DETAILED PROJECT REPORT
ON
INDUCTION FURNACE (750 KG)
(JAGADHRI BRASS & ALUMINIUM CLUSTER)

Bureau of Energy Efficiency

Prepared By

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INDUCTION FURNACE FOR BRASS MELTING (750 KG CAPACITY)

JAGADHRI BRASS AND ALUMINIUM CLUSTER

BEE, 2010

Detailed Project Report on Induction Furnace for Brass Melting (750 kg Capacity)

Brass & Aluminium SME Cluster, Jagadhri, Haryana (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No.: **JAG/MET/GAS (A)/01**

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Zenith Energy Services Pvt. Ltd.

Hyderabad

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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
- MSME - Micro Small and Medium Enterprises
- MoMSME - Ministry of Micro Small and Medium Enterprises
- NPV - Net Present Value
- ROI - Return On Investment
- SIDBI - Small Industries Development of India

EXECUTIVE SUMMARY

Zenith Energy Services Pvt. Ltd. is executing BEE-SME program in Jagadhri Brass & Aluminium Cluster, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in cluster units.

Jagadhri is renowned for the brass utensils, sheets, coils, strips and also Aluminium & Stainless steel utensils, there are about 150 to 200 brass and aluminium industries in the cluster. The brass & copper sheets, strips, coils and aluminium utensils produced in Jagadhri cluster are renowned in the country. Majority of the industries have been in operation for the last 15 to 30 years. The main raw materials are brass, copper and aluminium scrap is being procured from local agents.

The major Energy forms used in the cluster are electricity and fuels like Coke, Wood, and Furnace Oil etc. Electricity is used for driving the prime movers of pumps, fans, drives, rolling machine motors, induction and annealing furnaces and for lighting. Coke and Furnace oil is used for brass and aluminium melting in Pit Furnaces. Wood is used as a fuel in Annealing furnaces.

The cost of energy as a percentage of manufacturing cost varies anywhere between 3 to 5%, which includes electrical as well as thermal. Majority of the industries located in Jagadhri uses coke and furnace oil as energy in process for pit melting and a very few units are using electricity for wood Gasifiers for melting. Pit melting process requires large amount of thermal energy, inducing a high share of energy cost. The energy cost is next to the raw materials cost.

This DPR is prepared for installation of Induction furnaces for brass melting for reducing energy/production cost. DPR highlights the details of the study conducted for assessing the potential for possible reduction in energy consumption 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.

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

S. No	Particular	Unit	Value
1	Project cost	` (in Lakh)	19.85
2	Coke consumption in base case scenario	tonne/year	150
3	Electricity consumption in proposed case	kWh/year	375000
4	Monetary benefit	` (in Lakh)	16.12
5	Simple payback period	Years	1.23
6	NPV	` (in Lakh)	40.17
7	IRR	%age	61.93
8	ROI	%age	27.94
9	Average DSCR	Ratio	3.37
10	Estimated CO_2 reduction	tCO_2/year	104
	Process down time	Week	2

The projected profitability and cash flow statements indicate that the project implementation i.e. installation of Induction Furnace for Brass Melting will be financially viable and technically feasible.

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. Jagadhri Brass & Aluminium 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:

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.

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

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.

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

Jagadhri is renowned for the brass utensils, sheets, coils, strips and also Aluminium & Stainless steel utensils, there are about 150 - 200 brass and aluminium industries in the cluster. The brass & copper sheets, strips, coils and aluminium utensils produced in Jagadhri cluster are renowned in the country. The main raw materials are brass, copper and aluminium scrap is being procured from local agents.

The cost of energy as a percentage of manufacturing cost varies anywhere between 3 to 5%. Majority of the industries located in Jagadhri uses coke and furnace oil as energy in process for pit melting and a very few units are using electricity for wood gasifiers for melting. Pit melting process requires large amount of thermal energy, inducing a high share of energy cost. The energy cost is next to the raw materials cost.

1.1.1 Production process

The main process operation for aluminium melting and products manufacturing adopted in cluster units are as follows:

Brass Melting

Pit Furnace is a common type of furnace used in all cluster units for melting the scrap brass in the crucibles. Furnace oil is used as fuel. The pit furnace is a circular pit lined with refractories and the crucible is inserted in the furnace and Furnace oil is feeded underneath and sides of the pit furnace. The outer side of the furnace is lined with red bricks. The normal time for each batch of melting is two and half hours and subsequently the batch time reduces by about 20 minutes to 30 minutes than the initial batch.

Annealing

Different types of Annealing process are used in the cluster:

a) Electric annealing

b) Wood fired annealing

c) Oil fired annealing

The temperature required for annealing and re-heating the brass billets is 600 to 650 ^{o}C and Aluminium billets is 400-450 ^{o}C. The brass & aluminium sheets, billets and brass coils are heat treated for about 10 to 12 hours in a day.

Electric annealing

The brass sheets are heat treated for about 5 to 6 hours in a day by electrical energy and the production capacity of the annealing furnace in the cluster units is varying from 1000 kg to 3000 kg per batch. The annealing furnace is bogie type furnace fabricated with steel body and the inside of the furnace is constructed with the refractory bricks and insulation materials.

Wood fired annealing

Wood Fired Annealing Furnace is a common type of annealing furnace found in the cluster and is normally installed in smaller and medium size units. The wood fired furnace is used for heat treatment of the brass and aluminium sheets and circles and also reheating of the billets before hot rolling. The wood is used as fuel and the production capacity of the wood fired furnace in the cluster units is varying from 2000 kg to 4000 kg per batch. The annealing furnaces are of very old design and are constructed with red bricks and only the hearth of the furnace is constructed with the refractory bricks. The design of the annealing furnace is more or less identical in all cluster units.

Oil fired annealing furnace

The brass coils is heat treated for about 8 to 10 hours in a day. The furnace oil is used as fuel and the production capacity of the oil fired bell furnace in the cluster units is varying from 3000 kg to 4000 kg per batch. The annealing furnaces are bell type furnace fabricated with insulation steel drum and asbestos. The design of the bell annealing furnace is more or less identical in all the coil plant units.

Rolling

Different types of rolling process are used in the cluster:

a) Hot rolling

b) Cold rolling

Hot Rolling

The primary function of the Hot rolling is to reheat aluminium billets or hot casted billets nearly to their melting point, then roll them thinner and longer sheets through rolling machine driven by motors having capacity around 60 to 100 HP and annealing up the lengthened brass or aluminium sheets and used for the next process.

Cold Rolling

Cold rolling is carried out to allow desirable metal qualities that cannot be obtained by hot working such as eliminating shrinkage errors for higher dimensional accuracy of the metal. Furthermore, to have smoother surface of the final products, enhance strength and hardness. As such, the metal must be heated from time to time (annealed) during the rolling operation to remove the undesirable effects of cold working and to increase the workability of the metal.

Shearing

In the shearing process, the sheets are cut to required size out of larger sheets such as roll sheets. Shears are used as the intermediate or finished step in preparing for cold rolling or circle cutting processes.

Pressing

Pressing is a metal forming process in which sheet metal is stretched into the desired part shape. A tool pushes downward on the sheet metal, forcing it into a die cavity in the shape of the desired part. The tensile forces applied to the sheet cause it to plastically deform into a utensil-shaped part. Pressing is most effective with ductile metals, such as aluminum, brass, copper, and mild steel. Examples of parts formed with Pressing include milk tanks, cans, cups, kitchen utensil sinks, pots and pans.

The Pressing processes machine either in cam or hydraulic type is used having capacity 25 HP to 63 HP motors.

