETS	**890.39**	**1011.86**	**1132.53**	**1252.70**	**1372.61**	**1576.69**
Net Worth	414.80	648.17	880.74	1112.82	1344.64	1576.69
Debt Equity Ratio	2.55	1.95	1.35	0.75	0.15	0.00

Projected Cash Flow **Rs. (in lakh)**

Particulars / Years	0	1	2	3	4	5	6
Sources							
Share Capital	186.51	-	-	-	-	-	-
Term Loan	559.52						
Profit After tax		228.29	233.37	232.57	232.08	231.82	232.06
Depreciation		39.39	39.39	39.39	39.39	39.39	39.39
Total Sources	**746.03**	**267.68**	**272.76**	**271.97**	**271.47**	**271.21**	**271.45**
Application							
Capital Expenditure	746.03						
Repayment Of Loan	-	83.93	111.90	111.90	111.90	111.90	27.98
Total Application	**746.03**	**83.93**	**111.90**	**111.90**	**111.90**	**111.90**	**27.98**
Net Surplus	-	183.75	160.86	160.06	159.56	159.30	243.47
Add: Opening Balance	-	-	**183.75**	**344.61**	**504.67**	**664.23**	**823.54**
Closing Balance	-	183.75	344.61	504.67	664.23	823.54	1067.01

IRR **Rs. (in lakh)**

Particulars / months	0	1	2	3	4	5	6
Profit after Tax		228.29	233.37	232.57	232.08	231.82	232.06
Depreciation		39.39	39.39	39.39	39.39	39.39	39.39
Interest on Term Loan		65.21	53.66	51.12	48.23	45.04	41.16
Cash outflow	(746.03)	-	-	-	-	-	-
Net Cash flow	(746.03)	332.89	326.42	323.09	319.69	316.25	312.61
IRR	**37.01%**						
NPV	660.29						

Break Even Point **Rs. (in lakh)**

Particulars / Years	1	2	3	4	5	6
A. Variable Expenses						
Operation & Maintenance Exp (75%)	22.38	23.50	24.67	25.91	27.20	28.56
Sub Total	**22.38**	**23.50**	**24.67**	**25.91**	**27.20**	**28.56**
B. Fixed Expenses						
Operation & Maintenance Exp (25%)	7.46	7.83	8.22	8.64	9.07	9.52
Interest on Term Loan	65.21	53.66	51.12	48.23	45.04	41.16
Depreciation	39.39	39.39	39.39	39.39	39.39	39.39
Sub Total	**112.06**	**100.88**	**98.74**	**96.25**	**93.50**	**90.07**
C. Sales	470.45	470.45	470.45	470.45	470.45	470.45
D. Contribution	448.07	446.95	445.77	444.54	443.24	441.88
E. Break Even Point (B/D)	25.01%	22.57%	22.15%	21.65%	21.09%	20.38%
F. Cash Break Even	16.22%	13.76%	13.31%	12.79%	12.21%	11.47%
G.BREAK EVEN SALES	117.66	106.19	104.20	101.86	99.24	95.90

Return on Investment **Rs. (in lakh)**

Particulars / Years	1	2	3	4	5	6	Total
A.Net Profit Before Taxes	336.01	346.07	347.04	348.29	349.74	351.81	2078.95
B.Net Worth	414.80	648.17	880.74	1112.82	1344.64	1576.69	5977.86
							34.78%

Debt Service Coverage Ratio **Rs. (in lakh)**

Particulars / Years	1	2	3	4	5	6	Total
CASH INFLOW							
Profit after Tax	228.29	233.37	232.57	232.08	231.82	232.06	1390.19
Depreciation	39.39	39.39	39.39	39.39	39.39	39.39	236.34
Interest on Term Loan	65.21	53.66	51.12	48.23	45.04	41.16	304.42
TOTAL	**332.89**	**326.42**	**323.09**	**319.69**	**316.25**	**312.61**	**1930.95**
DEBT							
Interest on Term Loan	65.21	53.66	51.12	48.23	45.04	41.16	65.21
Repayment of Term Loan	83.93	111.90	111.90	111.90	111.90	27.98	83.93
TOTAL	**149.14**	**165.56**	**163.03**	**160.13**	**156.95**	**69.14**	**149.14**
Average DSCR	2.24						

Annexure 5: Details of procurement and implementation plan

Project Implementation schedule

S. No	Activity	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10
1	Placement of Orders for Equipment										
2	Manufacturing										
3	Erection and commissioning										
4	Trial runs										

Annexure 6: Details of technology/equipment and service providers

Equipment details	Source of technology	Service/technology providers
Waste heat recovery Power plant	Indian	**A.V.U. ENGINEERS PVT . Ltd.** AN ISO - 9001-2008 CERTIFIED COMPANY) Survey No . 53 , Bahadurpally , Quthbullpur Mandal , R R Dist, Hyderabad 500043 . Andhra Pradesh, INDIA. Phone : +91-40-23090968 , 23092343, 9493547191 E-mail : office@avuengineers.com avupurchase@yahoo.com

Annexure 7: Quotation or techno-commercial bid

TECHNICAL PROPOSAL

FOR

1 x 10 TPH WHR BOILERS

IN SPONGE IRON PLANT

SUBMITTED TO

M/s. APTICO.

SUBMITTED BY

ARTICULATED VESSELS & UTILITY ENGINEERS PVT LTD.

SECUNDERABAD- 500 009

AV-UE/WHRS-APTICO/Q/11-12:110 **Date: 03-11-2011**

M/s. APTICO

Kind Attn: Mr. GOPALA RAO

Dear Sir,

Ref:: With reference to the telephonic discussion had with our MD. Mr. PARAMVIR SINGH

We thank you very much for showing interest in AV-UE for your boilers. As required by you, we are pleased to submit herewith our Commercial Proposal for Supply, Erection & Commissioning of 2 x 10 TPH WHR Boilers at 66 Kg/cm2 (g) Pressure and 485±5 ºC Superheated Steam and Common Deaerator System for your Power Plant.

AV&UE supplies boilers designed and manufactured to several national & international standards like IBR, ASME Sec VIII Div 1 & BS 113.

We trust the above is in line with your requirement & in the meantime, if you need any further clarifications to evaluate our proposal please feel free to contact us.

Assuring you of our best attention, always.

Thanking you,

Yours faithfully,
for ARTICULATED VESSELS & UTILITY ENGINEERS PVT. LTD.

PARAMVIR SINGH
MANAGING DIRECTOR

INDEX

1.0 BRIEF DESCRIPTION OF THE SYSTEM:

i) THREE PASS THERMAL TECHNOLOGY FOR OPTIMUM HEAT RECOVERY

a) FIRST PASS CONSISTS OF:

- **FIRST ZONE OF WATER COOLED MEMBRANE WALLS**

Provides Maximum Recovery of Heat through Radiation. Fin welded membrane wall construction provides Gas tight furnace and structural rigidity.

b) <u>SECOND PASS CONSISTS OF:</u>

- **SCREEN TUBES:**

  The Screen section consists of bare tubes arranged to form a tube bundle. The tubes are arranged in such a manner that they face the gas flow directly. The top and bottom ends of the tubes are duly welded to headers, which in turn are connected to the water wall / water circuits respectively.

- **SUPER HEATER WITH MEMBRANE WALLS**

  Two stage Super heater with interstage spray type Attemperator enclosed by fin welded extended water walls. In this zone the waste heat is utilized to superheat the steam by convection and also additional recovery of heat by water walls by radiation.

- **EVAPORATOR WITH MEMBRANE WALLS**

  Efficient utilization of waste heat to generate saturated steam by both convection and radiation. Flag type evaporators which are arranged in a manner to ensure natural circulation with ease.

c) <u>THIRD PASS CONSISTS OF:</u>

- **ECONOMISER**

  This zone consists of economizer, the heat is recovered to preheat the Boiler Feed Water.

ii). Downward and upward flow through multipass arrangement of heat transfer surfaces to enable positive dust settlement through hoppers.

iii). Inter-Bank Soot Blowers for Superheater, Evaporator, Economiser sections for online cleaning.

iv). the equipments will be constructed in modules; this modular construction ensures easy transportation and easy maintenance.

v) Upper and Lower Headers of the Membrane Wall and the Evaporator are connected to the Steam Drum by Risers & Down Comers.

vi) Thermal Expansion joints are provided to absorb Thermal Expansion impact of the Boiler.

vii). Feed Water Control Valve is located down Stream of the Economizer to avoid steaming in the Economizer.

viii). Superheated Steam Temperature is controlled through Intermittent Spray Type Desuperheater located between primary & secondary super heater banks.

ix). Equipped with High Quality Standard Valves, Mountings & Instruments.

x). The Internal Trays and the Column Shell of the Deaerator shall be made of SS-304 material to eliminate rust formation due to Oxidation.

xi). The system ensures arresting of total dust through 3-Stage trapping system.

- At the Furnace Entry, the primary heavy dust is collected/ removed through Dust Hopper, provided at the bottom of the Furnace, by rotating valve.

- The Carry-Over dust particles from the Furnace chamber are removed in the Super heater and collected at Dust Hopper at the bottom of the Super heater Chamber.

