National Program

on

Promoting Energy Efficiency and Renewable Energy in MSME Clusters in India

Jamnagar Brass Cluster

Detailed Energy Audit Report
Atlas Metal Industries

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Abbreviations

APFC	Automatic Power Factor Controller
BEE	Bureau of Energy Efficiency
CNC	Computer Numerical Control
CT	Cooling Tower
FRPB	Fiber Reinforced Plastic Blades
GEF	Global Environment Facility
HP	Horse Power
kcal	Kilo Calories
kg	Kilogram
kVA	Kilo Volt Ampere
kW	Kilo Watts
kWh	Kilo Watt Hour
MDC	Maximum Demand Controller
MSME	Ministry of Micro Small and Medium Enterprises
PF	Power Factor
SEB	State Electricity Board
SEC	Specific Energy Consumption
SME	Small and Medium Enterprise
UNIDO	United Nation's Industrial Development Organization
VFD	Variable Frequency Drive

About the Project

The project titled "Promoting Energy Efficiency and Renewable Energy in selected MSME clusters in India" supported by Global Environment Facility (GEF), United Nations Industrial Development Organization (UNIDO), and Bureau of Energy Efficiency (BEE) aims to bring down the energy consumption in Jamnagar Brass cluster located in Jamnagar (Gujarat) by supporting them to adopt Energy Efficient and Renewable Energy practices. There are more than 4,000 Small and Medium Enterprise (SME) brass units operating in the various industrial pockets of the district. InsPIRE Network for Environment, New Delhi has been appointed as the executing agency to carry out the activities in the cluster.

The activities to be conducted under the proposed energy efficiency study in Jamnagar Brass Cluster include following:

- Conducting Pre-activity Workshop
- Comprehensive energy audit in 6 Brass units
- Discussion with 3 cluster experts and 2 equipment suppliers to develop best operation practice document for 5 key technologies
- Enumeration of common regularly monitorable parameter at the process level which have impact on energy performance, and listing of appropriate instrumentation for the same
- Identification of set of energy auditing instruments that should be used for carrying out periodic energy audits in the units
- Conducting 3 post energy audit technical workshops for knowledge dissemination

As part of the activities conducted under the energy efficiency study in Jamnagar Brass cluster, detailed energy audits in 6 Brass units in Jamnagar was conducted in the month of July'2015.

Executive Summary

Name of SME unit : M/s Atlas Metal Industries

Location of the SME unit : Plot No. 3686/87, GIDC Phase-III, Dared, Jamnagar, Gujarat

Based on the measurements carried out and data collected during field visit in the month of July'2015 and analysis of the data, process wise scope for energy efficiency improvement are identified and relevant recommendations are made. The proposed energy saving measures along with the annual savings, investment required and the simple payback period is given in the table 1 below:

Table 1: *Cost Economic Analysis*

SN	Energy Efficient Measures	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback Period (Years / months)
1	Avoiding overfilling of metals in the Induction Furnace	72,390	Nil	Immediate
2	Avoiding super heating of metals in the Induction Furnace	38,100	Nil	Immediate
3	Ladle Preheating	38,100	Nil	Immediate
4	Installation of timers in Cooling Tower (CT) fan system	9,131	17,000	1 year 9 months
5	Replacing conventional blades of cooling tower fans with Energy Efficient Fiber Reinforced Plastic Blades (FRPB)	13,697	20,000	1 year 6 months
6	Installation of Variable Frequency Drive (VFD) across Compressor	67,610	150,000	1 year 3 months
7	Arresting Compressor Leakages	110,245	Nil	Immediate
8	Replace conventional ceiling fan with Energy Efficient (BLDC) Ceiling fan	110,707	348,000	3 Years
9	Replace 55W florescent tube light with T-8 (20W) LED light	49,996	46,800	11 months
10	Replace 35W CFL with 18 W rocket LED lamp	333,90	63,294	1 Year 11 months
11	Replace 150W halogen street light with 60W LED street light	39,715	32,880	10 month
	Total	**549,691**	**677,974**	

- **Electrical Panels:**

The unit has grid connected load of 326 kVA. Electricity supply is taken from State Electricity Board (SEB) using separate meter connections {Meter 1 (95 kVA for Manufacturing), Meter 2 (27 kVA for Office and Building Lighting), Meter 3 (100 kVA for Manufacturing), Meter 4 (104 kVA for Induction Furnace)}. There is no step down distribution transformer installed by the unit. The unit has installed Automatic Power Factor Controller (APFC) to maintain power factor close to unity and also installed Maximum Demand Controller (MDC).

Induction Furnace:

Induction furnace is the most energy intensive equipment being used in the unit. The unit has installed induction furnace of 90 kW. During field visit it was observed that the induction furnace was placed on hold during pouring and metal composition of sample measurements, the furnace on hold consuming power to keep the molten metal at the required temperature. Further, there were many deficiencies observed in the current operation practice including no data logging, scrap loading above coil level etc. To improve the energy performance, it is suggested to maintain log records of type and quantity of scrap material being used and electricity consumed for every charge. Further specific format for following the best practices is also developed to be utilized as the guiding document and is at ***Annexure 3***. It is suggested that the overfilling above the furnace coil height should be avoided to save energy and time to melt, whereas, over metal heating should be avoided and ladle preheating should be practiced. It is further suggested to use graphite piece to cool down the furnace after shutting down. This way of heat removal from the furnace reduces the duration of cooling water pump operation resulting into significant energy saving. Further to this, in the cooling circuit timers can be added to switch off the cooling water circulating pumps and replacing cooling tower conventional blades with energy efficient Fiber Reinforced Plastic Blades (FRPB).

Compressor:

The unit has installed two air compressors of 6.7 HP and 8.2 HP capacities. The 6.7 HP compressor is normally operated, while newly installed 8.2 HP compressor, is not in operation due to some manufacturing defect. Air compressor is used to supply compressed air for machining section to operate pneumatic machines, moulding section, induction furnace, and painting section. Based on the information provided regarding compressor leakage trail, the leakage percentage of the 6.7 HP compressor was found to be around 11.61% which is higher as for a well maintained system the leakage should be less than 10%. It is strongly recommended to carry out leakage trail fortnightly to assess the leakage level and necessary actions to be taken if any. Variable Frequency Drive (VFD) can be installed in the compressor motor to save on energy.

Installation of energy efficient lightings and ceiling fans:

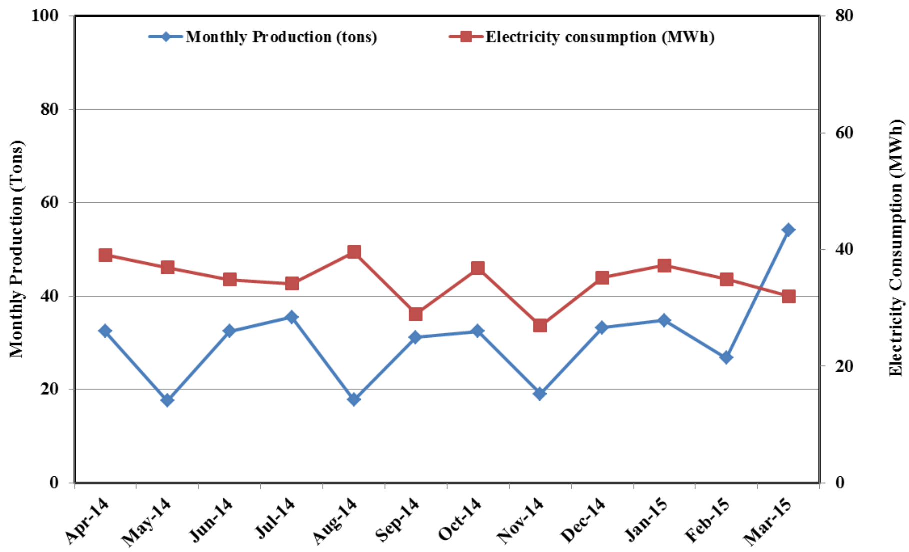
The unit has installed conventional lightings fixtures and ceiling fans in their factory premises which are presently consuming a significant amount of energy. Replacement of these fixtures with energy efficient equivalent will lead to significant savings in terms of energy consumption of the unit.