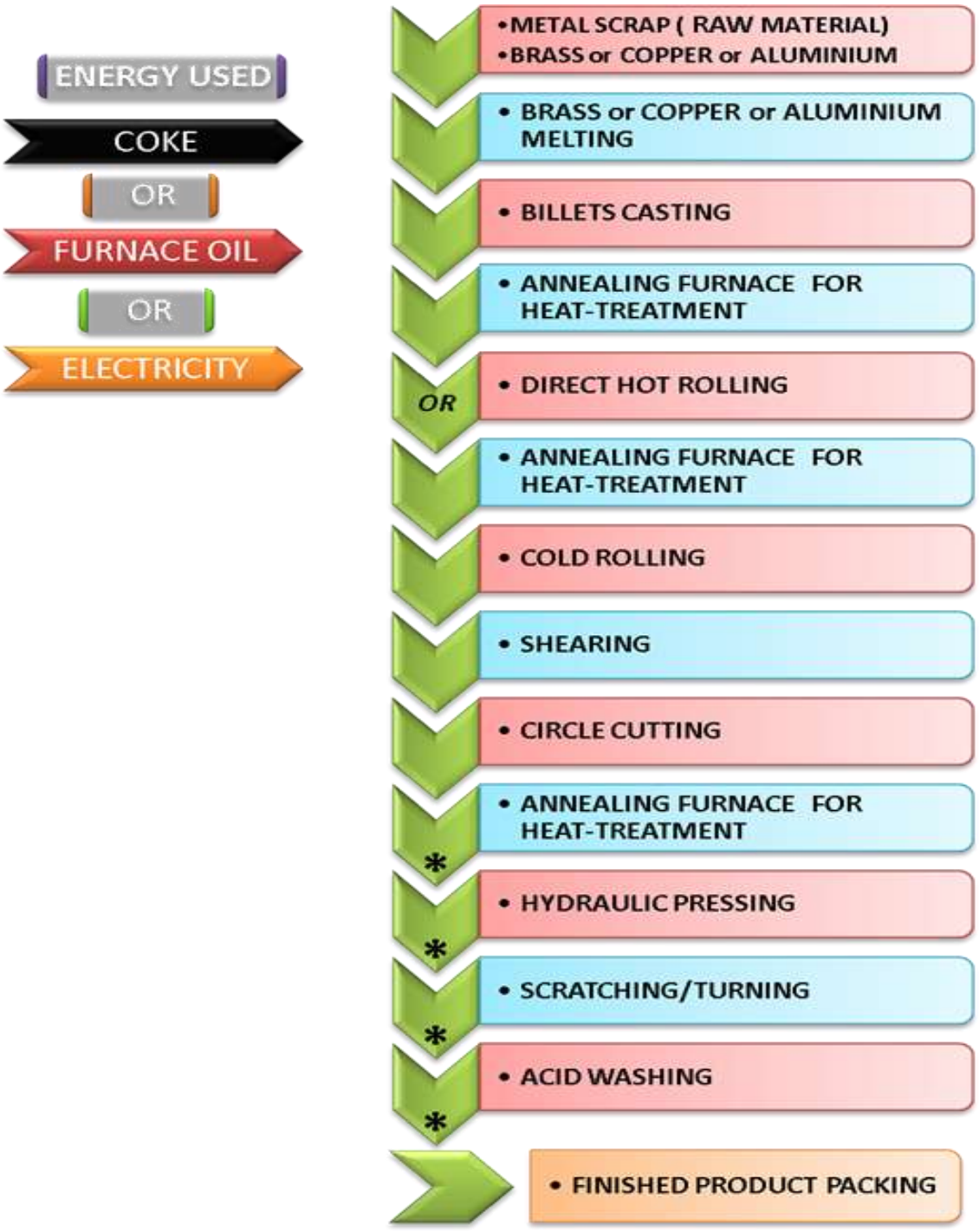


Figure 1.1: General Process Flowchart

For Product / Utensils Manufacturing

1.2 Energy performance in existing situation

1.2.1 Fuel and electricity consumption of a typical unit

The main energy forms used in a typical unit in the cluster are electricity, coke, furnace oil and wood. Electricity is used for driving the prime movers of blowers, hot and cold rolling machines, shearing machines and press. Coke is used as fuel in Pit Furnaces for brass melting and wood is used as fuel for annealing furnaces. The energy consumption of a typical unit in the cluster having pit furnace for brass melting is furnished in Table 1.1 below:

Table 1.1: Energy consumption of a typical unit (Ahuja Metal Industries)

S.No	Details	Unit	Value
1	Coke Consumption	tonne/annum	96
2	Grid Electricity consumption	MWh/annum	170
3	Wood Consumption	tonne/annum	240

1.2.2 Average production by a typical unit in the cluster

The average production in a year in a typical unit is 720 tonne.

1.2.3 Specific Energy Consumption

The main energy forms used in the brass processing units are electricity, furnace oil and wood. The Specific energy consumption for electrical and thermal energy per tonne or kg of Production for a typical unit is furnished in Table 1.2 below:

Table 1.2: Specific energy consumption for a typical unit (Ahuja Metal Industries)

S. No.	Type of Fuel	Units	Specific Energy Consumption
1	Coke consumption	tonne/ tonne of production	0.133
2	Grid Electricity consumption	MWh/ tonne of production	0.236
3	Wood consumption	tonne/ tonne of production	0.333

Equipment wise Specific Energy Consumption

The specific energy consumption of the equipments used in the Jagadhri Aluminium & Brass Industries is given in Table 1.3 below wherever possible.

Table 1.3 Equipment wise Specific Energy Consumption

S.No.	Equipments	Minimum SEC	Maximum SEC	Average SEC (for whole cluster)
1	Pit Furnace	0.110	0.150	0.130
2	Annealing Furnace	0.150	0.260	0.205

1.3 Existing technology/equipment

1.3.1 Description of existing technology

Pit Furnace is a common type of furnace used in all cluster units for melting the scrap brass in the crucibles. Coke is used as fuel and the production capacity of the pit furnace in the cluster units is 600 kg per batch. Normally about 4 to 5 batches are produced in a day. The furnace is operated on single shift basis normally 12 hours.

The pit furnace is a rectangular pit lined with refractories and the crucible is inserted in the furnace and coke is feeded underneath and sides of the pit furnace. The outer side of the furnace is lined with red bricks. After feeding coke and inserting crucible in the pit and the firing of the coke is started. The normal time for each batch of melting is two and half hours and subsequently the batch time reduces by about 20 minutes to 30 minutes than the initial batch. A small blower of local make of 1 HP is used for supplying combustion air and then casting of billets of required sizes.

1.3.2 Its role in the whole process

The pit furnace is used for melting the brass scrap. The number of melting batches varies as per the production requirement.