- Finally the dust particles will be removed in the dust collectors provided at the bottom of the economizer hopper.

xii). Please appreciate that the Dust particles carried by the flue gases from the Sponge Iron plant are just not Dust particles, but also has appreciable heat content in it. So removal of the dust from the Kiln exhaust flue gases, before entering Boiler chamber would result in loss of heat content, which ultimately hampers the over-all Thermal efficiency of W.H.R. System. Therefore, the 3-stage dust removal system suggested and incorporated in design (as above in Sl.No.11) is the most efficient and appropriate solution to maintain high Thermal Efficiency of the system and render the overall system dust free.

xiii). Most efficient, reliable, dependable and performance based system.

xiv). Since we have already supplied, Erected and Commissioned a number of WHR Systems, we assure you that the Erection & Commissioning of the WHRS, at your site, shall be within the stipulated schedules exhibiting a superior quality of workmanship.

2.0 EQUIPMENT DESCRIPTION:

2.1 RADIATION SECTION:

The objective of this section is to absorb the radiation heat & cool the gases well below the ash melting point temperature. The radiation chamber is a hollow passage for flue gas flow made of water cooled walls. The water-cooled walls consist of bare seamless tubes welded to each other by means of plain strips. These bare tubes are then welded to top and bottom headers, which in turn are connected to the steam drum respectively. The entire chamber is fully fusion welded to provide gas-tight chamber. Since heat transfer occurs in this section, predominantly by radiation mode, this chamber is called radiation chamber. The entire first pass is of this construction only. Heavy carry-overs from the Sponge Iron Kiln freely fall in to the hopper, without any hindrance. The hopper portion is lined by Castable refractory. Since there is no other heat transfer surfaces along this path, the choking problem is completely eliminated.

2.2 SCREEN TUBES:

The Screen section consists of bare tubes arranged to form a tube bundle. The tubes are arranged in such a manner that they face the gas flow directly. The top and bottom ends of the tubes are duly welded to headers, which in turn are connected to the steam drum / water circuits respectively. The Screen section is of sloping tubes, connected to the steam drum by means of the front wall tubes of the second pass water wall casing. The bottom header is connected bottom headers of rear water wall casing. Thus individual risers & down comers are eliminated. This reduces site erection activities to a considerable extent.

2.3 SUPERHEATER SECTION:

The super heater section heats the saturated steam at corresponding saturation temperature to required final temperature. The super heater section is divided in to two parts. The first part which heats saturated steam called Primary Super heater. The second part, which further heats superheated steam to the final required temperature, is called the Secondary Super heater. The Super heaters are of bare tube construction, tube material being SA 213 T11.

2.4 DE- SUPERHEATER SECTION:

Between the both the super heaters, an de-super heater is provided. The sole purpose of the de-super heater is to control final temperature of the super heater temperature. The De-Super heater is Spray Water Type, Which sprays relatively cold Boiler Feed Water in to the steam leaving the Primary Super heater. This causes the temperature of steam at outlet of primary Super heater to reduce. By varying the quantity of desuperheater spray water, the temperature of steam entering the secondary super heater can be controlled. Since the final temperature of steam leaving Secondary Super heater depends on the inlet temperature of steam, an attemperation at intermediate level is an efficient method of Final Superheat Temperature Control.

2.5 EVAPORATOR SECTION:

This section is formed by flag tube type evaporators, arranged in bundles, to ensure natural circulation of the steam and water. The bundles are constructed in Modules fashion, which will helpful to transportations as well as easy maintenance of the Boiler. The Heat Transfer takes mainly due to convection. The Tubes are welded to headers which in turn connected to risers and down comers.

2.6 ECONOMISER SECTION:

The Economizer section is provided to cool down flue gases to the required outlet temperature and use this heat to increase the temperature of Boiler Feed Water entering the Steam Drum. The economizer is of bare tube construction. The economizer is also constructed in modules. The feed water valve is located at the downstream of the economizer section to stop the steaming in the economizer.

2.7 GAS CIRCUIT

Exhaust gas from 1 x 100 TPD Plant ABC (After Burning Chamber) of kiln enters the radiant chamber where it gets cooled sufficiently before entering into second and third chamber. The gas then passes through the two stage superheater section, evaporator section and Economiser section and let into the ESP. ID Fan draws the cooled exhaust gas and lets into atmosphere through the chimney.

2.8 BLOW DOWN TANK

We have considered one no. common blowdown tank (Common for CBD & IBD for each boiler) to which the boiler blowdown, boiler drain lines from various systems will be connected.

2.9 WATER AND STEAM CIRCUIT

Deaerated water enters Economiser and gets heated. The heated water then enters the steam drum and then circulated (Natural Circulation) in evaporator sections and water wall. Saturated steam is collected in the steam drum. Saturated steam is then superheated in convection super heaters and taken out to turbine. Inter stage desuperheater is provided to control the steam temperature.

2.10 SOOT BLOWING SYSTEM

Soot blowing system consists of retractable and rotary soot blowers which use steam as blowing media. Retractable soot blowers are provided in the superheater zone. Rotary type soot blowers are provided in the evaporator and Economiser zones. Piping to individual soot blowers are adequately sized and properly routed to prevent the entry of water droplets into the soot blowers. Steam traps are provided in the pipeline to remove the condensate from the system.

2.11 DEAERATOR CUM STORAGE TANK:

This system consists of Deaerator in which the oxygen content in the feed water is reduced to the required level by spraying water as droplets in the presence of steam. There will be a storage tank below the Deaerator to store deaerated water.

2.12 CHEMICAL DOSING SYSTEM:

2.12.1 LP CHEMICAL DOSING SYSTEM

The feed water contains traces of oxygen due to the incomplete mechanical / Thermal deaeration. These traces of Oxygen are scavenged by chemical deaeration. Chemicals like sodium sulphite or hydrazine is dosed to the suction pipe of feed pump by LP dosing. In LP dosing sodium sulphite react with oxygen and forms sodium sulphate or Hydrazine React with O2 and forms water & nitrogen.

2.12.2 HP CHEMICAL DOSING SYSTEM

Scale formation is limited by converting hardness salts to a free flowing sludge. HP dosing is done by carbonate control and phosphate control by addition of sodium carbonate / or Trisodium phosphate respectively. Other chemicals such as sodium hydroxide carbonate or calcium oxyphosphate can also be added. Best result of calcium carbonate or magnesium hydroxide or calcium silicate, magnesium silicate will be available as free flowing sludges where caustic

alkalinity is 10 to 15% of the dis-solved solids. OH alkalinity leads to prevention of magnesium phosphate as bad scale by converting magnesium to magnesium hydroxide. Sludge conditioner can also be used, if there is no effective means of blowdown is available it is better not to concentrate on internal treatment.

3.0 TECHNICAL PROPOSAL:

S.NO.	DESCRIPTION	VALUE
3.1	**BASIC DATA**	
	Construction Code	Latest Version of IBR 1950. Where code is not applicable good engineering practice will be applicable.
	Type of Boiler	Three pass Vertical, Water tube, Natural circulation single drum Boiler with membrane water walls furnace, Primary & Secondary Super heaters, Bare tube Evaporator Bundle and Economiser.
3.2	**STEAM**	

	CHARACTERISTICS	
	Pressure at SHO	66 ± 0.5 Kg/cm²(g)
	Temp. at SHO	485 ± 5 °C
	Flow at SHO	10000 Kg/hr
	Design Pressure	75 Kg/cm²(g)
	Hydro Test Pressure	112.5 Kg/cm²(g)
3.3	**FLUE GAS PROPERTIES**	
	Type of Flue gas	Sponge Iron Kiln Exhaust Flue gas
	Kiln Gas Flow	25000 Nm3/hr
	Gas Inlet Temperature	950 °C
	Gas Outlet Temperature at exit of Economiser	160 ± 10 °C
3.4	**FLUE GAS ANALYSIS (V/V)**	
	CO_2	17.0 %
	H_2O	15.0 %
	O_2	02.4 %
	N2	65.6 %
	Gas density	1.303 Kg/Nm^3
	Dust Loading	40 gm/Nm^3
	Water temperature inlet to Economiser	126 °C
	Blow down losses (considered)	2%
	Radiation losses (considered)	2%
	Cooling water temperature	35 °C
	Temperature for Guarantee	45 °C
	Temperature for electrical design	50 °C
	Relative humidity	84%
	Still air velocity	1m/s
3.5	**ELECTRICAL DATA**	
	Supply	AC Three Phase
	Voltage	415 ± 10 V
	Frequency	50 CPS