Introduction

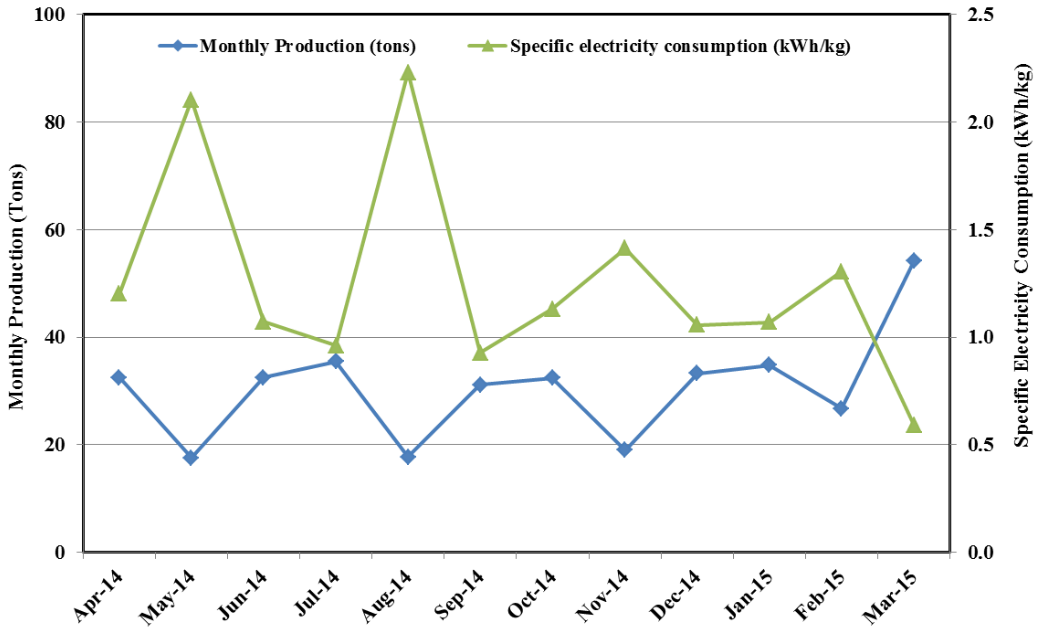
1.1 ABOUT THE UNIT

Atlas Metal Industries is an ISO 9001:2008 certified company established in 1996 and is engaged in leading manufacturing and exporting of electrical wiring and earthing accessories. The products are available in overseas market with ATCAB brand name and in domestic market with "ALITE" brand name.

The plant has annual capacity of 500 MT of which 95% products are exported. The unit uses electricity supply from SEBs for various process and utility applications in premises Figure 1.1 depicts monthly electricity consumption vis-à-vis total monthly production of the unit for last one year.



(a) - Monthly variation of production and electricity consumption



(b) – Monthly variation of production and specific electricity consumption

Figure 1.1: ***Electricity consumption and production details***

Inference: It can be observed from the above figures that the monthly energy consumption is directly proportional to the production for a month. However, specific energy consumption is inversely proportional to the production. Lower the productivity of the plant, higher is the specific electricity consumption. This implies that lower productivity means lower utilization of the equipment thus leading to higher downtime and high specific energy consumption.

However, as observed in Figure a and b above, anomalies in direct relationship between production and electricity consumption can be observed in certain months like August 2014 and September 2014. For the month of August 2014, the unit has a low production and a high energy consumption and reverse in the month of September 2014, wherein the unit has a high production with low energy consumption. These anomalies can be related to reasons such as lower productivity due to low demand, idle running of machines, higher rate of rejections, lower utilization and high peak hour operations.

Major electricity consumption is required by electrical induction furnace for scrap melting operation.

The monthly electricity consumption in the unit is around 34,710 kWh. According to the assessment of the energy consumption data collected, the specific electrical energy consumption is 1.13 kWh per kg of product. The specific energy consumption (in kCal) is 971.8 kCal per kg of product. Details of annual electrical energy consumption and specific energy consumption in M/s Atlas Metal Industries are presented in Table 1.1 below:

Table 1.1: ***Details of M/s Atlas Metal Industries***

SN	Parameter	Value	Unit
1	Name and address of unit	Atlas Metal Industries, Plot No. 3686/87, GIDC Phase-III, Dared, Jamnagar, Gujarat	
2	Contact person	Mr. Rajesh Changani, Contact Number- 02882730944	
3	Manufacturing product	Brass electrical wiring & earthling accessories , Cables lags	
4	Production	500 t/annum	
	Energy utilization		
5	Average monthly electrical energy consumption	34,710	kWh per month
6	Electrical specific energy consumption	1.13	kWh/kg of product
7	Specific energy consumption	971.8	kCal/kg of product
8	Electrical energy cost	8.50	Rs/kg of product
9	Total energy cost	8.50	Rs/kg of product

Note:

Thermal equivalent for one unit of electricity is 860 kCal/kWh.

Cost of Electricity = Rs. 7.5 per unit (average cost calculated from electricity bills)

1.2 ENERGY AUDIT METHODOLOGY

The primary objective of the energy audit was to study prevailing energy consumption pattern and to identify scope for energy efficiency improvement through technical intervention as well as inclusion of best operation practices. Figure 1.2 depicts the flow chart of activities being adopted for detailed energy audit study.

The activities for the current project started with organization of a pre-activity workshop attended by local unit owners, representatives from UNIDO. During the workshop, project objectives along with support required from the units were also discussed. After this workshop, six units for further consideration of energy audit studies were selected by the local association.

After selection of units, preliminary information relating to the energy consumption by the units was collected in a structured questionnaire. The intent of this preliminary data collection was mainly to get preliminary details about the units to make the energy audit process more effective. A copy of the same questionnaire is attached as ***Annexure 1***. Thereafter, field visit to selected industries was carried on a mutually decided dates. During energy audits, detailed data related to specific fuel consumption, various losses, operation practices being followed at the units were measured and collected. Further the gathered data is analyzed to assess prevailing energy consumption of each unit. Further, based on the observation as well as data analysis, recommendations related to energy conservation opportunities are also made. List of measuring instruments used during detailed energy audit are summarized in Table 1.2.