1.4 Establishing the baseline for the equipment to be changed

1.4.1 Design and operating parameters

The main energy forms used for pit furnace are coke. Electricity is also used in small quantities for operation of blower for supplying combustion air. The pit furnace is constructed by the in house workers and doesn't have name plate details. The coke consumption depends on the following parameters such as quantity of brass to be melted, temperature required, furnace oil heat value and design of the pit furnace. The operating parameters of the pit furnace collected for a typical unit during the field visit is furnished in Table 1.4 below:

Table 1.4 Details of Operating parameter

S. No.	Particular	Units	Value
1	Capacity of the pit furnace	kg/ batch	600
2	Quantity of brass melted	kg/ batch	600
3	Average coke consumption	kg/batch	80
4	Melting temperature measured	°C	1021
5	Temperature of waste flu gas	°C	500 – 550
6	Quantity of unburnt fuel left after the process	kg/batch	20

1.4.2 Coke & Electricity consumption and Operating Efficiency

The operating efficiency of the pit furnace in various units had been evaluated during energy use and technology audits using coke as fuel for brass melting. The efficiencies of the pit furnaces are found to be in the range of 8% to 12% in various units of the cluster. The details of furnace oil consumption, electricity consumption, efficiencies and energy cost involved for brass melting per kg for pit furnaces in 3 typical units is furnished below in Table 1.4 below:

Table 1.4 Energy Consumption & Efficiency of three typical units in the cluster

S. No	Name of the unit	Fuel Consumption (tonne/annum)	Electricity Consumption (MWh/annum)	Efficiency of pit furnace (% age)	Waste Heat Recovery System
1	Ahuja Metal Industries	96	170	11.4	No
2	Usha Enterprises	57	159	11.0	No
3	Arun metals	120	159	10.8	No

1.5 Barriers for adoption of new technology/equipment

1.5.1 Technological Barriers

The major technical barriers that prevented the implementation of the Induction furnace for brass melting in the cluster are:

- Firstly, Lack of awareness about the technology and there was no considerable research by the consultants or local service providers.

- Most of the operators/supervisors are non technical and doesn't have knowledge on the design and technical aspects.
- Secondly, due to lack of knowledge of the technical benefits of the Induction furnace among the SME owners in the cluster.
- Thirdly, majority of the owners of the cluster are more focused on the successful implementation of the proposed technology in the cluster before going to implement it as so far, no unit had been implemented Induction furnace.

1.5.2 Financial Barrier

- Further, lack of awareness about the losses occurred due to waste heat and monetary benefit of the Induction furnace is also one of the major barrier that prevented implementation of the wood Gasifier in cluster units
- Energy Efficiency Financing Schemes such as SIDBI's, if taken up in the cluster, many SME owners will come forward to up taken up the technology due to financial attractiveness of the technology.

1.5.3 Skilled manpower

Not applicable

1.5.4 Other barrier(s)

The power supply is intermittent in Jagadhri and the cluster units are facing severe power cuts. It is well known fact for induction melting that continuous power supply is required otherwise, materials gets solidify in the furnace leading to damage of the material, furnace and also on production. Hence, there is a fear among SME owners of the losses and this was also one of the major barriers that prevented implementation.

2. DESCRIPTION OF PROPOSED TECHNOLOGY/EQUIPMENT

2.1 Detailed description of technology/equipment selected

2.1.1 Description of technology

The induction furnace for brass melting essentially consists of the following systems:

Solid State Starter

Solid State Power Supply Unit conditions the incoming power suitable to operate induction furnace. The incoming three-phase supply at 50 Hz is converted into a DC using a three phase fully controlled thyristorised rectifier. The DC supply is converted to a single phase AC at required frequency using single phase thyristorised current source (parallel) inverter. The Power Supply Unit consists of fast acting semiconductor grade back up HRC fuses, thyristorised six pulse, DC smoothing choke, single phase thyristorised bridge inverter, controlled electronics with necessary feed-back elements and power supply, protection circuits, a set of fault indicating lamps, meters, push buttons, interconnecting bus bars, flow monitoring switch and conductivity meter for monitoring conductivity of de-ionized water. All these components are fitted into a dust proof MS cubicle.

Capacitors

Medium Frequency water cooled capacitors are used to form a tank circuit with the furnace coil. This presents unity power factor load to the inverter. The electrical connections to the main bus bars are provided by water cooled tubes to ensure proper cooling at the joint. Flow monitoring switches are used to ensure proper flow in the capacitor. Colour coded PVC braided pipes are used for inlet and outlet water connection.

DC Choke

The iron core DC choke reduces rate of rise of current upto dangerous level and allows front-end thyristorised converter stop current flow within 6 - 8 milliseconds. This protection is faster than any other circuit breaking device with minimum risk of fuse blowing and thyristor failures.

DM Water Circulation

Components of solid state power supply unit, medium frequency capacitors and interconnecting bus bars are cooled by water. De-ionized water is used for cooling various components in a closed loop. The de-ionized water circulation system consists of water storage tank, non-ferrous pump, plate type heat-exchanger, a mixed bed resin cartridge and inter-connecting pipelines. The conductivity of de-ionized water is continuously monitored and stops the Power Supply Unit in case exceed the pre-set level. Occasional make-up of this de-

ionized water is required. A plate type heat exchanger which is much easier to maintain is used to cool de-ionized water. The plates of this heat exchanger are made out of stainless steel grade 316 for better corrosion resistance.

Hydraulic System

This system consists of Hydraulic power pack, hydraulic cylinders, interconnecting pipelines and direction control valves. Hydraulic cylinders are used for tilting the furnace. Required pressure and flow for tilting the furnace is generated by this hydraulic power pack which consists of motor, pump, pressure relief valves, filters and adequate capacity oil tank. Hydraulic power pack is connected to the cylinders by seamless hydraulic pipes through a direction control valve. Furnace tilting is controlled by operator using direction control valve.

Melting Furnace

Aluminum Frame Furnaces are manufactured with energy efficient coil to perform under typical harsh melt shop environment. The coil is made out of rectangular cross section electrolytic grade copper. The gap between two turns of the coil is maintained using spacers. The coils are electrically insulated by a special resin based coating. The coil is firmly secured to insulating bars equally spaced around the coil periphery. These bars provide mechanical strength against deformation during maintenance and normal operation.

Inter Connecting Bus Bars & Flexible Water Cooled Cables

Inter connecting bus bars between capacitors and coil carry large reactive currents. Adequately rated EC copper bus bars with tinning at the contact points are used to keep the losses minimum. Flexible cables are used to feed power to the furnace coil. The cables carry the same current as that of the bus bars and are also water cooled. Rubber hoses of the flexible cables are carbon free and are provided with braiding for preventing puncture due to accidental metal splashes.

2.1.2 Technology /Equipment specifications

Sr. No.	Description	Rating
1.	MF Output Power- Rated (KW)	250
2.	At Input KVA	289
3.	Line PF at full load	0.94
4. *	Power Supply Unit Input Voltage (Nominal) (Volts)	415
5.	Frequency (Hz)	500
6.	MF Output Voltage (Volts)	850
7.	Power Supply Unit Efficiency (%)	94
8.	Nominal Capacity of furnace in Kg for Copper/Brass	750
9.	Melting Rate of Copper/Brass (•)	Copper at 1200^0 C - 720 Kg/Hr Brass at 950^0 C - 810 Kg/Hr
10. **	Water Storage capacity of emergency overhead tank in liters	2500

Details of technical specification are also shown in Annexure 8.

2.1.3 Justification & Suitability of the technology selected

Brass melting in the present conventional pit furnaces is costly due to low efficiency, high coke cost and more manpower requirement. The melting in induction furnaces is low comparatively with pit furnaces due to more efficiency of induction heating, less manpower cost, more yields of brass and low energy cost. Further, the parameters can be critically controlled in the induction furnaces. Overall, the energy cost per tonne of brass melting is low than the pit furnaces. The following are the reasons for selection of this technology:

- The melting furnace gives higher yield.
- It starts up instantaneously thereby reducing the time to reach working temperature.
- It is highly flexible no molten metal is necessary to start medium frequency coreless induction melting equipment.
- The natural stirring helps in the uniform melting.
- Melting is cleaner.
- They can be installed even in the small place. Small furnace can provide high melting rate.
- The small size with respect to melting rate results in the requirement of much less refractory than fuel-fired units.
- It is energy efficient.