4.0 THERMAL DESIGN DATA:

S.No.	Description	Unit	Value
4.1	**Heating Surface Areas**		
a.	Water walls	m^2	415
b.	Screens	m^2	21
c.	Evaporator -I	m^2	173
d.	Evaporator -II	m^2	186
e.	Primary Super heater (SH-I)	m^2	74
f.	Secondary Super heater (SH-II)	m^2	69
g.	Economiser 1 & 2	m^2	508
	Total	m^2	1446
4.2	**Flue Gas Pressure Profile**		
a.	Radiation chamber	mmWC	10
b.	Superheater I & II	mmWC	10
c.	Evaporator I & II	mmWC	20
d.	Economiser I & II	mmWC	65
e.	Ducting	mmWC	20
f.	ESP (Not in AVUE Scope)	mmWC	35
	Total	mmWC	160
4.3	**Flue Gas velocity Profile**		
a.	Radiation chamber	m/s	7-5
b.	Superheater -II	m/s	7-6
c.	Superheater -I	m/s	7-6
d.	Evaporator I & II	m/s	7-6
e.	Economiser I & II	m/s	7-5
4.4	**Steam & Water Pressure Profile**		
a.	At the outlet of MSSV	Kg/cm^2 (g)	66
b.	Drum working Pressure	Kg/cm^2 (g)	68
c.	Economiser inlet pressure	Kg/cm^2 (g)	70
d.	Super heater S.V. Set Pressure	Kg/cm^2 (g)	70
e.	Drum S.V.1 Set Pressure	Kg/cm^2 (g)	72.5
f.	Drum S.V.2 Set Pressure	Kg/cm^2 (g)	73.5
4.5	**Flue Gas Temperature Profile**		
a.	Radiation chamber inlet	Deg C	950
b.	Inlet to Superheater -II	Deg C	740 -730

c.	Inlet to Superheater -I	Deg C	660-650
d.	Inlet to Evaporator I & II	Deg C	560-550
e.	Inlet to Economiser I & II	Deg C	365-355
f.	Inlet of ESP	Deg C	160 ± 10
4.6	**Water/ Steam Temperature**		
a.	Inlet to Economiser	Deg C	126
b.	Economiser Outlet	Deg C	267
c.	Inlet of Super heater -I	Deg C	281
d.	Outlet of Super heater-I	Deg C	405
e.	Inlet of Super heater -II	Deg C	385
f.	Outlet of Super heater-II	Deg C	485± 5

5.0 EQUIPMENT TECHNICAL DATA:

S.No	Description	Value
5.1	**Specification of Radiation chamber (membrane water walls)**	
a.	Design code	IBR 1950 with its latest amendments
b.	Design pressure	75 kg/cm² g
c.	Design temperature	317 °C
d.	Hydro test pressure	112.5 kg/cm² g
e.	Type	Vertical
f.	Type of tubes	Bare
g.	Tube outer diameter	50.8 mm
h.	Tube thickness	4.47 mm
i.	Fin thickness	5 mm
j.	MOC of tubes	BS 3059 Seamless
k.	MOC of fins	IS 2062
l.	MOC of headers	SA 106 Gr B
5.2	**Specification of Secondary Superheater**	
a.	Design code	IBR 1950 with its latest amendments
b.	Design pressure	75 kg/cm² g
c.	Design temperature	524 °C
d.	Working temperature	490± 5 °C
e.	Hydrotest pressure	112.5 kg/cm² g
f.	Type	Horizontal
g.	Type of tubes	Bare
h.	Tube outer diameter	38.1 mm
i.	Tube thickness	4.06 mm
j.	MOC of tubes	SA 213 T11
k.	MOC of headers	SA 106 Gr B / SA 335 P11

S.No	Description	Value
5.3	**Specification of Primary Superheater**	
a.	Design code	IBR 1950 with its latest amendments
b.	Design pressure	75 kg/cm² g
c.	Design temperature	444 °C
d.	Working temperature	405 °C
e.	Hydrotest pressure	112.5 kg/cm² g
f.	Type	Horizontal
g.	Type of tubes	Bare
h.	Tube outer diameter	38.1 mm
i.	Tube thickness	4.06 mm
j.	MOC of tubes	SA 210 Gr A1
k.	MOC of headers	SA 106 Gr B
5.4	**Specification of Evaporator 1 &2**	
a.	Design code	IBR 1950 with its latest amendments
b.	Design pressure	75 kg/cm² g
c.	Design temperature	317 °C
d.	Working temperature	289 °C
e.	Hydro test pressure	112.5 kg/cm² g
f.	Type	Flag
g.	Type of tubes	Bare
h.	Tube outer diameter	44.5 mm
i.	Tube thickness	4.06 mm
j.	MOC of tubes	BS 3059 Seamless
k.	MOC of headers	SA 106 Gr B
5.5	**Specification of Economiser 1 &2**	
a.	Design code	IBR 1950 with its latest amendments
b.	Design pressure	78 kg/cm² g
c.	Design temperature	300 °C
d.	Working temperature	289 °C
e.	Hydrotest pressure	117 kg/cm² g
f.	Type	Horizontal
g.	Type of tubes	Bare
h.	Tube outer diameter	38.1 mm
i.	Tube thickness	3.66 mm
j.	MOC of tubes	BS 3059 Seamless
k.	MOC of headers	SA 106 Gr B
5.6	**Steam Drum specification**	

S.No	Description	Value	
a.	Design code	IBR 1950 with its latest amendments	
b.	Design pressure	75 kg/cm² g	
c.	Design temperature	317 °C	
d.	Hydrotest pressure	112.5 kg/cm² g	
e.	Length	3750 mm	
f.	Inner diameter	1220 mm	
g.	Thickness	56 mm	
h.	Material of construction	SA 516 Gr 70	
i.	Quantity per boiler	1 no.	
j.	Corrosion allowance	1.5 mm	
k.	Internals	Demister pad	
l.	Quantity of safety valves	2 nos.	
m.	Drum S.V.1 Set Pressure	73.5 kg/cm² g	
n.	Drum S.V.2 Set Pressure	74.5 kg/cm² g	
5.7	**Specification of Attemperator**		
a.	Type	Fixed Nozzle spray type Attemperator	
b.	Nos	One	
c.	Location	Between primary & secondary SH	
d.	MOC of headers	SA 335 P11	
e.	Header outer diameter & Thickness	219.1 mm, Thickness as per IBR	
5.8	**Specification of Soot Blowers**		
		Long Retractable	**Rotary soot blower**
a.	Location	Super heater	Evaporator & Economiser zones
b.	Qty	2	4
c.	Steam temperature	Super-heated steam	
d.	Steam pressure	20-30 kg/cm2(g)	
e.	Source of Steam	SH steam form primary SH Outlet header	
f.	Drive	Motorized	
5.9	**Specification of HP Dosing System**		
a.	Major Parts	Storage Tank – 1 No., Stirrer – 1 No., Dosing Pumps – 2 Nos.	
b.	Size of Storage Tank	600 mm x 500 mm	
c.	Tank Capacity	150 liters	
d.	MOC of Tank	SS	
e.	MOC of Chemical Basket	SS 304	
f.	Pump Capacity	6 LPH	

S.No	Description	Value
g.	Pump Type	Reciprocating Plunger Type
h.	Type of Operation	Motorised
5.10	**Specification of LP Dosing System**	
a.	Major Parts	Storage Tank – 1 No., Stirrer – 1 No., Dosing Pumps – 2 Nos.
b.	Size of Storage Tank	800 mm x 650 mm
c.	Tank Capacity	200 liters
d.	MOC of Tank	SS
e.	MOC of Chemical Basket	SS 304
f.	Pump Capacity	6 LPH
g.	Pump Type	Reciprocating Plunger Type
h.	Type of Operation	Motorized
3.12	**Deaerator cum Storage Tank**	
a.	Design Code	As per IBR 1950 with Latest Amendments & Good Engineering Practice
b.	Outside Diameter	1200mm
c.	Length of shell (tan to tan)	4500 mm
d.	Thickness of shell	12 mm
e.	Type of dish end	2: 1 Ellipsoidal with straight face
f.	Thickness of dished end	12 mm
g.	Operating pressure	2.45 kg/cm² a
h.	Design Pressure	Full Vacuum/ 3.5 kg/cm² g
i.	Hydro Test Pressure	5.25 kg/cm² g
j.	Operating temperature	126 °C
k.	Design Temperature	180 °C
l.	Design Outlet feed water capacity	10.6 m3/hr
m.	Corrosion allowance	3.2 mm over & above design code requirement
	Condensate Oxygen content (at DA inlet)	Design = 300 ppb / Normal = 42 ppb
n.	Condensate Oxygen content (at DA outlet)	0.005 ml/Ltr (7 PPB)
o.	Storage capacity Normal Level to Low-Low water level)	30 m3
5.11	**Specifications of Blow down tank**	
a.	Design code	IBR
b.	Tank height	1000 mm
c.	Tank OD	960 mm
d.	Shell thickness	10 mm