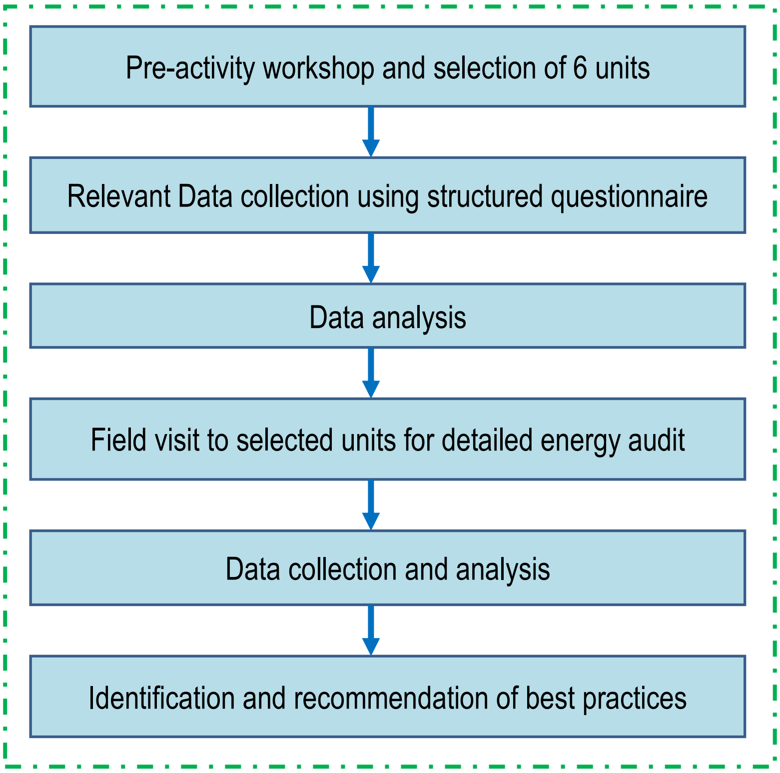


Figure 1.2: ***Flowchart depicting sequence of activities followed for carrying out detailed energy audit***

Table 1.2: ***List of Instruments used during energy audit***

SN	Name of Instrument	Make / Model
1	Three Phase Power Quality Analyzer	Fluke/434/UNI
2	Single Phase Power Quality Analyzer	Fluke/43B
3	Ultra Sonic Water Flow Meter	GE Panametrics/PT878
4	Rotating Vane Anemometer	Prova Ltd., Taiwan/AVM -05
5	Lux Meter	Metravi/1332
6	Portable Non-contact Infrared Thermometer	Raytek, USA/ST 80
7	Flue Gas Analyzer	Kan May, KM 900

Present Process, Observations and Proposed Technology

2.1 PRODUCTION PROCESS OF PLANT

Atlas Metal Industries is involved in the production of finished brass products including different size rods and sections. The process flow chart being followed in the unit is shown in Figure 2.1. The detailed description of each step along with the type of energy input and details related to critical parameters are provided in subsequent paragraphs.

- **Raw Material Sorting and Scrap Pressing:**

The raw material is received after mostly visual inspection. It is then subjected to manual sorting based on their alloy composition. The scrap pressing is carried out only for selected type of raw materials and the pressing machine is operated only when required.

- **Metal Melting:**

The sorted as well as compressed scrap material is melted in the induction furnace. The capacity of the induction furnace is 90 kW with 300 kgs crucible size. Based on the final product requirement, raw material composition in the induction furnace is added. Scrap material is heated to around 1050^{0}C. The process requires electrical energy input for induction furnace as well as for pumps and motors being used in the cooling circuit of induction furnace. The critical parameters to be observed in this process are composition of the molten metal and its temperature.

- **Metal Pouring:**

The molten metal from the induction furnace is poured directly into sand moulds after checking it's temperature visually by its colour dissipated. The molten metal composition is checked by using spectrometer before metal pouring.

- **Fettling and Cleaning:**

The brass castings are taken out by breaking the sand moulds and separating out runners / risers. Visual inspection of the common defects such as shrinkage defects, formation of bubbles, and pouring metal defects (misruns, cold shuts, and inclusions) are checked. The fresh ones are cleaned in next process (fettling) and ready for final operation.

- **Machining:**

Finally, the castings are passed through a number of Computer Numerical Control (CNC) machining operations to arrive at final desired product as per the customer order.

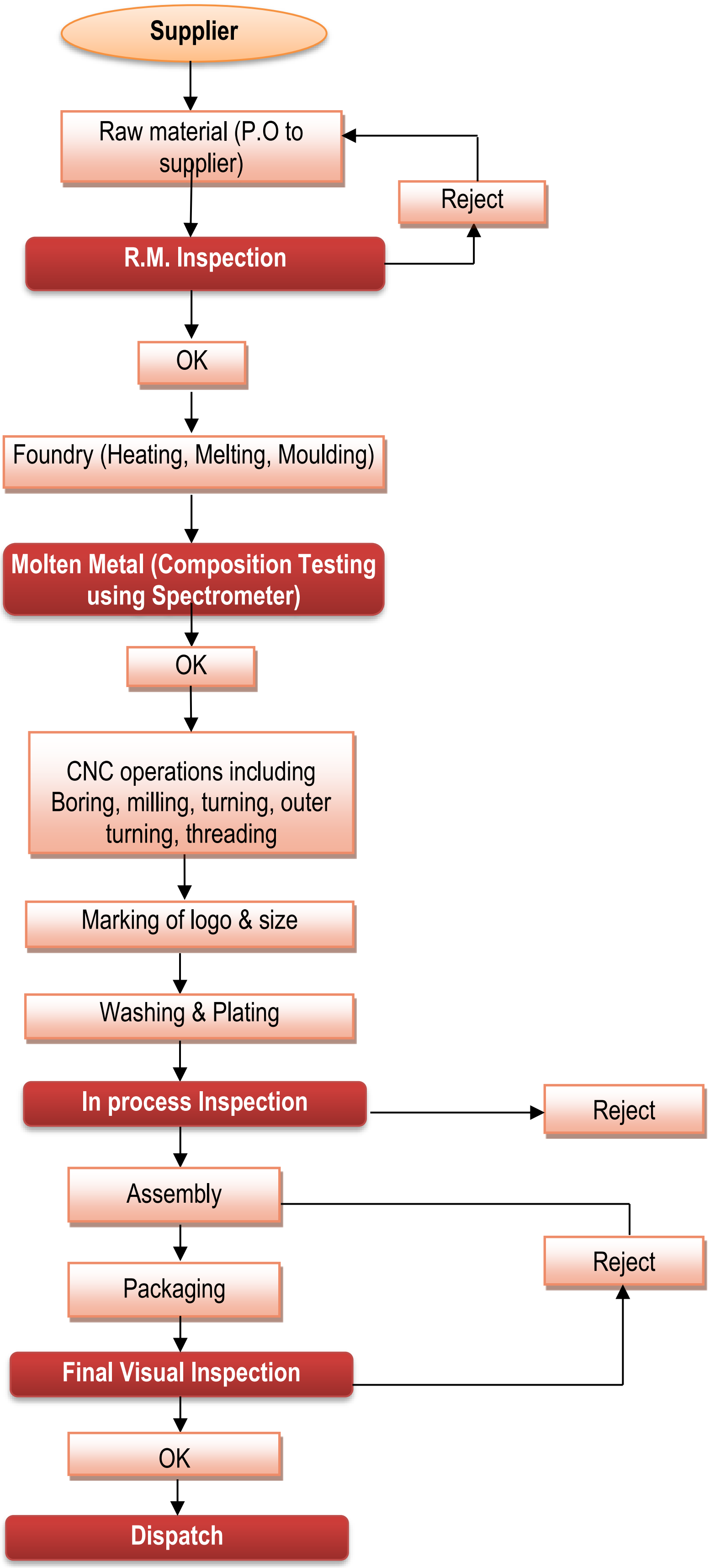


Figure 2.1: *Process flow diagram*

Pictorial Representation of Production Process

Figure 2.2: ***Preparation of sand moulds***

Figure 2.3: ***Sand moulds ready for pouring***

Figure 2.4: ***Melting of scrap material in Induction furnace***

Figure 2.5: ***Poring of molten material in sand moulds***

Figure 2.6: ***Castings after pouring***

Figure 2.7: ***Material after cleaning***

Figure 2.8: ***Machining of castings***

Figure 2.9: ***Products before and after machining process***

Figure 2.10: ***Final Products after series of machining process***

2.2 PRESENT TECHNOLOGIES ADOPTED

The Unit primarily uses electricity as energy input for carrying out regular operations. Induction furnace is the most energy consuming equipment. In addition, Unit has also installed several numbers of lathe machine and CNC machines for carrying out machining operations. Table 2.1 below summarizes process wise energy consumption. Further details about these machines are provided in ***Annexure 2.***