2.1.4 Superiority over existing technology/equipment

The following are the benefits of the induction furnace:

- Reduces energy cost per tonne of brass melting
- Low batch time and hence more production for the same period
- Reduces dependency on the manpower
- Lower payback periods

2.1.5 Availability of the proposed technology/equipment

The induction furnace suppliers are available in Delhi, which is 250 kms from Jagadhri. Details of the local service provider are furnished in Annexure 7.

2.1.6 Source of technology/equipment

The technology is indigenous and is locally available

2.1.7 Service/technology providers

The service providers are available in Delhi.

2.1.8 Terms of sales

- 40% advance by DD payable at Ahmedabad
- Balance payment together with taxes and duties and other expenses by DD payable at Ahmedabad before Despatch

Performance Guarantee

The warranty is for 12 months from the date of commissioning or 15 months from the date of dispatch, whichever is earlier. It should be clearly understood that this warranty is against any manufacturing defects, if any. The warranty does not extend to components like fuses, thyristors, capacitors, etc. and consumables such as refractories and rubber parts. Our liability is only limited to repairing the equipment or replacing free of cost any defective part / equipment but does not extend to any incidental or consequential damages. Any damage during transit or caused by accident shall also not be covered under this warranty. This warranty is valid only if (i) the equipment is commissioned and serviced by our engineer, (ii) the equipment is used as per our guidelines and (iii) genuine spare parts supplied by us are used by you. The warranty may elapse if the customer is found to be using components from any other sources or manufactured by himself without Electrotherm (India) Ltd's express written permission or has tampered any of the settings of the system.

After Sales Service

During the warranty period as said above, the seller shall depute their Service Engineer(s) free of cost to the works of the buyer, as and when necessary. However, the buyer shall bear the expenses on boarding and lodging of the Service Engineer(s) during stay at buyer's place, the local conveyance and to and fro travel expenses. Thereafter, our regular service charge will be charged besides to and fro air/rail fare boarding and lodging, conveyance and any other incidental expenses.

2.1.9 Process down time during implementation

The process down time is considered for installation of induction furnace is two weeks. A detail of process break down is given in the Annexure 6.

2.2 Life cycle assessment and risks analysis

The life of the Induction Furnace is considered at 15 years.

2.3 Suitable unit in terms of capacity

The capacity of proposed induction furnace is 750 kg per batch and can be installed in all the brass melting units of having pit furnaces of 600 kg capacity and above also average brass melting of 2500 kg per day.

3. ECONOMIC BENEFITS OF NEW ENERGY EFFICIENT TECHNOLOGY

3.1 Technical benefits

3.1.1 Fuel savings per year

Installation of new energy efficient Induction furnace will replace coke consumption in base case scenario. Proposed system will replace total 150 tone of coke consumption in base case scenario by total 375000 kWh of electricity per year.

3.1.2 Electricity savings per year

As it well known that Induction furnace consumes electricity hence, total electricity consumption would be 375000 kWh per year.

3.1.3 Improvement in product quality

Due to better control of the melting or thermal parameters in Induction Furnace, the product quality may improve to certain extent.

3.1.4 Increase in production

The melting of brass in induction furnaces is faster than melting in pit furnaces and hence, more production will achieve for the same time period.

3.1.5 Reduction in raw material consumption

The main raw material for brass manufacturing is brass scrap, copper and Zinc. The melting of scrap in induction furnaces results in more yield than pit furnaces, hence, the raw material consumption will reduce.

3.1.6 Reduction in other losses

There is no significant reduction in other losses.

3.2 Monetary benefits

The installation of new induction furnace will reduce production cost in Brass melting and hence, totals monetary savings ` 16.12 lakh per annum. A detail of monetary benefit calculation is given in Annexure 3.

3.3 Social benefits

3.3.1 Improvement in working environment in the plant

The project activity is induction furnace and the process of melting is closed and no heat is dissipated outside and hence the working environment will improve considerably.

3.3.2 Improvement in skill set of workers

The technology selected for the implementation is new. The technology implemented will create awareness and operation & maintenance of the new technology and hence improves skills of the workers.

3.4 Environmental benefits

3.4.1 Reduction in effluent generation

There is no significant impact in effluent generation due to implementation of the project activity.

3.4.2 Reduction in GHG emission such as CO_2, NOx, etc

The major GHG emission reduction source is CO_2. The proposed technology will completely replace the coke consumption which is about 150 tonne per year while at same time about 375 MWh electricity will consume by the Induction furnace hence, total emission reductions are estimated at 104 tonne of CO_2 per annum or 104 CER due to implementation of the project activity.

3.4.3 Reduction in other emissions like SOx

As the project activity reduces coke consumption, the SOx emissions also reduces to some extent.

4. IMPLEMENTATION OF PROPOSED EQUIPMENT

4.1 Cost of technology/equipment implementation

4.1.1 Cost of technology/equipments

The total cost for installation of induction furnace for brass melting for a 750 kg per batch capacity is estimated at ` 18.60 lakh, which includes the cost of Induction furnace, DM water plant, Electrical panels and Controls, cables and connections and supply of equipment etc.

4.1.2 Other costs

The erection and commissioning charges for the Induction furnace is estimated at ` 1.25 lakh. The details of the item wise cost are furnished in Table 4.1 below:

Table 4.1 Total Project cost

S.No	Particular	Unit	Value
1	Cost of induction furnace and allied equipments Furnace	` in lakh	18.60
2	Erection and Commissioning	` in lakh	1.25
3	Investment without IDC	` in lakh	19.85
4	Interest During Implementation	` in lakh	0.00
5	Total Investment	` in lakh	19.85

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 ` 4.96 lakh.

4.2.2 Loan amount

The term loan is 75% of the total project, which works out at ` 14.89 lakh.

4.2.3 Terms & conditions of loan

The interest rate is considered at 10.00% which is prevailing interest rate of SIDBI for energy efficiency 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 ` 12.41 lakh in the first year operation and increases to ` 67.52 lakh at the end of eighth year.

4.3.2 Simple payback period

The total project cost of the proposed technology is ` 19.85 lakh and monetary savings due to reduction in energy/production cost is ` 16.12 lakh and payback period works out to be 1.23 years.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10.0% interest rate works out to be ` 40.17 lakh.

4.3.4 Internal rate of return (IRR)

The after tax Internal Rate of Return of the project works out to be 61.93%. Thus the project is financially viable. The average DSCR works out at 3.37.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 27.94%.

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 monetary savings and decrease. For the purpose of sensitive analysis, two scenarios are considered are.

- Increase in monetary savings by 5%
- Decrease in monetary 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 at different scenario

Particulars	IRR %	NPV ` in lakh	ROI %	DSCR
Normal	61.93	40.17	27.64	3.37
5% increase in monetary savings	65.68	43.26	28.06	3.55
5% decrease in monetary savings	58.18	37.09	27.80	3.20

As can be seen from above, the project is highly sensitive to fuel savings, the debt service coverage ratio works out to be 3.20 times in worst scenario, which indicates the strength of the project.

4.5 Procurement and implementation schedule

The project is expected to be completed in 12 weeks from the date of financial closure and release of work order to the supplier. The detailed schedule of project implementation is furnished in Annexure 6.