S.No	Description	Value
e.	Type of ends	Dished
f.	Material of construction	SA 516 Gr 70
5.12	**Boiler feed water pumps**	
a.	Qty	2 Nos (1 W +1S, Common for Two WHR Boilers)
b.	Design water flow	20 m3 /hr
c.	Pressure head	865 mmWC
d.	Temperature	126 ºC
e.	Speed	2900 RPM
f.	Type	Centrifugal
5.13	**Specifications of Sample Coolers**	
a.	Type	Shell & Coil type
b.	Sampling Points	Feed water line (Common for two boilers), Blow down line, Saturated steam line & Superheated Steam line
c.	Shell Material	Carbon Steel
d.	Coils Material	Stainless Steel
5.14	**Ducting**	
a.	Material of Construction	MS
b.	Thickness	5 mm
5.15	**ID Fan**	
	Flow	12.3 m3/sec
	Developed head (Design)	180 mmWC
	Temperature (Design)	180 ± 10 °C
	Motor rating	Later, KW
	Speed	Later, RPM
	Quantity	1 no
	Type of Fan	Centrifugal
	Medium	Ambient
	Motor Voltage, V	415
	Type of control	Pneumatically generated power cylinder actuated regulating damper control with VFD
5.16	**Painting**	
a.	Two Coats of Red Oxide in shop	All the equipments supplied by AV-UE
b.	Final painting	All the equipments supplied by AV-UE

6.0 GUARANTEED PARAMETERS:

Following are the guaranteed parameters for WHRSG:

Steam output at SH outlet	Kg/h	10000
Steam pressure at SH outlet	Kg/cm^2 (g)	66 ± 0.5
Steam temperature at SHO	°C	485 ± 5
Design pressure	Kg/cm^2 (g)	75
Hydro test pressure	Kg/cm^2 (g)	112.5
Gas Flow Kiln	Nm^3/hr	25000
Gas side pressure Drop	mm WC	160
Gas Inlet Temperature (Considered Normal Condition)	°C	950
Gas outlet Temperature (It may vary based on Temperature and Gas flow)	°C	160 ± 10
Blow down losses (considered)	%	2
Radiation losses (considered)	%	2

7.0 INSTRUMENTS AND SPECIAL VALVES:

7.1 Field Mounted Instruments:

a. Feed Water Circuit:

S.No	Location of inst.	Measured variable	Qty Nos	Instrument provided
1	Eco inlet header	Pressure	1	Field mounted Local Pressure gauge
2	-do-	Temperature	1	Field mounted RTD
3	Eco outlet header	Temperature	1	Field mounted RTD
4	-do-	Pressure	1	Field mounted Local Pressure gauge
5	Feed line	Flow	1	Field mounted local orifice plate
6	-do-	Flow	1	Field mounted local DP transmitter
7	Feed pump outlet	Pressure	2	Field mounted Local Pressure gauge
8	Feed pump inlet	Pressure	2	Field mounted Local Pressure gauge

b. Attemperator Spray water line:

S.No	Location of inst.	Measured variable	Qty Nos	Instrument provided
1	Attemperator line	Pressure	1	Field mounted local pressure gauge

c. Steam Drum:

S.No	Location of inst.	Measured variable	Qty Nos.	Instrument provided
1	Steam drum	Level	2	Field mounted local level gauge of Transparent type with illumination
2	-do-	Level	2	Field mounted Diff. Pressure transmitter
3	-do-	Pressure	1	Field mounted Local Pressure gauge

d. Steam Drum to Soot Blower Steam line:

S.No	Location of inst.	Measured variable	Qty Nos	Instrument provided
1	After PCV in SB line	Temperature	1	Field mounted local temperature gauge
2	After PCV in SB line	Pressure	1	Field mounted Local Pressure gauge
3	After PCV in SB line	Pressure	1	Field mounted local Pressure transmitter

e. Steam line from Steam Drum to Main Steam Stop valve:

S.No	Location of inst.	Measured variable	Qty Nos	Instrument provided
1	Steam line after SH-2	Temperature	1	Field mounted local Thermocouple
2	Main steam line	Pressure	1	Field mounted local Pressure gauge
3	-do-	Pressure	1	Field mounted local Pressure transmitter
4	-do-	Temperature	1	Field mounted local Thermocouple
5	-do-	Flow	1	Field mounted local orifice plate
6	-do-	Flow	1	Field mounted local DP transmitter

f. Flue gas path:

S.No	Location of inst.	Measured variable	Qty Nos	Instrument provided
1	Flue gas flow path (at boiler inlet)	Temperature	1	Field mounted local thermocouple
2	Flue gas flow path (at boiler inlet)	Pressure	1	Field mounted manometer
3	Flue gas flow path (at boiler inlet)	Pressure	1	Field mounted Local Pressure transmitter
4	Flue gas flow path (between SH-1 and SH-2)	Temperature	1	Field mounted Local thermocouple
5	Flue gas flow path (between SH-1 and Evaporator -1)	Temperature	1	Field mounted Local thermocouple
6	Flue gas flow path between Evaporator - II and Economiser	Pressure	1	Field mounted local manometer
7	Flue gas flow path between Evaporator - II and Economiser	Temperature	1	Field mounted local thermocouple
8	Flue gas flow path after Economiser	Temperature	1	Field mounted local thermocouple
9	Flue gas flow path after Economiser	Pressure	1	Field mounted local manometer
10	Flue gas flow path before ID fan	Temperature	1	Field mounted local Temperature gauge
11	Flue gas flow path before ID fan	Pressure	1	Field mounted local manometer
12	Flue gas flow path after ID fan	Pressure	1	Field mounted local manometer

g. Blow down tank:

S.No	Location of inst.	Measured variable	Qty Nos	Instrument provided
1	Blow down tank's drain line	Temperature	1	Field mounted local Temperature gauge
2	Blow down tank's level gauge	Level	1	Field mounted local level gauge of tubular type

h. Deaerator cum storage tank:

S.No	Location of inst.	Measured variable	Qty Nos	Instrument provided
1	Deaerator cum storage tank	Level	1	Field mounted Local Level gauge of Transparent type with illumination
2	Deaerator cum storage tank	Level	1	Field mounted Level switch
3	Deaerator cum storage tank	Level	1	Field mounted Diff. Pressure transmitter
2	Deaerator cum storage tank	Pressure	1	Field mounted Diff. Pressure transmitter
5	Deaerator cum storage tank	Pressure	1	Field mounted local pressure gauges

i. Low Pressure Dosing system:

S.No	Location of inst.	Measured variable	Qty Nos	Instrument provided
1	LP Dosing system	Level	1	Field mounted Local Level gauge
2	LP Dosing system – Discharge line of Dosing pumps	Pressure	1	Field mounted local pressure gauges

j. High Pressure Dosing system:

S.No	Location of inst.	Measured variable	Qty Nos	Instrument provided
1	HP Dosing system	Level	1	Field mounted Local Level gauge
2	HP Dosing system – Discharge line of Dosing pumps	Pressure	1	Field mounted local pressure gauges.

7.2. LIST OF CONTROL VALVES:

S.No	Description of equipment / pipeline on which the instrument is mounted	Controlled variable	Qty Nos	Details of control valve
1	Attemperator line	Flow	1	Pneumatic actuated
2	Soot blower line	Flow	1	Pneumatic actuated
3	Start-up vent line	Flow	1	Pneumatic actuated
4	Feed line	Flow	1	Pneumatic actuated
5	DM Water line (to Deaerator)	Flow	1	Pneumatic actuated

7.3. LIST OF MOTORISED VALVES:

S.No	Description of equipment / pipeline on which the instrument is mounted	Qty Nos	Details of control valve
1	Main steam line	1	Electric motor actuated with Limit switches for Open / Close indication. - Gate valve (along with manual bypass valve)

8.0 SCOPE OF SUPPLY & EXCLUSIONS:

AV-UE : ARTICULATED VESSELS & UTILITY ENGINEERS SCOPE
CL : CLIENT SCOPE

ENGG : DETAILED ENGINEERING SUP : SUPPLY
FAB : FABRICATION E&C : ERECTION & COMMISSIONING

S. No.	DESCRIPTION	QTY	ENGG	SUP	FAB	E&C	REMARKS
8.1	**WATER WALLS**						
a.	Membrane Water Walls	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	Hoppers	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Screen section	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
d.	Support tubes with cleats	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
e.	Headers for Support tubes	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
f.	Buckstays	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.2	**SUPER HEATER –II**						
a.	Headers with coil bundle	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	Bends	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Supports	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	

S. No.	DESCRIPTION	QTY	ENGG	SUP	FAB	E&C	REMARKS
8.3	**SUPER HEATER –I**						
a.	Headers with coil bundle	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	Bends	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Supports	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.4	**DESUPERHEATER**						
a.	De-Superheater assembly	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
4.5	**EVAPORATOR BANK-I**						
a.	Headers with coil bundle	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	Bends	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Supports	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.6	**EVAPORATOR BANK-II WITH CASING**						
a.	Headers with coil bundle	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	Bends	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Supports casing	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.7	**STEAM DRUM**						
a.	Shell	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	Dished ends	**2 Nos**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Demister pads	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
d.	Cyclone separators	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
e.	Saddles	**2 Nos**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
f.	Internal piping	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
g.	Manholes	**2 Nos**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
h.	Nozzles	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
i.	Canopy on steam drum	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.8	**ECONOMISER I & II**						
a.	Headers with coil bundle	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	Bends	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Supports casing	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.9	**RISERS & DOWNCOMERS**						
a.	Pipes	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	Bends & fittings	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Supports	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.10	**SOOT BLOWERS**						
a.	Retractable blowers	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	