Table 2.1: *Process wise energy consumption information*

SN	Process	Nos. of Installations	Energy Source	Rated Consumption	Daily operation in hours	Days per month
1	Induction Furnace	1	Electricity	Induction Furnace (90 kW), Cooling motor/ pumps (9 HP)	10 hours (furnace) & 15 hours (cooling motor/pumps)	25
2	Sand Mixture	2	Electricity	1.7 HP & 2 HP	10 hours	25
3	CNC Machine	9	Electricity	3 HP motor each	20 Hours	25
4	Lathe Machine	22	Electricity	Sizes ranging from 0.5 HP to 7.5 HP	10 hours	25
5	Air Compressor	2	Electricity	6.7 & 8.2 HP	20 hours	25

2.3 DETAILED ENERGY AUDIT

During field visit to the unit, detailed measurement of the following equipment were carried out. Following sections provides present observations and recommendations for each equipment to improve energy efficiency.

2.3.1 Electrical Panels

The Unit has contract demand of 326 kVA. They are taking electricity supply from SEB using separate meter connection. There is no transformer installed in the unit. The unit has installed Automatic Power Factor Controller (APFC) as well as Maximum Demand Controller (MDC). Furthermore, due to automatic power factor controller installation the power factor of the unit was observed to be in the range of 0.96 to 0.98. The voltage Total Harmonic Distortion (THD) was measured to be in the range of 1.2 to 2.8%.

2.3.2 Induction Furnace

- **Present System:**

The present operational practice of the induction furnace (90 kW) and the specification is given in Table 2.2 below. The melting time of the furnace is around 1 hour and pouring time is 20 minutes. It was observed that the power supply to induction furnace is not reduced during pouring operation; instead some machining return material is added in the furnace during the pouring operation (Figure 2.11). The furnace was run on full load during pouring and metal composition measurements, as a result the furnace was consuming power and the molten metal temperature was increased. It was observed that the furnace was put on hold condition due to non-availability of moulds. The furnace holding is considered as bad practice, it enhances energy consumption. A good planning in subsequent processes, like, timely completion of sample testing should be lined up, making moulds ready for pouring, etc. may be meticulously followed.

Table 2.2: *Furnace specifications*

Model/Make	Raju Engineering (Local make)
Energy Input	Electricity, 90 kW
Capacity	300 kg

▶ Observations:

The present operation of induction furnace was studied and recorded capturing the power consumption, time taken to carry out each sub-activities, input material, furnace rheostat setting (kW consumption), etc. Based on the field visit, following observations are made:

- Out of 100 kgs of scrap material, 30% is lost as runner and riser. Out of the remaining 70 kgs, 60% material is lost in machining which is eventually fed back into the furnace. Thus, only 40% of the material is yielded as finished product. Based on the data collected, the SEC of the induction furnace is found to be around 508 kWh per ton.
- During the visit, measurements were carried out for the induction furnace, the details of which are given in Table 2.3. As a normal practice during molten metal pouring operation electricity supply to the furnace is not reduced. Instead the runner and riser return separated from immediate moulds are fed into the furnace. This practice has three problems; firstly, it consumes more energy as the furnace is operated at full load, but the furnace is partly loaded as molten metal in the furnace is taken out. Secondly, the molten metal temperature is increased due to lesser load and thirdly, the runner and riser return is not cleaned so sand is added into the furnace increasing the slag loss and energy loss. During trial run, the best practice of operating furnace was adopted; during holding time the input power to the furnace was reduced to only 20~25% of full load. The runner and riser return was not put back into the furnace. The furnace operator and management were convinced to adopt better operating practice. In this trial, specific energy consumption was observed to be 336 kWh per tons of molten metal.
- It was further observed that the furnace operator overloads the furnace or loads the metal above the induction coil. Furnace overloading actually consumes more power as well as takes more time to melt. It was also observed that heel metal is kept in the furnace which again is a bad practice adopted and in turn consumes more energy. During trial, all these practices were corrected to get better energy savings or improved Specific Energy Consumptions (SECs).
- It is observed that main decision parameter "molten metal temperature" measurement is not practised. The Unit does not have dip stick temperature measurement devices. Decision regarding completeness of the melting operation is based on the operator's judgement. This most of the times results in overheating of the metal.

Figure 2.11: ***Heating of material in induction melting furnace***

Table 2.3: *Summary of performance study*

EE Trial No.	Total Metal (kg)	Total Melt Time (hh:mm)	Pouring Time (hh:mm)	Total kWh Consumed	SEC (kWh/ ton)	Remarks
1	306	01:06	00:22	103	336	Furnace was operated with energy efficiency measures

Recommendations:

The key recommendations made are following:

- Best Practice #1 (Material Log Book): Maintain log records of type and quantity of scrap material being used and electricity consumed for every charge (See ***Annexure 3***).
- Best Practice #2 (Furnace Loading & Operation): Level of molten metal should not exceed the level of induction furnace coil (See ***Annexure 4***).
- Holding of furnace should be avoided by proper planning in advance for sample analysis / testing and make available moulds.
- Heel metal should be avoided.
- During checking of metal composition (or sample testing) and pouring of molten metal in moulds, power supply to the induction furnace should be reduced to around 25% of the full capacity.
- As far as possible, no overheating of material beyond the required temperature should be carried out as it directly consumes energy. This can be ensured by using proper temperature measurement device.
- Cooling Tower (CT) is used to cool Induction furnace cooling circuit. It is suggested to install timers in the cooling tower fan system and replace the conventional cooling tower fan blades with fibre reinforced plastic blades which leads to sufficient energy saving owing to the better aerodynamic shape of its blades

The cost economic analysis of the above suggested measures are compiled in Table 2.4. It can be observed that all the measures suggested towards energy efficiency improvements of furnaces have good energy saving with attractive payback.

Table 2.4: *Cost Economic Analysis – Induction Furnace*

SN	Energy Efficient Measure	Estimated Energy savings (kWh/year)	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback Period (Year / months)
1	Avoiding overfilling of metals in the Induction Furnace	9,652	72,390	Nil	Immediate
2	Avoiding super heating of metals in the Induction Furnace	5,080	38,100	Nil	Immediate
3	Ladle Preheating	5,080	38,100	Nil	Immediate
4	Installation of timers in cooling tower fan system	1,217	9,131	17,000	1 year 10 months
5	Installation of energy efficient fiber reinforced plastic blades	1,826	13,697	20,000	1 year 6 months
	Total	**22,855**	**171,418**	**37,000**	

2.3.3 Compressor

▶ Present System:

The Unit has installed two air compressors of 6.7 HP (Reciprocating type), 8.2 HP (Screw type) to meet compressed air demand in the Unit. The 6.7 HP compressor is operated continuously while the 8.2 HP compressor is newly installed and not in operation due to manufacturing defect. The compressed air is used in moulding section, induction furnace, machining section and painting section. The complete specification of the compressor is given in Table 2.5.

Table 2.5: *Specifications of compressors*

Make	Toyo
Type	Reciprocating
HP	6.7
Working Pressure (kg/cm^2) G	6.5
Discharge Pressure (CFM)	240
Hydraulic Test Pressure (kg/cm^2) G	11.5

▶ Observations:

Compressor Motor Loading: During field visit, measurement of electrical parameters was carried out to estimate the percentage loading of the compressor. Measurement/observations are summarized in Table 2.6. Based on the measured data, it was observed that compressor motor is overloaded during loading (121%) i.e. when compressor motor is in ON condition. During unloading when compressor motor is OFF, the loading is found to be 45.9%.