ANNEXURES

Annexure 1: Evaluation of furnace efficiency

1) Ahuja Metal Industries

S.No	Parameter	Units	Details
1	Fuel used	---	Coke
2	Quantity of brass melted in the pit furnace in the crucible	kg/day	2400
3	Specific heat of brass	kCal/kg ^{o}C	0.092
4	Initial temperature of brass	^{o}C	30
5	Final temperature of brass (molten metal)	^{o}C	1021
6	Heat output	kCal/day	2,18,812
7	Quantity of coke consumption	kg/day	320
8	Calorific value of coke	kCal/kg	6000
9	Heat input	kCal/day	19,20,000
10	Efficiency	% age	11.4

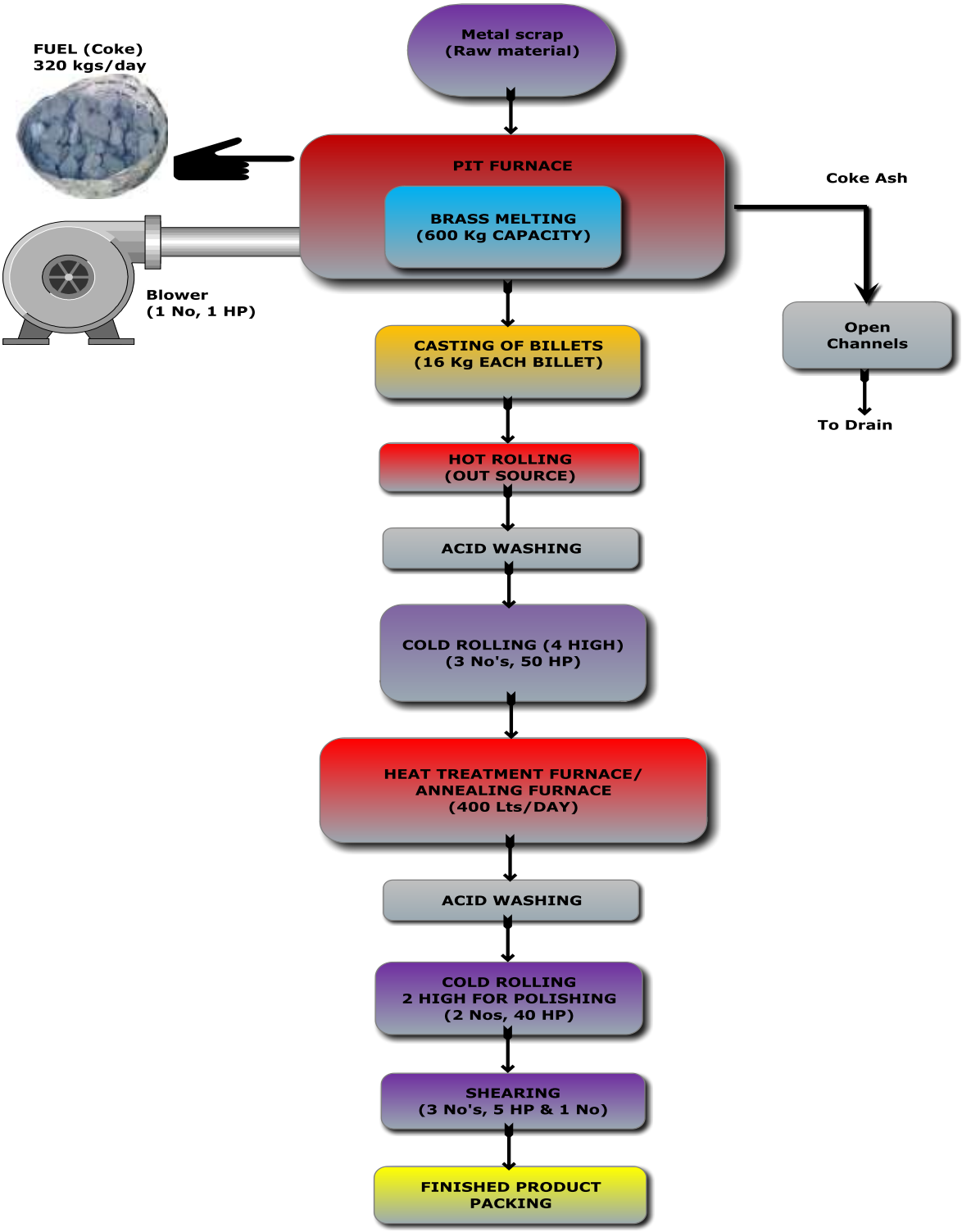
2) Usha Enterprises

S.No	Parameter	Units	Details
1	Fuel used	---	Coke
2	Quantity of brass melted in the pit furnace in the crucible	kg/day	2400
3	Specific heat of brass	kCal/kg ^{o}C	0.092
4	Initial temperature of brass	^{o}C	30
5	Final temperature of brass (molten metal)	^{o}C	1017
6	Heat output	kCal/day	2,17,929
7	Quantity of coke consumption	kg/day	320
8	Calorific value of coke	kCal/kg	6000
9	Heat input	kCal/day	19,20,000
10	Efficiency	% age	11.35

3) Arun metals

S.No	Parameter	Units	Details
1	Fuel used	---	Coke
2	Quantity of brass melted in the pit furnace in the crucible	kg/day	3000
3	specific heat of brass	kCal/kg ^{o}C	0.092
4	Initial temperature of brass	^{o}C	30
5	Final temperature of brass (molten metal)	^{o}C	970
6	Heat output	kCal/day	2,59,440
7	Quantity of coke consumption	kg/day	400
8	Calorific value of coke	kCal/kg	6000
9	Heat input	kCal/day	24,40,000
10	Efficiency	% age	10.81