S. No.	DESCRIPTION	QTY	ENGG	SUP	FAB	E&C	REMARKS
b.	Rotary blowers	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Drive motors	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
d.	Limit switches	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
e.	Power cabling from Control Panel to Soot blowers motors	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
f.	Signal Cabling from Soot blower limit switches to Control Panel	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
g.	Soot blower Supports	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
h.	Soot blower drain valve	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
i.	Pressure Reducing Station	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.11	**FEED WATER PIPING**						
a.	Water treatment plant to Make up water control station	**1Set**	**CL**	**CL**	**CL**	**CL**	
b.	Make up water control station to Deaerator	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Deaerator to BFWP suction	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
d.	BFWP Discharge to FW Flow control station	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
e.	FW flow control station to Economiser	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
e.	Economiser to Steam Drum	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
f.	FW Piping to Desuperheater FCV	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
g.	Desuperheater FCV to Desuperheater	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.12	**STEAM PIPING**						
a.	Steam drum to PSH	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	PSH to Desuperheater	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Desuperheater to SSH	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
d.	SSH to MSSV	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
e.	Main steam stop valve to Common header	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	15 Mtrs

S. No.	DESCRIPTION	QTY	ENGG	SUP	FAB	E&C	REMARKS
f.	Common header to Turbine ESV	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	30 Mtrs
g.	Super heater PRV to Soot blowers	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
h.	Venting points to Safe height	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
i.	SH line to Startup vent valve	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
j.	Startup vent valve to Silencer	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
k.	Superheater safety valve to Silencer	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
m.	Turbine extraction to Deaerator PCV	**As Req.**	**CL**	**CL**	**CL**	**CL**	
n.	Steam piping from common steam header to turbine emergency stop valve	**As Req.**	**CL**	**CL**	**CL**	**CL**	
o.	Steam piping from common steam header to PRDS-1 for deaerator initial heating	**As Req.**	**CL**	**CL**	**CL**	**CL**	
p.	Steam piping from PRDS-1 to deaerator	**As Req.**	**CL**	**CL**	**CL**	**CL**	
o.	Steam piping from common steam header to PRDS-2 for ACC ejector and GCV	**As Req.**	**CL**	**CL**	**CL**	**CL**	
o.	Steam piping from PRDS-2 to ACC ejector and GCV	**As Req.**	**CL**	**CL**	**CL**	**CL**	
p.	Deaerator PCV to Deaerator	**As Req.**	**CL**	**CL**	**CL**	**CL**	
8.13	**COOLING WATER PIPING**						
a.	Source to Battery limit	**As Req.**	**CL**	**CL**	**CL**	**CL**	
b.	Battery limit to Individual eqpts.	**As Req.**	**CL**	**CL**	**CL**	**CL**	
8.14	**DRAIN PIPING**						
a.	Steam Drum to BD Tank	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	Individual drain points to BD Tank	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	

S. No.	DESCRIPTION	QTY	ENGG	SUP	FAB	E&C	REMARKS
c.	BD Tank to Nearest surtrench	**As Req.**	**CL**	**CL**	**CL**	**CL**	
8.15	**BLOW DOWN TANK**						
a.	Shell & dished ends	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	Valves & Mountings	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Foundation bolts	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
d.	Instruments as per list	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
e.	Nozzles	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.16	**DUCTING**						
a.	ABC outlet to Boiler inlet	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	Boiler outlet to ESP inlet	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	ESP outlet to ID fan inlet	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
d.	ID fan outlet to Stack inlet	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.17	**HOPPERS**						
a.	For first Pass	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	For Second Pass	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	For Third Pass	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.18	**EXPANSION JOINTS**						
a.	At inlet of boiler	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	At other ducting supplied by AV-UE.	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	ESP inlet and outlet expansion joints	**2 Nos**	**CL**	**CL**	**CL**	**CL**	
8.19	**STRUCTURE**						
a.	Boiler Supporting Structure up to operating Floor (RCC)	**As Req.**	**CL**	**CL**	**CL**	**CL**	
b.	Boiler supporting structure from Operating Floor	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Platform & handrails above Operating floor,	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
d.	Ladders staircases	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
e.	Foundation bolts for structures	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
f.	Supports for AV-UE supplied ducting	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	

S. No.	DESCRIPTION	QTY	ENGG	SUP	FAB	E&C	REMARKS
g.	Supporting steel structures for boiler roof & side cladding	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.20	**FIELD INSRUMENTS**						
a.	As per standards practice	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	Remote Level Gauge	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Instrument hardware	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
d.	Instrument (Signal & control) cabling from field instruments to local JB's	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
e.	Instrument cabling from local JB s to DCS and vice versa	**As Req.**	**CL**	**CL**	**CL**	**CL**	
f.	Instrument air piping from source to battery limits	**As Req.**	**CL**	**CL**	**CL**	**CL**	
g.	Instrument air piping from battery limit to instruments	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.21	**CONTROL PANEL**						
a.	Control panel with its accessories	**1Set**	**CL**	**CL**	**CL**	**CL**	
b.	DCS	**1Set**	**CL**	**CL**	**CL**	**CL**	
c.	UPS	**1Set**	**CL**	**CL**	**CL**	**CL**	
8.22	**SILENCER**						
a.	silencer for Steam drum safety valves	**2 Nos**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	Silencer for Superheater safety valve and start-up vent valve	**2 Nos**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.23	**VALVES & MOUNTINGS**						
a.	As per IBR requirement	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.24	**SAMPLE COOLERS**						
a.	On FW line	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	On saturated steam line	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	On superheated steam line	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
d.	On Blow down line	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.25	**ELECTRICALS**						
a.	MCC Panel	**1 No**	**CL**	**CL**	**CL**	**CL**	
b.	Compensating cables, Impulse piping & instrument cable, signal cables, control cables from	**As Req.**	**CL**	**CL**	**CL**	**CL**	

S. No.	DESCRIPTION	QTY	ENGG	SUP	FAB	E&C	REMARKS
	field instruments to JB's						
c.	Incoming cables to LT MCC	**As Req.**	**CL**	**CL**	**CL**	**CL**	
d.	Local push button station	**As Req.**	**CL**	**CL**	**CL**	**CL**	
e.	Lighting for plant	**As Req.**	**CL**	**CL**	**CL**	**CL**	
g.	Earthing materials	**As Req.**	**CL**	**CL**	**CL**	**CL**	
8.26	**REFRACTORY**						
a.	On gas Inlet duct	**As Req.**	**CL**	**CL**	**CL**	**CL**	
b.	On hoppers	**As Req.**	**CL**	**CL**	**CL**	**CL**	
c.	Refractory anchors	**As Req.**	**CL**	**CL**	**CL**	**CL**	
d.	Application curing	**As Req.**	**CL**	**CL**	**CL**	**CL**	
8.27	**INSULATION WITH ALLUMINIUM CLADING**	**As Req.**	**CL**	**CL**	**CL**	**CL**	
8.28	**DEAERATOR**						
a.	Deaerator	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
d.	Storage tank	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
e.	Valves & Mountings	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
f.	Instruments	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
g.	PRV station	**1Set**	**CL**	**CL**	**CL**	**CL**	
8.29	**HP DOSING SYSTEM**						
a.	Motorized stirrer	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
d.	Dosing pumps	**2 Nos**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
e.	Storage Tank	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
f.	Interconnecting piping	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
g.	Instruments	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.30	**FEED WATER PUMPS**						
a.	Centrifugal pumps	**2 Nos**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	Electric motors	**2 Nos**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Flexible spacer type with MS guards	**2 Nos**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
d.	Cabling from MCC to LPBS	**As Req.**	**CL**	**CL**	**CL**	**CL**	
e.	LPBS	**As**	**CL**	**CL**	**CL**	**CL**	

S. No.	DESCRIPTION	QTY	ENGG	SUP	FAB	E&C	REMARKS
		Req.					
f.	Conical strainers	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
g.	Auto Recirculation valves	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
h.	Cooling water supply piping from Battery limit to Feed water pump skid	**As Req.**	**CL**	**CL**	**CL**	**CL**	
i.	Cooling water return piping from Feed water pump skid to Battery limit	**As Req.**	**CL**	**CL**	**CL**	**CL**	
j.	Blow-off piping from Feed Water pumps to Deaerator	**As Req.**	**CL**	**CL**	**CL**	**CL**	
k.	Leak-off piping from Feed water pumps to near-by surface trench	**As Req.**	**CL**	**CL**	**CL**	**CL**	
l.	Spill-back piping from Auto Recirculation valves to Deaerator	**As Req.**	**CL**	**CL**	**CL**	**CL**	
8.31	**LP DOSING SYSTEM**						
a.	Motorized stirrer	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
d.	Dosing pumps	**2 Nos**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
e.	Storage Tank	**1 No**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
f.	Interconnecting piping	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
g.	Instruments	**1Set**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.32	**ELECTRO STATIC PRECIPITATOR**						
a.	ESP & its components	**1Set**	**CL**	**CL**	**CL**	**CL**	
8.33	**INDUCED DRAFT FAN**						
a.	ID FAN	**1 No**	**CL**	**CL**	**CL**	**CL**	
b.	Motor	**1 No**	**CL**	**CL**	**CL**	**CL**	
c.	Coupling	**1 No**	**CL**	**CL**	**CL**	**CL**	
d.	Pneumatic operated Control damper	**1 No**	**CL**	**CL**	**CL**	**CL**	
8.34	**RCC STACK**	**1 No**	**CL**	**CL**	**CL**	**CL**	
8.35	**ASH HANDLING SYSTEM (After RAV's on boiler and ESP)**	**1Set**	**CL**	**CL**	**CL**	**CL**	
8.36	**PAINTING**						
a.	Shop primer	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	