Table 2.6: *Measurements performed on the compressor*

Compressor Reference	Loading Condition	Average Current (Amps)	Voltage (Volts)	Actual Power (kW)	Rated Motor kW (HP)	Loading (%)
Toyo	Unload	10.67	402	5.05	11 (14.75)	45.90
	Load	21.33	404	13.32	11 (14.75)	121.04

Compressor Leakage Trial: Compressor leakage test was conducted on 6.7 HP compressor when the unit was not in operation. . Based on the compressor leakage trail, the leakage percentage was found to be around 11.61%. This leakage percentage is slightly on the higher side as for a well maintained system the leakage should be less than 10%. (Format attached in ***Annexure 5***)

Table 2.7: ***Leakage Test Trail Toyo Make Air Compressor (Reciprocating type)***

SN	Load Time (Second)	Unload Time (Second)	Cycle Time (second)	% Leakage
1	1.51	11.63	13.14	11.49
2	1.52	11.62	13.14	11.57
3	1.50	11.35	12.85	11.67
4	1.52	11.59	13.11	11.59
5	1.51	11.39	12.90	11.71
Average	**1.512**	**11.516**	**13.028**	**11.61**

Recommendations:

- Based on the compressor leakage trial, it is suggested to reduce leakage in the compressed air line to bring it below acceptable limits. To do so, leakages in pipelines and discharge side of compressor should be identified and arrested.
- It is strongly recommended to carry out leakage trial every week or fortnightly to assess the leakage level and necessary actions to be taken if any.
- This leakage reduction would also bring down the power consumption and thereby overloading of the system.
- In table 2.8, the cost benefit for arresting leakage in the compressor is exhibited. It can be seen from the table that energy saving up to 14,699 kWh/ year can be achieved, which amounts to monetary saving of Rs 1.1 Lakhs / year.

Table 2.8: ***Cost Economic Analysis - Leakage***

SN	Energy Efficient Measure	Estimated Energy savings (kWh/Year)	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback Period (Years)
1	Arresting Leakage in the Compressor	14,699	110,244	Nil	Immediate

- It is suggested to change worn out or leaked guns to improve compressor efficiency.
- It is suggested to check and clean the inlet air filters regularly to remove dust, dirt and moisture which may lead to clogging pressure drop in the system
- It is further suggested to install VFD in compressor. Given below in Table 2.9, the cost benefit for installation of VFD in compressor is exhibited. It can be seen that by installing VFD in compressor energy saving up to 9,015 kWh / year can be achieved, which amounts to monetary saving of Rs 0.67 Lakhs / year.

Table 2.9: *Cost Economic Analysis - VFD*

SN	Energy Efficient Measure	Estimated Energy savings (kWh/Year)	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback Period (Years)
1	Installation of VFD in Compressor	9,015	67,610	150,000	2.22

2.3.4 Installation of Energy Efficient Lighting and Ceiling Fans

- **Present System:**

The unit has installed conventional lighting fixtures in the factory premises, comprising of florescent tube lights, compact florescent lamps and halogen lights. The ceiling fans used in the factory premises are of conventional design, consuming significant amount of energy. The unit has 120 nos. of conventional design ceiling fans of 60 W each, 72 nos. of florescent tube lights of 55 W each, 66 nos. of compact florescent lamps of 35 W each and 3 nos. of halogen lights of 150 W each

- **Observations:**

During the plant visit, a study was carried out to find out the energy saving potential from replacement of existing lightings and ceiling fans with energy efficient equipment and fixtures. A detailed compilation of energy consumed by the lighting and ceiling fan was carried out and compared vis-à-vis to the use of energy efficient lightings and ceiling fans. In order to find out the capacity required for the new lighting fixtures, existing lux level was checked and desired capacity of replaced energy efficient lighting based on the existing lux level was determined. Similarly for ceiling fan, capacity determination on the basis of application was carried out.

- **Recommendations:**

Based on the observation made at site and detailed analysis of the existing system, it is suggested to replace the existing lighting and ceiling fan with energy efficient lightings and ceiling fans. The table below summarizes the list of equipment and fixtures to be replaced with energy efficient equipment and fixtures:

Table 2.10: *Replacement of conventional lightings and ceiling fans with energy efficient equivalents*

Existing system	Propose system
55W florescent tube light – 72 Nos.	T-8 (20W) LED light – 72 Nos.
35W compact florescent lamp – 66 Nos	18W rocket LED lamp – 66 Nos
150W halogen street light with – 3 Nos	60W LED street light – 3 Nos.
Conventional ac ceiling fan (60Watt) – 120 Nos	Energy Efficient (BLDC) Ceiling fan (28W) – 120 Nos

The estimated annual savings, estimated investment and simple pay-back for replacement of existing lightings and ceiling fans with energy efficient equivalent are summarized below:

Table: 2.11: ***Cost-benefit analysis – installation of energy efficient ceiling fans and lightings***

SN	Energy Efficient Measures	Annual Savings (In Rs)	Estimated Investment (In Rs)	Simple Payback Period (Years / months)
1	Replace conventional ceiling fan with Energy Efficient (BLDC) Ceiling fan	110,707	348,000	3 Years
2	Replace 55W florescent tube light with T-8 (20W) LED light	49,996	46,800	11 months
3	Replace 35W CFL with 18 W rocket LED lamp	333,90	63,294	1 Year 11 months
4	Replace 150W halogen street light with 60W LED street light	39,715	32,880	10 month

2.3.5 Exploring Opportunity for Renewable Energy Usage

During field visit, opportunities of using renewable energy applications were explored. However, based on the higher temperature requirement in the operation process possibility of using solar thermal technology for thermal applications may not be applicable. Further, there were also constraints related to the area availability. Finally, during discussion with unit owner, possibility of using renewable energy was ruled out due to lesser anticipated savings against the cost and operational complexity associated with renewable energy interventions.

Questionnaire*

Energy Audit – Questionnaire Form

"Promoting Energy Efficiency and Renewable Energy in MSME Clusters in India – Jamnagar Brass Unit"

Name of the MSME unit:	ATLAS METAL INDUSTRIES
Address:	PLOT NO. 3686/87, GIDC PHASE-III, DARED, JAMNAGAR, GUJARAT
Ph. No:	(0288) 0273 09 44
Name of the respondent	Mr. RAJESH CHANGANI
Designation:	PARTNER

1. **Year of Establishment: 1996**
2. **Type of Products: a) BRASS ELECRICAL WIRING ACCESSIORS**
   b) EARTHING ACCESSIORS
   c) CABLE LAGS
3. **Installed Capacity: 90KW+90KW+90KW**
4. **Operating hrs. Per day: 10 hrs. per day**
5. **Connected Load: _________________ (kVA or kW please specify)**
6. **Supply Voltage:___________ Volt**
7. **Annual Energy Consumption/ Production:**

Financial Year (April to March)	2012-13	2013-14	2014-15
Coke consumed (kg)			
Cost of coke (in Rs.)			
Electrical units consumed (In kWh)	6,58,174	5,66,586	4,16,525
Electricity charges (in Rs.)	52,65,394	43,82,383	34,86,488
LDO/HSD/ FO consumption (L)			
Fuel Cost (in Rs.)			
Production (kg)	500.720	410.828	367.434

8. **Source and Calorific Value of Fuels:**

Fuel	Source	Calorific Value (kCal)
Coke (Kg)		
HSD (L)		
LDO (L)		
FO (L)		

*Unit specific questionnaire were sent to units prior to the conduction of energy audits. Some portion of the questionnaire was not filled or left blank by the units, due to lack of understanding. However, data used for the energy audit calculations and reporting were subsequently collected during the physical visit of the energy audit team to the site.