Annexure 2: Process flow diagram

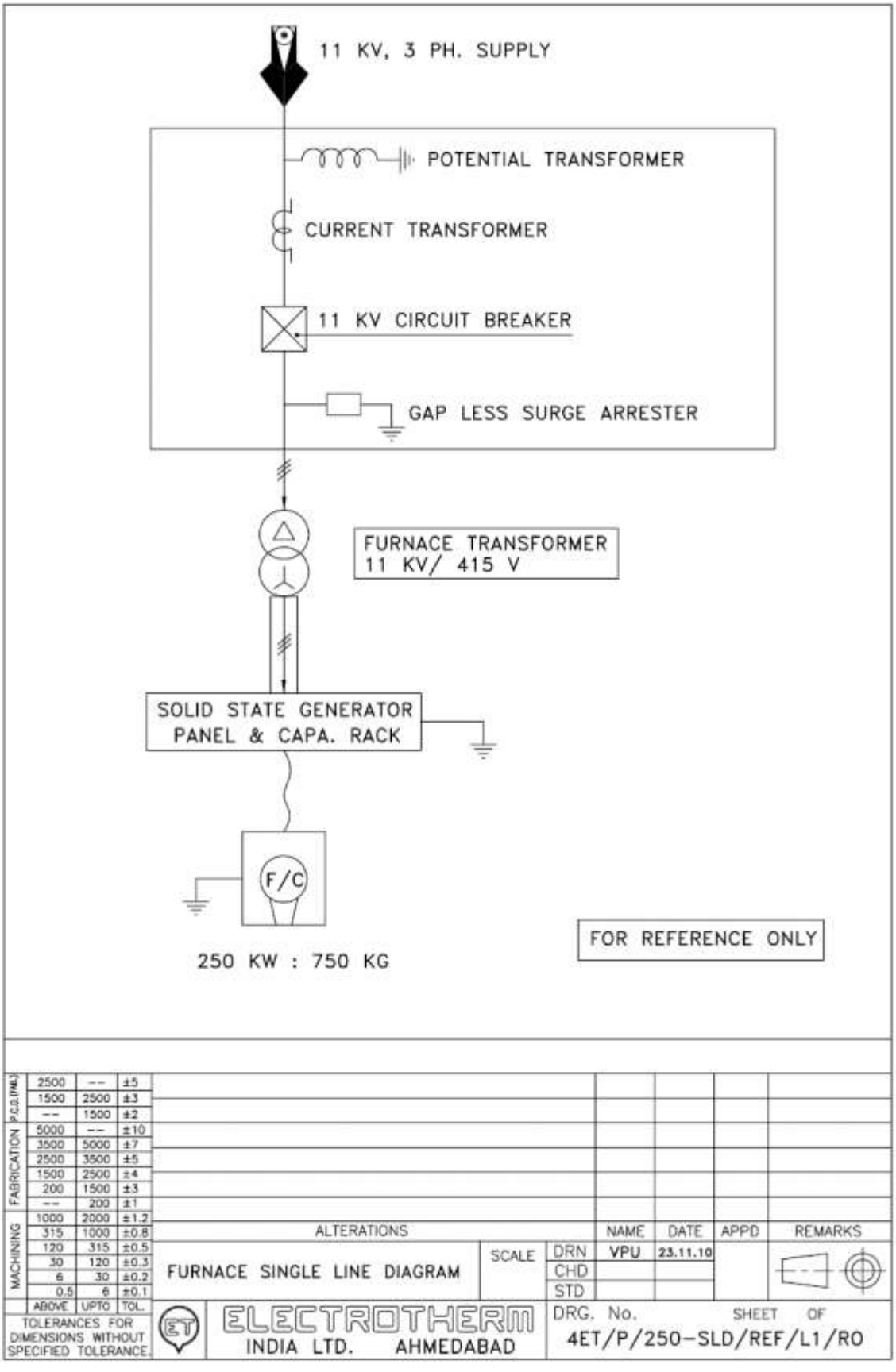


Annexure 3: Detailed technology assessment report- wood gasifier

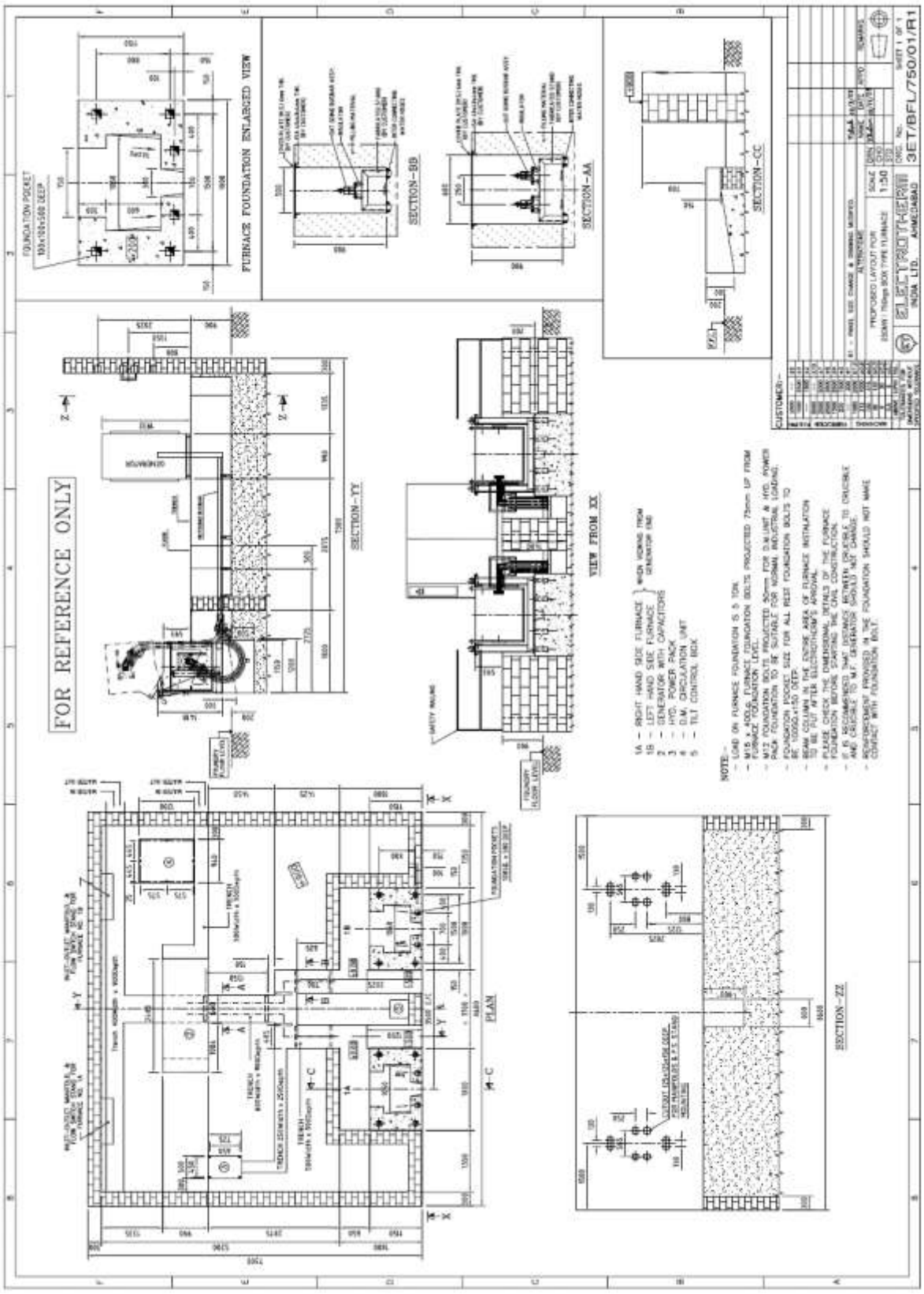
The cost benefit analysis of Induction furnace for brass melting is furnished below:

S.No	Parameter	Unit	Value
1	Present quantity of Brass melting per batch in pit furnaces	kg/batch	600
2	Average coke consumption per batch	kg/batch	80
3	Cost of coke	`/kg	22
4	Coke cost per batch	`/batch	1760
5	Coke cost for melting 750 kg brass	`	2200
Induction Furnace			
1	Quantity of brass melting per batch	kg/batch	750
2	Electricity consumption for induction furnace	kWh/batch	250
3	Cost of electricity	`/kWh	4.5
4	Electricity cost per batch	`/batch	1125
Cost Benefit analysis			
1	Monetary savings due to Induction Furnace	`/batch	1075
2	Monetary savings due to Induction Furnace	`/tonne	1433
3	No. of batches per day	batch/day	5
4	No. of days of operation per annum	days/annum	300
5	Monetary savings per annum	` in lakh	16.12
6	Investment required	` in lakh	19.85
7	Payback period	years	1.23

Annexure 4: Technical/Civil drawings of the Induction furnace recovery system



CONSERVE IT


FOR REFERENCE ONLY
FURNACE FOUNDATION ENLARGED VIEW
SECTION-BB
SECTION-AA
SECTION-CC
SECTION-YY
VIEW FROM XX
PLAN
SECTION-ZZ
3ET/BFL/750/01/R1