S. No.	DESCRIPTION	QTY	ENGG	SUP	FAB	E&C	REMARKS
b.	Site final painting	**As Req.**	**CL**	**CL**	**CL**	**CL**	
8.37	**CIVIL**						
a.	Civil load data	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	All civil design & civil works	**As Req.**	**CL**	**CL**	**CL**	**CL**	
c.	Control room for control panel /MCC etc.	**As Req.**	**CL**	**CL**	**CL**	**CL**	
8.38	**OTHER ITEMS**						
a.	First fill of lubricants	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	Alkali bailouts	**As Req.**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Complete water treatment plant	**1 No**	**CL**	**CL**	**CL**	**CL**	
d.	DM water storage tank	**1 No**	**CL**	**CL**	**CL**	**CL**	
f.	Air Compressor with accessories	**1Set**	**CL**	**CL**	**CL**	**CL**	
8.39	**Erection & Commissioning**						
a.	Erection & commissioning	**For supplied equipments**	**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
8.40	**IBR Formalities**						
a.	Issue of certificate of materials supplied		**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
b.	Site IBR activities		**AV-UE**	**AV-UE**	**AV-UE**	**AV-UE**	
c.	Statutory IBR Fees		**CL**	**CL**	**CL**	**CL**	

9.0 TERMINAL POINTS:

S. No.	Description	Terminal

S. No.	Description	Terminal
9.1	DM water	At the inlet of Deaerator LCV.
9.2	Condensate Return	At the inlet Nozzle of Deaerator.
9.3	Startup Vent Steam	At the outlet of silencers to 1 m safe elevation
9.4	Relief Steam from SH Safety valve	At the outlet of silencers to 1 m safe elevation
9.5	Main steam	At inlet of Turbine ESV (30 Mtrs)
9.6	LP steam for Deaeration	From the outlet of Deaerator PRV station.
9.7	Drain	At Blow down tank / nearest floor trench (within 10 meters from Boiler)
9.8	Electrical Power	At individual equipment / drives Inlet/outlet of MCC
9.9	Instrument signal	At the outlet of local JB boxes. Local junction boxes will be mounted on the WHRB Main Support Columns.
9.10	Instrument air	From one point near the boiler. (Within 5 meters from the WHRB) to individual Instruments

10.0 WATER QUALITY REQUIREMENT:

FEED WATER SPECIFICATION:

Drum Operating pressure bar (g)	61-100	Remarks
Hardness, max ppm	Nil	Note 4
pH at 25 deg C	8.8 to 9.2	Note 1
Oxygen, max ppm	0.007	
Total Iron, max ppm	0.01	
Total Copper, max ppm	0.01	
SiO2, max ppm	0.02	Note 4
Conductivity at 25 deg C after cation exchanger in H+ form and after CO2 removal max μs / cm	0.5	Note 4
Hydrazine residual ppm	0.01 to 0.02	

BOILER WATER SPECIFICATION:

Drum operating pressure bar (g)	61 to 100	Remarks
PH at 25 deg C	9.8 to 10.2	
Phosphate residual, ppm	15-25	Note 7
TDS, max ppm	Not more than 100	Note 5
Specific electrical conductivity at 25 deg C, max μs / cm	Not more than 200	
Silica, max ppm	To be controlled on the basis of silica in boiler water and drum Pr. And boiler water pH relationship to maintain less than 0.02 ppm in steam leaving the drum	
Sodium sulphite as Na2SO3, ppm		Note 2

Notes:

All the measurements of feed water shall be made at high-pressure heater outlet or economiser inlet.

1 Morpholine or any other volatile amine may be used to elevate the pH. The concentration of volatile chemical in feed water shall not exceed 1 ppm. (Expressed as ammonia)

2 Sodium sulphite shall be dosed in the feed water, after the tapping point for desuperheater spray so that it does not get contaminated.

3 The phosphate and pH shall be maintained in accordance with coordinated phosphate pH curve, to prevent the presence of free hydroxide in boiler water.

4 If the feed water is used for desuperheating spray, for all pressures

4.1 Hardness shall be nil.

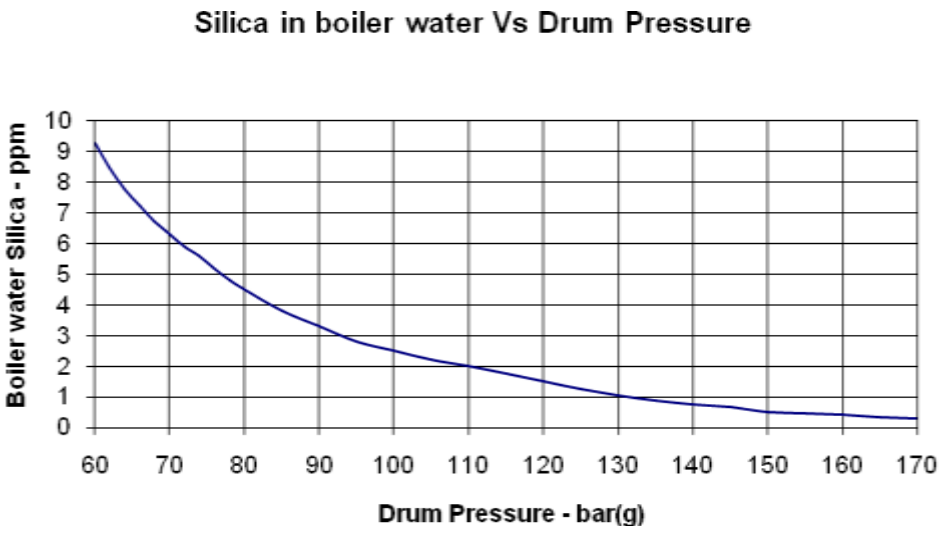
4.2 SiO2 shall not exceed 0.02 ppm.

4.3 Conductivity at 25 deg C measured after cation exchanger in H+ form after CO2 removal not to exceed 2 micromho / cm.

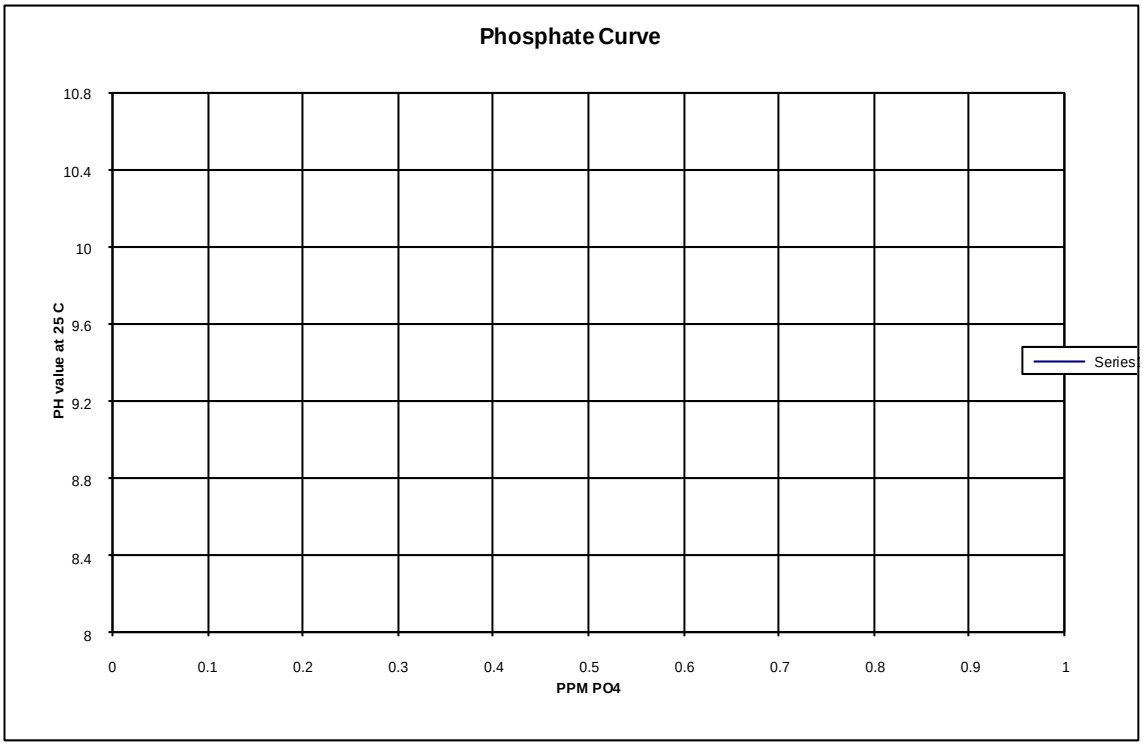
5 Total alkalinity in boiler water shall not exceed 20% TDS.