Fuel	Source
Electricity (kWh)	

9. **Monthly Energy Consumption and Production Data:**

Month	Production (Kg)	Coke consumption (Kg)	Electricity consumption (kWh)	HSD/LDO /FO (L)	Any other fuel (specify units)
April, 14	32,491.507	-	39050	-	-
May, 14	17,540.355	-	36907	-	-
June, 14	32,479.516	-	34820	-	-
July, 14	35,495.709	-	34169	-	-
August, 14	17,719.945	-	39550	-	-
September, 14	31,197.010	-	28952	-	-
October, 14	32,461.064	-	36757	-	-
November, 14	19,051.024	-	26941	-	-
December, 14	33,266.465	-	35166	-	-
January, 15	34,815.690	-	37258	-	-
February, 15	26,756.433	-	34916	-	-
March, 15	54,163.992	-	32039	-	-

10. **Duration of electricity supply: <u>10 Hours/ day</u>**

11. **Cost variables per Kg of Production:**

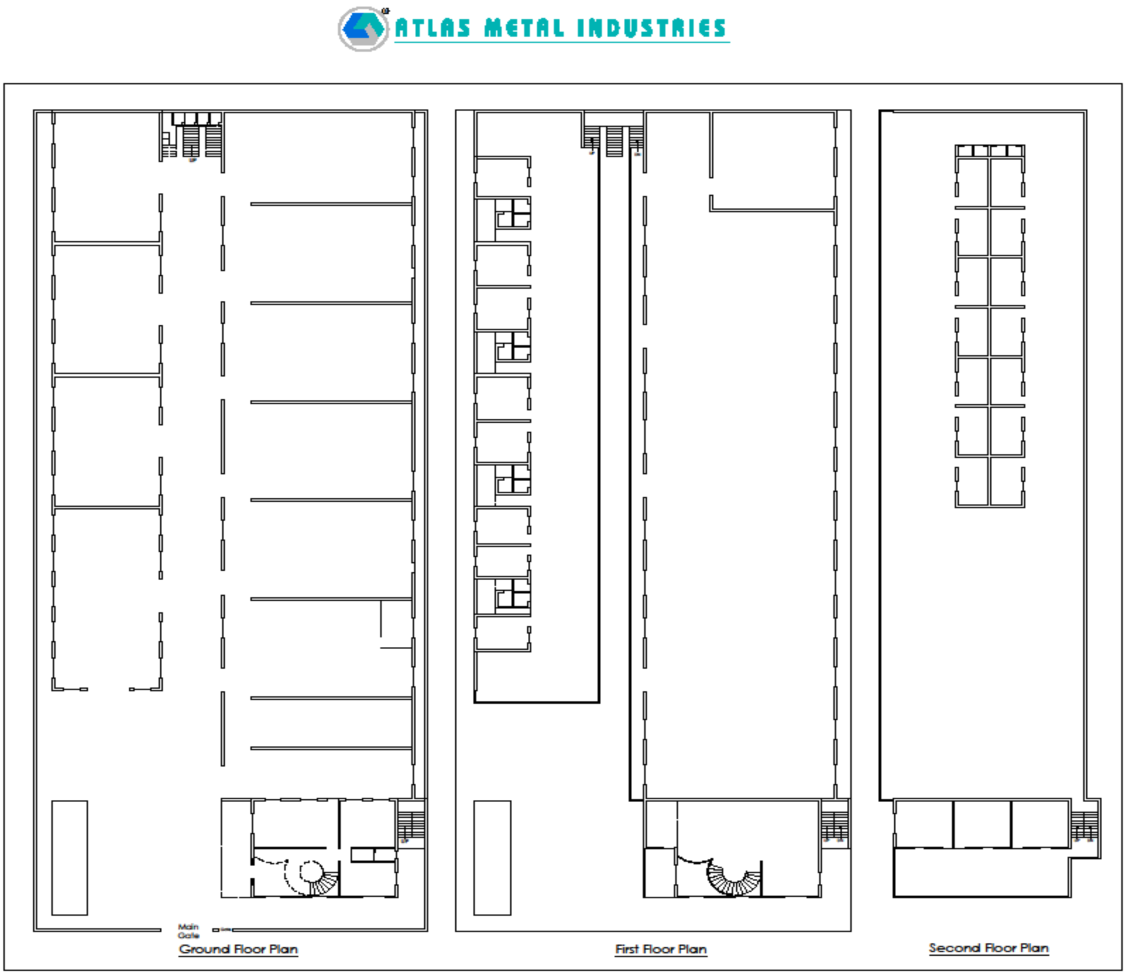
Cost Variable	Cost/ kg of production
Electricity Cost	9.50
Coke Cost	-
Fuel Cost (LDO/HSD/FO) etc.	-
Labour Cost	40.00
Material Cost	325.00
Other Cost	5.00
Total Production Cost	379.50