Annexure 5: Detailed financial calculations & analysis

Assumptions

Name of the Technology	**Energy Efficient Pit Furnace - Brass Melting**		
Rated Capacity	**750 kg**		
Details	***Unit***	***Value***	***Basis***
Installed Capacity	Kg	750	
No of working days	Days	300	
No of operating hours	Hrs	12	
Proposed Investment			
Induction Furnace - Brass Melting	` (in lakh)	18.60	
Service Charge Towards design and engineering for Electromechanical works and Cabling & Switches	` (in lakh)	1.25	
Investment without IDC	` (in lakh)	19.85	
Interest During Implementation	` (in lakh)	0.00	
Total Investment	` (in lakh)	19.85	
Financing pattern			
Own Funds (Equity)	` (in lakh)	4.96	Feasibility Study
Loan Funds (Term Loan)	`. (in lakh)	14.89	Feasibility Study
Loan Tenure	years	5	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	66	Assumed
Interest Rate	%age	10.00%	SIDBI Lending rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	4.00	Feasibility Study
Annual Escalation	%age	5.00	Feasibility Study
Estimation of Revenue			
Monetary savings per ton of brass melting	`/ tons	1433	
Annual production	tons	1125	
St. line Depn.	%age	5.28	Indian Companies Act
IT Depreciation	%age	80.00	Income Tax Rules
Income Tax	%age	33.99	Income Tax

Estimation of Interest On Term Loan **(` in lakhs)**

Years	*Opening Balance*	*Repayment*	*Closing Balance*	*Interest*
1	14.89	1.20	13.69	1.72
2	13.69	2.40	11.29	1.26
3	11.29	2.75	8.54	1.01
4	8.54	3.00	5.54	0.72
5	5.54	3.20	2.34	0.42
6	2.34	2.34	0.00	0.07
		14.89		

WDV Depreciation **(` in lakhs)**

Particulars / years	*1*	*2*
Plant and Machinery		
Cost	19.85	3.97
Depreciation	15.88	3.18
WDV	3.97	0.79

Projected Profitability (` in lakhs)

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Revenue through Savings								
Fuel savings	16.12	16.12	16.12	16.12	16.12	16.12	16.12	16.12
Total Revenue (A)	16.12	16.12	16.12	16.12	16.12	16.12	16.12	16.12
Expenses								
O & M Expenses	0.79	0.83	0.88	0.92	0.97	1.01	1.06	1.12
Total Expenses (B)	0.79	0.83	0.88	0.92	0.97	1.01	1.06	1.12
PBDIT (A)-(B)	15.33	15.29	15.25	15.20	15.16	15.11	15.06	15.00
Interest	1.72	1.26	1.01	0.72	0.42	0.07	-	-
PBDT	13.61	14.03	14.24	14.48	14.74	15.04	15.06	15.00
Depreciation	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
PBT	12.56	12.98	13.19	13.44	13.69	13.99	14.01	13.96
Income tax	-	3.69	4.84	4.92	5.01	5.11	5.12	5.10
Profit after tax (PAT)	12.56	9.29	8.35	8.51	8.68	8.88	8.89	8.86

Computation of Tax (` in lakhs)

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Profit before tax	12.56	12.98	13.19	13.44	13.69	13.99	14.01	13.96
Add: Book depreciation	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
Less: WDV depreciation	15.88	3.18	-	-	-	-	-	-
Taxable profit	(2.27)	10.85	14.24	14.48	14.74	15.04	15.06	15.00
Income Tax	-	3.69	4.84	4.92	5.01	5.11	5.12	5.10

Projected Balance Sheet

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Liabilities								
Share Capital (D)	4.96	4.96	4.96	4.96	4.96	4.96	4.96	4.96
Reserves & Surplus (E)	12.56	21.85	30.20	38.72	47.40	56.27	65.17	74.02
Term Loans (F)	13.69	11.29	8.54	5.54	2.34	0.00	0.00	0.00
Total Liabilities D)+(E)+(F)	31.21	38.10	43.70	49.22	54.70	61.23	70.13	78.98
Assets	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Gross Fixed Assets	19.85	19.85	19.85	19.85	19.85	19.85	19.85	19.85
Less: Accm. Depreciation	1.05	2.10	3.14	4.19	5.24	6.29	7.34	8.38
Net Fixed Assets	18.80	17.75	16.71	15.66	14.61	13.56	12.51	11.47
Cash & Bank Balance	12.41	20.35	27.00	33.56	40.09	47.67	57.61	67.52
TOTAL ASSETS	31.21	38.10	43.70	49.22	54.70	61.23	70.13	78.98
Net Worth	17.52	26.82	35.16	43.68	52.36	61.24	70.13	78.98
Dept equity ratio	2.76	2.27	1.72	1.12	0.47	0.00	0.00	0.00

Projected Cash Flow:

Particulars / Years	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Sources									
Share Capital	4.96	-	-	-	-	-	-	-	-
Term Loan	14.89								
Profit After tax		12.56	9.29	8.35	8.51	8.68	8.88	8.89	8.86
Depreciation		1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
Total Sources	19.85	13.61	10.34	9.40	9.56	9.73	9.93	9.94	9.90
Application									
Capital Expenditure	19.85								
Repayment of Loan	-	1.20	2.40	2.75	3.00	3.20	2.34	-	-
Total Application	19.85	1.20	2.40	2.75	3.00	3.20	2.34	-	-
Net Surplus	-	12.41	7.94	6.65	6.56	6.53	7.59	9.94	9.90
Add: Opening Balance	-	-	12.41	20.35	27.00	33.56	40.09	47.67	57.61
Closing Balance	-	12.41	20.35	27.00	33.56	40.09	47.67	57.61	67.52

Calculation of Internal Rate of Return **(` in lakhs)**

Particulars / year	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Profit after Tax		12.56	9.29	8.35	8.51	8.68	8.88	8.89	8.86
Depreciation		1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
Interest on Term Loan		1.72	1.26	1.01	0.72	0.42	0.07	-	-
Cash outflow	(19.85)	-	-	-	-	-	-	-	-
Net Cash flow	(19.85)	15.33	11.60	10.41	10.28	10.15	10.00	9.94	9.90
IRR	61.93%								
NPV	40.17								

Break Even Point

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Variable Expenses								
Oper. & Maintenance Exp (75%)	0.60	0.63	0.66	0.69	0.72	0.76	0.80	0.84
Sub Total (G)	0.60	0.63	0.66	0.69	0.72	0.76	0.80	0.84
Fixed Expenses								
Oper. & Maintenance Exp (25%)	0.20	0.21	0.22	0.23	0.24	0.25	0.27	0.28
Interest on Term Loan	1.72	1.26	1.01	0.72	0.42	0.07	0.00	0.00
Depreciation *(H)*	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05
Sub Total (I)	2.96	2.52	2.28	1.99	1.71	1.37	1.31	1.33
Sales (J)	16.12	16.12	16.12	16.12	16.12	16.12	16.12	16.12
Contribution (K)	15.53	15.50	15.46	15.43	15.40	15.36	15.32	15.28
Break Even Point (L= G/I)	19.09%	16.24%	14.73%	12.93%	11.08%	8.93%	8.58%	8.69%
Cash Break Even {(I)-(H)}	12.34%	9.47%	7.95%	6.14%	4.28%	2.11%	1.74%	1.83%
Break Even Sales (J)*(L)	3.08	2.62	2.37	2.08	1.79	1.44	1.38	1.40

Return on Investment

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Total*
Net Profit Before Taxes	12.56	12.98	13.19	13.44	13.69	13.99	14.01	13.96	107.81
Net Worth	17.52	26.82	35.16	43.68	52.36	61.24	70.13	78.98	385.89
									27.94%