6 Presence of oil or organic matter is not allowed in feed water which will induce foaminess and cause carryover of impurities in to steam.

7 The phosphate and pH are recommended in accordance with coordinated phosphate curve to prevent presence of free hydroxide in boiler water. If the recommended pH is consistently obtained phosphate residual can be maintained near lower limits.



The above curve is for Boiler water pH = 10, for drum pressures of 60 to 98 bar(g)



11.0 MATERIAL OF CONSTRUCTION OF MAJOR EQUIPMENTS:

Description	MOC	Remarks
Steam Drum Shell	516 Gr 70/ Equiv.	
Drums Dished Ends	516 Gr 70/ Equiv.	
Internal Piping in Steam Drum	SA 106 Gr B	
Steam Purifier in Steam Drum	SS 304	Non-IBR
Superheater 1 Tubes	SA 210 Gr. A1	
Superheater 2 Tubes	SA 213 T11	
Inbed Coils	SA 210 Gr. A1	
Economiser Tubes	BS 3059 Smls	
Water walls/ Evaporator	BS 3059 Smls	
Air Preheater	IS 1239	Non-IBR
Bed Coils	SA 210 Gr A1	
Blow Down Tank	IS 2062	
Superheater 1 **Outlet Header** **Inlet Header**	 SA 106 Gr. B HFS SA 106 Gr. B HFS	
Superheater 2 **Outlet Header** **Inlet Header**	 SA 335 P11 HFS SA 106 Gr. B HFS	

Inbed Headers & Water Wall Headers	SA 106 Gr. B HFS	
Economiser Headers	SA 106 Gr. B HFS	
Deaerator	IS 2062	

OTHER ITEMS:

Flanges for Pressure Parts	:	SA 105 / Equiv.
Inlet Duct	:	IS 2062 Gr. B / Equiv.
Outlet Box	:	IS 2062 Gr. B / Equiv.
Saddle Support	:	IS 2062 / Equiv.
Stud/ Bolt/ Nuts for Press. Part	:	SA 193 Gr.B7/SA 194 Gr. 2 H/ Equiv.
Ducting	:	IS 2062 Gr. B
Structurals	:	IS 2062 Gr. B
Hoppers	:	IS 2062 Gr. B

12.0 CODES AND STANDARDS APPLICATION:

The Design, Manufacture, inspected and testing of Waste Heat Recovery Steam Generating System (WHRSG) and accessories will comply with latest editions of the codes and standards indicated below or equivalent international standards and will meet statutory regulations and safety codes:

- Design code (Press. Parts)	: IBR 1950
- Materials	: ASME/ASTM/I.S
- Design code (Piping)	: ANSI B 31.1
- Design code (Non-Press. Parts)	: GEP
- Pipe fittings & flanges	: ASME-B16.5,B16.11,B 16.9
- Welding & Welder test	: ASME Sec.IX & ANSI B 31.3
- N.D.E	: ASME Sec. V
- Safety valves	: IBR
- Testing of valves	: ASME-B31 & B.S.6755,
- Steel valves –flgd & BW	: ANSI-B16.3,B16.10& 16.25
- Centrifugal pumps	: API 610 / DIN 1944
- Code of practice for general construction in steel	: I.S. 800
- Criteria of Earth quake resistant design of structures	: I.S. 1893
- Stairs, Ladders and Walkways	: BS 5395

- Code of Practice for design loads for Building & Structures Wind load	
- Heat Exchangers	: ASMESec.VIIIDiv.1& TEMA
- Storage Tanks	: API 650
- Fasteners (Bolts & Nuts)	: EJMA
- Surface preparation	: Acc. To AV-UE
- Painting	: Acc. To AV-UE
- Sound pressure measurement	:ISO 6190 & ISO 1680

13.0 INSPECTION & DOCUMENTATION:

WHRSG will be fabricated and tested under stage wise and final inspection of Chief Inspector of Boilers, AP and following approvals shall be obtained.

- General Arrangement drawing with Fabrication part drawings.
- Materials Test Certificates for compliance with specification.
- Stage wise inspection during fabrication by QC of AV-UE & CIB
- Relevant Weld procedures and qualification tests.
- Final equipment dimensions verifications.
- Hydro Test and any other tests as required by the code/CIB/Client

We will furnish the following documentation after dispatch of the equipment:

Material Test Certificates, Check Test Reports, Stage Inspection Reports, Radiographic Test Results, Charts for Stress Relieving, Thinning and Ovality Reports, Works Test Certificate, Works Guarantee Certificate etc., along with following documents:

As Built Drawings (in ammonia print)	: 2 Sets
As Built Drawings (in soft copy)	: 1 Set
I.B.R. Documentation Folder (original)	: 1 Set
I.B.R. Documentation Folder (photocopy)	: 2 Sets
Installation Instruction Manual	: 2 Sets
Operation and Maintenance Manuals	: 2 Sets

14.0 LIST OF PRINCIPAL VENDORS FOR BOUGHT OUT COMPONENTS:

PRESSURE PARTS ENDOR LIST:

- Plates (Boiler quality) : SAIL / Imported
- Tubes & Pipes (Boiler quality) : MSL / JINDAL / Imported

INSTRUMENT VENDOR LIST:

A. Air Filter Regulator:

- Shavo Norgen (India) Pvt Ltd, Placka, Veljan, SMC Pnematic

B. Flow Nozzle / Orifice:

- AV&UE(Orifice), Star Mech, JN Marshall, Hydro Pneumatics, GIC, Eureka Industrial Equipment ltd

C. Instrumentation & Ext. Cables:

- Finolex, Finecab

D. I/P Converters:

- Watson Smith (Mtl), H&B / Rosemount, Moore, Anirudh Engineers, Forbes Marshall, Fischer, ABB, MIL, Imported

E. Level Gauges & Level Switches:

- Levcon instruments Pvt Ltd, Protolona Instruments, Yarway, Hitech, Becon pvt. Ltd (Solatron Make), Chemtrol (level switch), Pune Techtrol, Imported

F. Pressure, DP, Flow & Level Transmitter:

- ABB, Emerson, Yokogawa, Fuji, Rosemount, Siemens, H&B, Imported

G. Pressure & Temperature Gauges:

- General Instruments Co., Radix Electro Systems, H.Guru, Pyro electric, Wika, Waaree instruments, Forbes Marshall, Radix Micro Systems

H. Pressure Switch & Temperature Switches:

- Indfoss, Switzer, AN Instruments

I. RTD and Thermocouples:

- Tempsen, Radix Electro Systems, Pyroelectric, GIC, Nutech Engineers, Detriv, Thermal instruments, Waree

J. PLC:

- Allen Bradely, LSS, Schneider Electric, Siemens, Tata Honeywell, ABB, GE Fanuc, Rockwell automation

K. EWLI:

- Level State, Radix Electro Systems, Yarway, Solatron

L. O2 Flue Gas Analyser (In Situ Tpe):

- Ametek, Chemtrol, Enotech, ABB Kent, Land Combustion, Emerson, Forbes marshall, YBL

M. Flue Gas Analyser

- Codel, Chemtrol, Ametek, ABB Kent, Land CCombustion, Emerson, Forbes marshall, YBL

N. VFD:

- ABB, Siemens, GE, Allan Bradley, L&T, Dan Foss, Schneider, Eurotham Automation, Vacon, Fuji Electric-VFD

O. Desuperheater / PRDS:

- Forbes marshall, Yarway, Fisher Sanmar, AV&UE (De-Super heater), Mazda, JN Marshall, Dewrence, Chemtrols

P. Single Loop Controller:

- Bells Controls, Siemens ltd, Tat Honeywell Ltd, Yokogawa Blue Star ltd

Q. SWAS:

- AV&UE, Forbes Marshal, Swan, Rosemount, Chemtrol, Yokogawa, VJ Engineering, ABB

ELECTRICAL VENDOR LIST:

A. Motor Control Centers:

- AV&UE, Seimens, L& T

B. Motors –LT

- Kirloskar, BHEL, Siemens, BNGEF, Bharat Bijlee, ABB, Rotomotive, Alstom

C. Power Control Cables:

- Cable Corporation of India, Polycab, UCl, NICCO, Fort Closter, TCL

D. Transducers:

- BABB, Siemens, AE, Alstom, Minilee

E. LT Switch Gear Components:

- Siemens, L&T, ABB, Alstom , LG -LS

F. CTs & PTs:

- Precise, Kappa, Indcoil, Alstom, Areva

G. Push Button Station:

- GEPC, Standard Gold, Technic, Vaishnov

H. Selector Switches:

- Kavcee, SCI, GEPC

I. Digital Meters:

- Enercon, Neptune, HPL, IMP

J. Protection Relays:

- Alstom, LG - LS

K. Auxiliary Relays:

- Alstom, LG – LS, Siemens

L. Cable Trays & Accessories:

- APT Engineering, Premier, Jamuna metals, Globe

M. Air Circuit Breaker / MCCB:

- Seimens, L&T, GE power, Schneider Electric

N. Analog Meters:

- AE, Rishabh

O. Motor Protection Relays:

- Alstom, LG -LS

P. Contractor:

- Siemen, L&T, GE power, Schneider Electric, BCH, Telmechanique, LG -LS

Q. Ac Switches:

- Seimens, L&T, GE power, Schneider Electric, LG -LS

R. DC Switches:

- Kaycee

S. VFD panels:

- ASEA Brown Boveri Limited, Danfoss industries Private Limited, Eurotherm Del India Limited, L&T, Siemens L:imited, TB Wood,s India PCT Limited, Amtech, HI Rel, AV&UE