12. Major Energy Consuming Equipment:

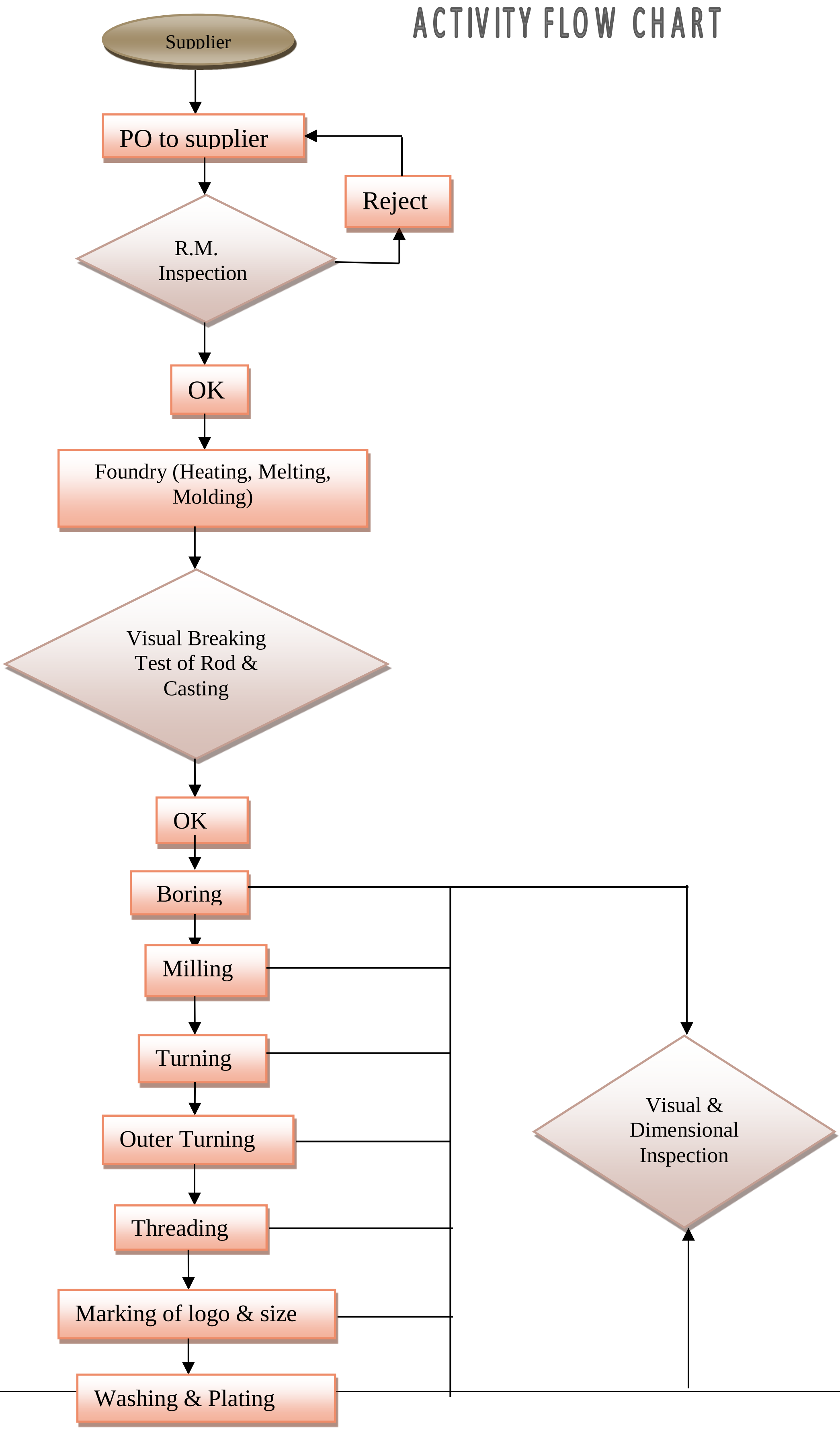
SN	Equipment	Energy source	Make/ Supplier	Year of Installation	Technical Specification/ capacity	Use	Comments
1	MILLING MACHINE	Electric	Amul	2009	3HP		
2	TURNING MACHINE	Electric	Amber	2009	3HP		
3	MILLING MACHINE	Electric	Roto Motive	2009	3HP		
4	BORING MACHINE	Electric	Amul	2009	3HP		
5	CNC MACHINE	Electric	China	2009	7.5HP		
6	CNC MACHINE	Electric	China	2009	7.5HP		
7	MARKING MACHINE	Electric	Amul	2009	0.5HP		
8	DIE BOX WITH TURNING M/C	Electric	Crompton	2009	2HP		
9	THREADING MACHINE	Electric	Crompton	2009	2HP		
10	BOARING MACHINE	Electric	Roto Motive	2009	1.5HP		
11	TURNING MACHINE	Electric	Roto Motive	2009	1.5HP		
12	TURNING MACHINE	Electric	Roto Motive	2009	1.5HP		
13	MILLING MACHINE	Electric	Roto Motive	2009	1.5HP		
14	HOLE CUTTING WITH DIE BOX	Electric	Amber	2009	3HP		
15	HOLLE CUTTING M/C	Electric	Amul	2009	3HP		
16	HOLLE CUTTING M/C	Electric	Amul	2009	1.5HP		
17	GRINDER MACHINE	Electric	Jyoti	2009	0.5HP		
18	THREADING MACHINE	Electric	Amber	2009	1.5HP		
19	THREADING MACHINE	Electric	Amber	2009	1.5HP		
20	AUTO DIE BOX MACHINE	Electric	Crompton	2009	1.5HP		
21	TURNING MACHINE	Electric	Roto Motive	2009	1.5HP		
22	MILLING MACHINE	Electric	Amul	2009	1.5HP		
23	BORING MACHINE	Electric	Roto Motive	2009	3HP		
24	THREADING MACHINE	Electric	Amber	2009	3HP		
25	TURNING MACHINE	Electric	Roto Motive	2009	2.2HP		
26	LATH M / C OLD	Electric	Hindustan	2009	1HP		
27	Sand Mixture	Electric	Crompton	2009	1.7HP		
28	Sand Mixture	Electric	Crompton	2009	2HP		
29	Water Motor	Electric		2009	3HP		
30	Water Motor	Electric		2009	3HP		
31	Water Motor	Electric		2009	3HP		
32	Chimni	Electric	China	2009	5HP		

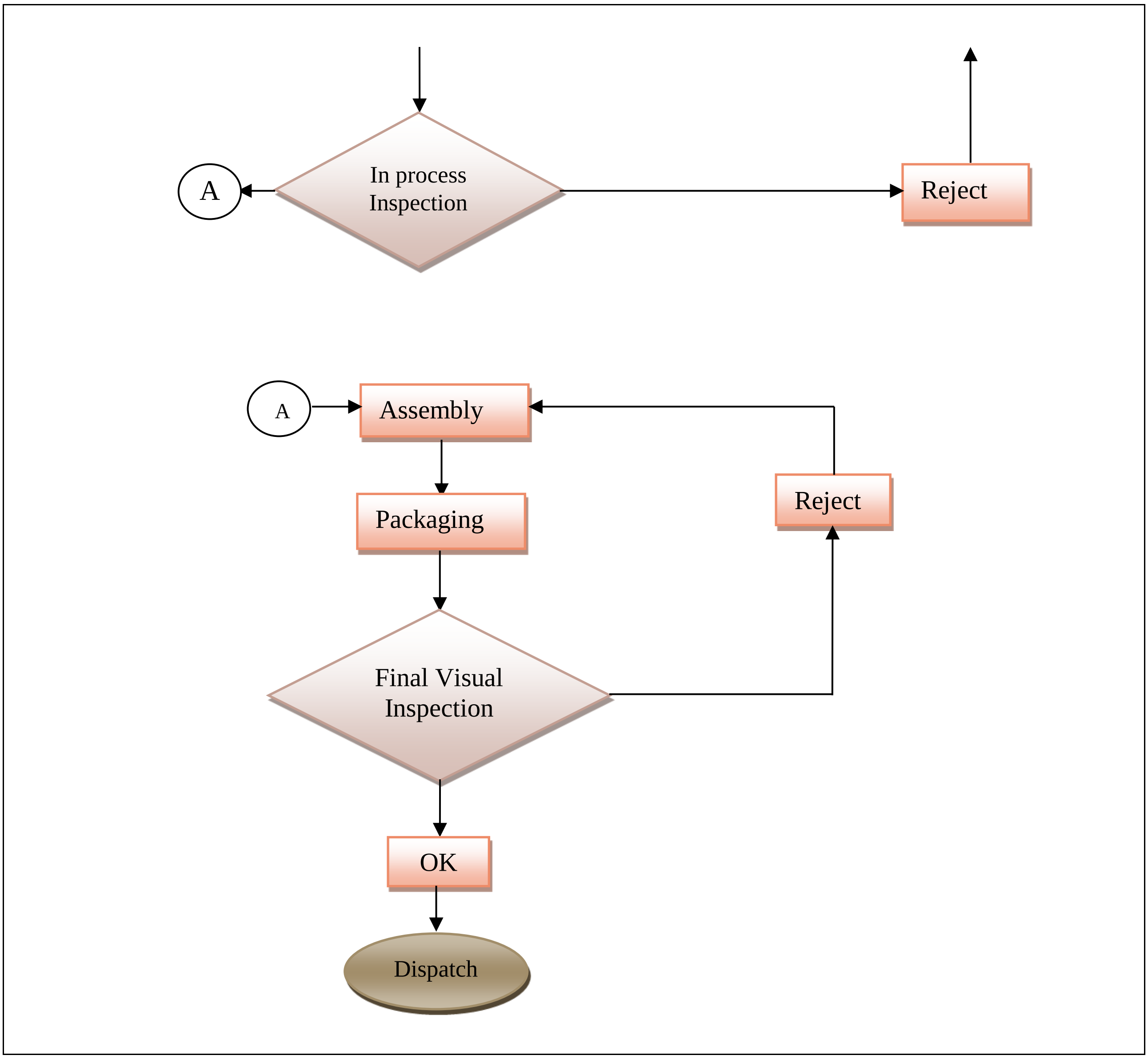
SN	Equipment	Energy source	Make/ Supplier	Year of Installation	Technical Specification/ capacity	Use	Comments
33	CNC (CK30)	Electric	China	2012	3HP		
34	CNC (CK30)	Electric	China	2012	3HP		
35	CNC (CK30)	Electric	China	2012	3HP		
36	CNC (CK30)	Electric	China	2012	3HP		
37	CNC (CK30)	Electric	China	2012	3HP		
38	AIR COMPRESSURE	Electric		2012	5HP		
39	CNC (CK30)	Electric	China	2012	3HP		
40	CNC (CK30)	Electric	China	2012	3HP		
41	CNC (CK30)	Electric	China	2012	3HP		
42	CNC (CK30)	Electric	China	2012	3HP		