Debt Service Coverage Ratio

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Total*
Cash Inflow									
Profit after Tax	12.56	9.29	8.35	8.51	8.68	8.88	8.89	8.86	56.27
Depreciation	1.05	1.05	1.05	1.05	1.05	1.05	1.05	1.05	6.29
Interest on Term Loan	1.72	1.26	1.01	0.72	0.42	0.07	0.00	0.00	5.19
TOTAL (M)	15.33	11.60	10.41	10.28	10.15	10.00	9.94	9.90	67.76

DEBT

Interest on Term Loan	1.72	1.26	1.01	0.72	0.42	0.07	0.00	0.00	5.19
Repayment of Term Loan	1.20	2.40	2.75	3.00	3.20	2.34	0.00	0.00	14.89
Total (N)	2.92	3.66	3.76	3.72	3.62	2.41	0.00	0.00	20.08
	5.25	3.17	2.77	2.77	2.81	4.15	0.00	0.00	3.37
Average DSCR (M/N)	3.37								

Annexure 6: Details of procurement and implementation plan with schedule/timelines

Project Implementation Schedule – Induction furnace

S. No.	Activities	Weeks							
		1	2	3	4	5/6	7/8	9/10	11/12
1	Release of work orders								
2	Fabrication work								
3	Panels, cabling and DM plant								
4	Commissioning and Trial Runs								

Process Breakdown

S. No.	Activities	Weeks							
		1	2	3	4	5/6	7/8	9/10	11/12
1	Civil works								
2	Panels fabrication								
3	Electrical cabling								
4	Commissioning and Trial Runs								

Annexure 7: Details of technology/equipment and service providers with contact nos.

Equipment details	Source of technology	Service/technology providers
Induction Furnace	India	ELECTROTHERM (INDIA) LTD. 72, Palodia, (Via Thaltej), Ahmedabad-382115, Gujarat (India), Ph : +91-2717-234554, 660550 E mail: mkt@electrotherm.com Website: www.eletrotherm.com Contact person: Mr. Anurag Gupta Contact num: 09811956239 Email: eidel@electrotherm.com

Annexure 8: Quotations or techno-commercial bids for new technology/equipment

Zenith Energy Services Pvt. Ltd., Haryana

Dear Sir,

Thank you very much for your E-mail enquiry, regarding your requirement of Medium Frequency Induction Melting Furnace for your proposed Foundry.

We take this opportunity to introduce ourselves as the leading manufacturers of Medium Frequency Induction Furnaces for steel ingots and billets, Induction Heating and Hardening equipments, Ladle Refining Furnaces and Metal Refining Konverter. Electrotherm (India) Ltd., started its manufacturing in 1983. Within a span of 26 years, we have supplied more than 3000 Medium Frequency Induction Melting Furnaces in India as well as abroad.

Electrotherm (Engineering and Project division) caters to ferrous and non-ferrous foundries as well as to all segments of the steel industry. It has state of the art manufacturing plant with modern office complex and Research & Development Centre at Ahmedabad, India. We have designed, developed, manufactured and commissioned integrated Stainless Steel lines with Medium Frequency Induction furnace, Ladle Refining Furnace and Metal Refining Konverter. We have already supplied 10 kW / 1 Kg to 14000 kW / 40 MT Medium Frequency Induction Furnaces. Our contribution to metal melting industry in terms of MW rating comes to more than 2,500 as on date.

Considering your requirement, we are sending our offer no. **ET/I/DEL/SQ/10206/R1/10-11 for one number 175 kW / 500 Hz Quick-Melt-P Solid State Power Supply Unit with one number of 500 Kg Aluminum Frame Furnace.** The offer consists of quotations, technical specifications, scope of supply and terms and conditions.

With a copy of this offer we are instructing our regional office to get in touch with you for techno-commercial discussion.

We are sure that you will find the above offer in line with your requirement. If you need any further information/details, please feel free to contact us.

Thanking you,

Yours faithfully,
for ELECTROTHERM (INDIA) LIMITED

SHAILESH BHANDARI
MANAGING DIRECTOR

Copy to:

Mr. Sharat Chojar (M) 98104 22911 / Mr. Anurag Gupta (M) 98119 56239
Delhi Branch Ph: 011 2592 0224 E-mail: eildel@electrotherm.com

Page: 2 **Proposal No: ET/I/DEL/SQ/10206/R1/10-11** **Date: 12-Oct-2010**

Zenith Energy Services Pvt. Ltd., Haryana

Doc No. 031E005 Rev. 01

OFFER FOR 250 KW / 750 KG MEDIUM FREQUENCY INDUCTION FURNACE

Sr. No.	Description	Qty.	Price (Rs. in Lacs)
1	250 kW Solid State Power Supply Unit with DM Water Circulating Unit.	1 No.	10.80
2	750 Kg Aluminum Frame Melting Furnace with Hydraulic Tilting Arrangement, Bus bar, Water Cooled Cables, etc	1 No.	7.80
3	Hydraulic Power Pack	1 No.	
	Total Price for above: Rs.18.60 Lacs (RUPEES EIGHTEEN LACS SIXTY THOUSAND ONLY)		

Please refer to our standard terms and conditions attached with this offer for price basis and commercial terms.

for ELECTROTHERM (INDIA) LIMITED

SHAILESH BHANDARI
MANAGING DIRECTOR

Encl: 1. Scope of Supply, Doc No 031D006 Rev 01
2. Technical Specification, Doc No. 031D005 Rev. 02
3. Terms & Conditions, Doc No 031D007 Rev. 05

Zenith Energy Services Pvt. Ltd., Haryana

Doc No. 031 D005 Rev. 02

TECHNICAL SPECIFICATION

MEDIUM FREQUENCY INDUCTION MELTING FURNACE

Sr. No.	Description	Rating
1.	MF Output Power- Rated (KW)	250
2.	At Input KVA	289
3.	Line PF at full load	0.94
4. *	Power Supply Unit Input Voltage (Nominal) (Volts)	415
5.	Frequency (Hz)	500
6.	MF Output Voltage (Volts)	850
7.	Power Supply Unit Efficiency (%)	94
8.	Nominal Capacity of furnace in Kg for Copper/Brass	750
9.	Melting Rate of Copper/Brass (•)	Copper at 1200^0 C - 720 Kg/Hr Brass at 950^0 C - 810 Kg/Hr
10. **	Water Storage capacity of emergency overhead tank in liters	2500

** Emergency tank capacity has been calculated on the basis of 40% flow rate for 1 hour. It is presumed that emergency power is available to refill the overhead tank in case of power failure.

- Melt rate specified is on charge weight with best charging practices and best melting operations, excluding all non productive time (when furnace is not doing any melting operation viz. initial charging, de-slagging, holding for chemical analysis, superheating and pouring)
- The scrap should be clean, sized and dense, yield should be better than 98%. Slag consumes nearly double the power than that consumed by scrap.
- Furnace lining should be in hot condition after second heat of lining with recommended lining thickness. Water temperature of coil should be as specified.
- Input Power to the melting system should be at rated voltage. Power drops if the input supply drops below 98.5%.
- There should not be any stoppages during heat while trial run.
- The charging and slag removal should be uniform and without any noticeable delay.

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

Zenith Energy Services Pvt. Ltd
10-5-6/B, My Home Plaza, Masab
Tank HYDERABAD, AP 500 028
Phone: 040 23376630, 31,
Fax No.040 23322517
Website: www.zenithenergy.com

India SME Technology Services Ltd
DFC Building, Plot No.37-38,
D-Block, Pankha Road,
Institutional Area, Janakpuri, New Delhi-110058
Tel: +91-11-28525534, Fax: +91-11-28525535
Website: www.techsmall.com