T. Junction boxes:

- AV&UE, SAI-BEE , Mithsagar, Baliga

MECHANICAL VENDOR LIST:

A. Feed Water Pumps:

- KSB, Sulzer, Kirlosker

B. Insulation:

i. Mineral Wool insulation:

- Llyod Rock Fibres, Rock Wool Industries, Orient, Mine wool , Thermo wool

ii. Aluminium Caldding:

- Balco, Indal, Hindlaco, Anish Metals, Alluminium India

iii. Refractory & insulation Bricks:

- ACC, Dalmia Refractory, Tata Refractories, Pacific Refractories, Castwell

C. Fans & Accessiroes:

- Air Flow, Ritz, CB Doctor, imported

D. Chemical Dosing System:

- AV&UE, Metapow, Positive Metering Systems

E. Pipe work, Valves & Fittings:

i. Safety valves:

- TYCO Sanmar, MH Valves, Fainger & Lesser, Diaton China, BHEL, Mazda

ii. **Blow down valves:**

- Levcon, BHEL, Fluid Line, Diaton China, MH Valves

iii. Control Valves:

- MIL, Fisher Xomox, Imported, Mascot Valves, Samson Controls

iv. Solenoid Valves:

- Rotex, ASCO

v. Manual Valves

- BHEL, KSB, Alsa, Prime, Fluidline, Daiton

F. Paints:

- Asian paints , Berger paints India Limited

15.0 GENERAL SPECIFICATIONS:

15.1 QA AND WELD PLAN:

Appropriate Q.A. Plan covering WPS, PQR, thinning and Ovality, mock up test, radiography, D.P. Test, other NDEs, stress relieving, surface preparation, activities/inspection, acceptance criteria, verifying documents, etc.., taking into consideration technical requirements of the code/specifications of the client and his consultant will be submitted on receipt of the order for comments/approvals and finalization of the hold points.

15.2 INSPECTION AND ACCEPTANCE BY BUYER/OWNER:

You will have complete access to undertake inspection of the equipment as per the hold points or at any other stage including final testing. All facilities available with us will be extended free of cost to carry out the inspection. However, inspection and acceptance by you does not absolve our contractual/guarantee obligations.

15.3 PROGRESS REPORTING:

We will furnish progress report on a fortnightly basis covering the following:

a) Basic Engineering

b) Detailed engineering specifications and drawings

c) Q.A Plan and W.P.S.

d) Procurement

e) Fabrication & Testing

15.4 CONCESSION REQUEST:

Any deviations arising during execution of the contact will be submitted to you with corrective action for approval. No rectification will be carried out without your written approval.

15.5 WELDING:

We will clearly indicate details of the welding in the fabrication drawings. Only qualified welders as per IBR will be employed. The welding will be carried out as per established WPS and PQR with approved electrodes and Filler Rods.

15.6 SHOP TESTING:

On successful completion of fabrication, all the Pressure parts will be subjected to hydrostatic test in the presence of IBR/Third party Inspection authority/OWNER.

15.7 STATUS AND SUB-CONTRACTING:

The equipments offered vide this proposal will be manufactured and tested at our works, located at Hyderabad. Any sub-contracting will be informed to you in advance.

15.8 WARRANTEES:

We warrantee the equipment to be free from defective raw materials and faulty workmanship for a period of 18 months from the date of dispatch or 12 months from the date of commissioning, whichever is earlier. Any parts found defective under normal working conditions will be supplied free of cost. However this warrantee does not cover normal wear and tear in operation and damages during transit and erection.

Bought out components are guaranteed by us only to the extent of guarantees given to us by our suppliers. Electrical components such as heaters, motors, contractors etc., rubber components and instruments such as pressure gauges, thermometers, comb stats, etc.. are, however, not covered under this warranty.

The warranty is subject to :

a) Installation having been completed within three months of dispatch of the equipment and as per our installation instructions.

b) The supply/installation having been formally accepted as per the handing over clause.

c) Supply of right gases as per relevant specification.

d) The equipment or part thereof not being subject to accident, alternation, abuse or misuse.

e) The equipment being operated and maintenance as per our operation and maintenance manual.

COMMERCIAL PROPOSAL

FOR

1 x 10 TPH WHR BOILERS

IN SPONGE IRON PLANT

SUBMITTED TO

M/s. APTICO.

SUBMITTED BY

ARTICULATED VESSELS & UTILITY ENGINEERS PVT LTD.

SECUNDERABAD- 500 009

M/s. AV-UE/WHRS-APTICO/Q/11-12:110 **Date: 03-11-2011**

M/s. APTICO .

Kind Attn: Mr. GOPALA RAO

Dear Sir,

Sub: Commercial Proposal for Supply, Erection & Commissioning of 1 x 10 TPH Waste heat recovery Systems.

Ref: With reference to the telephonic discussion had with our MD. Mr. PARAMVIR SINGH

We thank you very much for showing interest in AV-UE for your boilers. As required by you, we are pleased to submit herewith our Commercial Proposal for Supply, Erection & Commissioning of 1 x 10 TPH WHR Boilers at 66 Kg/cm2 (g) Pressure and 485±5 ºC Superheated Steam and Common Deaerator System for your Power Plant.

AV&UE supplies boilers designed and manufactured to several national & international standards like IBR, ASME Sec VIII Div 1 & BS 113.

We trust the above is in line with your requirement & in the meantime, if you need any further clarifications to evaluate our proposal please feel free to contact us.

Assuring you of our best attention, always.

Thanking you,

Yours faithfully,
for ARTICULATED VESSELS & UTILITY ENGINEERS PVT. LTD.

PARAMVIR SINGH
MANAGING DIRECTOR

1.0 PRICE SCHEDULE:

The Prices are quoted as per scope of supply given in our Technical offer.

SNO.	DESCRIPTION	Qty (Nos)	Total Cost In Laks
1 x 10 TPH WASTE HEAT RECOVERY BOILERS:			
1.	Supply of 1 x 10 TPH WHR Boilers includes Water wall furnace, Two stages Superheater, Desuperheater, Evaporators, Economiser as per our scope of supply.	**1 set**	**2,82,10,900**
2.	Complete Boiler structural & Non pressure part includes main columns, bracings, tie beams, foundation bolts, walkways, handrails, staircases, flue gas ducting etc., as per scope of supply	**1 set**	
3.	Boiler integral feed water & Steam pipelines	**1set**	
4.	Blow down tank, HP Dosing system, Sample coolers & Soot Blowers with Controls as per our scope of supply	**1set**	
5.	Valves, Mountings & Instruments as per our scope of supply	**1 set**	
FEED WATER SYSTEM:			
1.	10.6 M^3 Deaeration capacity Deaerator cum 5 M^3 Storage Tank with Valves Mountings and Instruments	**1 set**	**15,68,700**
2.	Feed Water Pumps with Motors (each 10.6 M^3 Capacity)	**2 sets**	**26,45,000**
3.	i. Feed water piping from to Deaerator to Economiser Inlet ii. Common Steam pipeline from MSSV to Common Header iii. Common header to Turbine ESV	**1 set**	**16,57,000**
4.	LP Dosing System	**1 set**	**3,60,000**
ERECTION & COMMISSIONING:			
1.	Erection & Commissioning	**For Each Boiler**	**21,50,000**
2.	Site IBR Activities & Approvals		
TOTAL			**3,73,41,260**

2.0 COMMERCIAL TERMS AND CONDITIONS:

PRICES - Prices quoted are Ex-works, Hyderabad basis.
Packing & Forwarding charges are included in our quoted price.
Transit Insurance has to be Bourne by Client

FREIGHT - Extra on to-pay basis.

TAXES & DUTIES - Extra at actual.

DELIVERY - The Equipment will be delivered on Ex-works, Hyderabad basis within **Ten (10) Months** from the date of receipt of your technically and commercially clear order along with advance.

VALIDITY - Our offer is valid for a period of 30 days from the date of this quotation.

PAYMENT TERMS - **FOR SUPPLIES**

20 % advance along with Order.

20 % against drawings approval.

Balance 60% against Proforma Invoice prior to dispatch of each equipment on prorate basis.

GUARANTEE - The above system will be guaranteed against defective raw materials and bad workmanship for a period of 18 months from the date of supply or 12 months from the date of commissioning, whichever is earlier.

FORCE MAJEURE: - We shall not be liable for any penalties/liquidated damage charges for delayed deliveries due to reasons beyond our control such as War, Riots, Inclement weather, Floods, Act of God etc.

for ARTICULATED VESSELS & UTILITY ENGINEERS PVT. LTD.

PARAMVIR SINGH
MANAGING DIRECTOR