13. Factory Layout (Please provide sketch of factory layout):



14. Please provide detailed manufacturing process for each major products manufactured:





15. Any Energy Efficient Technology installed in the unit:

Technology	Specification	Cost	Year of Installation

16. Any Energy Efficient Technology the management wants to implement in the unit:

Technology	Cost (Rs.)	Use
Power Control Factor	2,00,000	Enhance PF

17. Any factory expansion plan:

Annexure 2:

Major Energy Consuming Equipment

SN	Equipment	Energy Source	Make/ Supplier	Year of Installation	Technical Specification/Capacity
1	MILLING MACHINE	Electric	Amul	2009	3HP
2	TURNING MACHINE	Electric	Amber	2009	3HP
3	MILLING MACHINE	Electric	Roto Motive	2009	3HP
4	BORING MACHINE	Electric	Amul	2009	3HP
5	CNC MACHINE	Electric	China	2009	7.5HP
6	CNC MACHINE	Electric	China	2009	7.5HP
7	MARKING MACHINE	Electric	Amul	2009	0.5HP
8	DIE BOX WITH TURNING M/C	Electric	Crompton	2009	2HP
9	THREADING MACHINE	Electric	Crompton	2009	2HP
10	BOARING MACHINE	Electric	Roto Motive	2009	1.5HP
11	TURNING MACHINE	Electric	Roto Motive	2009	1.5HP
12	TURNING MACHINE	Electric	Roto Motive	2009	1.5HP
13	MILLING MACHINE	Electric	Roto Motive	2009	1.5HP
14	HOLE CUTTING WITH DIE BOX	Electric	Amber	2009	3HP
15	HOLLE CUTTING M/C	Electric	Amul	2009	3HP
16	HOLLE CUTTING M/C	Electric	Amul	2009	1.5HP
17	GRINDER MACHINE	Electric	Jyoti	2009	0.5HP
18	THREADING MACHINE	Electric	Amber	2009	1.5HP
19	THREADING MACHINE	Electric	Amber	2009	1.5HP
20	AUTO DIE BOX MACHINE	Electric	Crompton	2009	1.5HP
21	TURNING MACHINE	Electric	Roto Motive	2009	1.5HP
22	MILLING MACHINE	Electric	Amul	2009	1.5HP
23	BORING MACHINE	Electric	Roto Motive	2009	3HP
24	THREADING MACHINE	Electric	Amber	2009	3HP
25	TURNING MACHINE	Electric	Roto Motive	2009	2.2HP
26	LATH M / C OLD	Electric	Hindustan	2009	1HP
27	SAND MIXTURE	Electric	Crompton	2009	1.7HP
28	SAND MIXTURE	Electric	Crompton	2009	2HP
29	WATER MOTOR	Electric		2009	3HP
30	WATER MOTOR	Electric		2009	3HP
31	WATER MOTOR	Electric		2009	3HP
32	CHIMNI	Electric	China	2009	5HP
33	CNC (CK30)	Electric	China	2012	3HP
34	CNC (CK30)	Electric	China	2012	3HP
35	CNC (CK30)	Electric	China	2012	3HP
36	CNC (CK30)	Electric	China	2012	3HP
37	CNC (CK30)	Electric	China	2012	3HP
38	AIR COMPRESSURE	Electric		2012	5HP
39	CNC (CK30)	Electric	China	2012	3HP
40	CNC (CK30)	Electric	China	2012	3HP
41	CNC (CK30)	Electric	China	2012	3HP
42	CNC (CK30)	Electric	China	2012	3HP

Annexure 3:

Material Log Book – Induction Furnace

Furnace ID:	…………………………	**Date**	…………………			**Charge Number** …………	**Material Type**	…………………
Time Details						**Material Input**		
Melting		**Holding**		**Pouring**		**SN**	**Material Type**	**Quantity (kg)**
Start Time (A)	…………	Start Time (D)	……….	Start Time (G)	………			
End Time (B)	…………	End Time (E)	……….	End Time (H)	………	1	……………………………………	……………....
Total time (C) = (B) – (A)	…………	Total time (F) = (D) – (C)	……….	Total time (I) = (F) – (E)	………	2	……………………………………	……………....
Temperature Details						3	……………………………………	……………....
Melting Temperature (⁰C)			……………………			4	……………………………………	……………....
Tapping Temperature (⁰C)			……………………			5	……………………………………	……………....
Pouring Temperature (⁰C) at start of pouring			……………………			6	……………………………………	……………....
Pouring Temperature (⁰C) at end of pouring			……………………			7	……………………………………	……………....
Electricity Consumption (kWh)						Total Input Material (M)		……………....
Initial Reading (J)			……………………...			Total Material Output (N)		……………....
Final Reading (K)			……………………...			Material Lost (O) = (M) – (N)		……………....
Total Electricity consumption (L) = (K)-(J)			……………………...			Specific Electricity consumption (kWh/tons) (P) = (L) * 1000/ (M)		……………....
Remarks: Please capture any other information related to operation like reason for furnace holding, higher time taken for furnace holding etc…								

Annexure 4:

Best Operating Practice

Following are the best practices to be followed for efficient operation of induction furnaces

- Maintain log records of type and quantity of scrap material being used and electricity consumed for every charge
- Loading of scrap material should always be done till the induction furnace coil height.
- As far as possible, no overheating of material beyond the required temperature should be carried out as it directly consumes energy. Use of molten metal temperature measurement device to measure the required temperature.
- Holding of furnace should be avoided by proper planning of moulds / shells in advance.
- Heel metal in the induction furnace should be avoided.
- During pouring and scrap composition measurement, power supply to the induction furnace should be reduced to around 25% of the full capacity.

Annexure 5:

Compressor Leakage Trail Format

(DATE) / (DAY): (dd/mm/yyyy) / (day) …………………	
START TIME (hh:mm): …………	**END TIME (hh:mm): …………**
COMPRESSOR ID: ………………	**CAPACITY: ……… CFM**
PRESSURE SETING : Max - ……… bar; Min - ……… bar	**MOTOR: ………. kW**

S. NO.	ON TIME				OFF TIME			
	START TIME	END TIME	AMPERE	ON TIME (MINS)	START TIME	END TIME	AMPERE	OFF TIME (MINS)
(A)	(B)	(C)	(D)	(E) = (C) - (B)	(F)	(G)	(H)	(I) = (G) - (F)
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
		Average				Average		

Percentage Leakage Calculation:

Total Cycle Time = (E) + (I)

Percentage Leakage = { (E) X 100 }/ { (E) + (I) }

Interpretation:

If percentage leakage is below 10% "Well Maintained System"

If percentage leakage is between 10 ~ 20% "Average Maintained System" - Requires leakage plugging

If percentage leakage is above 30% "Poorly Maintained System" - Requires immediate leakage plugging

NOTE :

1 : READING SHOULDBE TAKEN WITH BALL VALVES AT OPEN POSITION

2 : READING SHOULD BE CONSISTENT