MANUAL ON ENERGY EFFICIENCY MEASURES IN BANGALORE MACHINE TOOL CLUSTER

Bureau of Energy Efficiency

Ministry of Power, Government of India

Prepared By

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CHAPTER - 1

1.0 ABOUT BEE SME PROGRAM

Worldwide the Micro, Small and Medium Enterprises (MSMEs) have been accepted as engines of economic growth to promote and accelerate equitable development. The major advantage of this sector is its enormous employment potential at significantly low capital involvement. This can be established from the simple fact that the MSMEs constitute over 90% of total enterprises in most economies and are credited with generating the highest rates of employment growth and account for a major share of industrial production and exports. In Indian context, MSMEs play a pivotal role in the overall industrial economy. In recent years the sector has consistently registered higher growth rate as compared to the overall industrial sector. With its agility and dynamism, the sector has shown admirable innovativeness and adaptability to survive the recent economic downturn and recession.

As per available statistics (the 4th Census of MSME Sector), this sector employs an estimated 59.7 million persons spread over 26.1 million enterprises. It is estimated that in terms of value, MSMEs have a 40% share in total industrial output at a huge volume of producing over 8,000 value-added products. At the same time, MSMEs contribute nearly 35% share in Direct Export and 45% share in the Overall Export from the country. SMEs exist in almost all-major sectors in the Indian industry such as Food Processing, Agricultural Inputs, Chemicals & Pharmaceuticals, Electrical & Electronics, Medical & Surgical Equipment, Textiles and Garments, Gems and Jewellery, Leather and Leather Goods, Meat Products, Bioengineering, Sports goods, tea, Plastics Products, Computer Software etc.

However, despite the significant contributions made towards various aspects of the nation's socio-economic scenario, this sector too faces several critical issues that require immediate attention. One such factor that falls in the ambit of this publication is the prevalence of age old technologies across the sectors and inherent inefficiencies associated with resource utilization, including, energy. The National Mission for Enhanced Energy Efficiency in Industry under the National Action Plan for Climate Change (released by Government of India on June 30, 2008) has emphasized the need for improving Energy Efficiency (EE) in the manufacturing sector. A number of sector-specific studies have also unanimously confirmed that energy intensity in the industry can be reduced with the widespread adoption of proven and commercially available technologies, which will improve EE and produce global benefits from reduced Green House Gasses (GHGs) emissions.

As a result of increasing awareness towards efficient usage of energy and other resources, there has been a visible reduction in energy intensity in comprehensive Indian industrial sector. However, focusing the observation on the MSME sector reveals that the energy intensity per unit of production is much higher than that of the organized large scale sector. Since energy cost is significant contributor to the overall production cost of SMEs due to high and rising energy costs in current scenarios, it is required to increase the Energy Efficiency (EE) levels in order to ensure the sustenance of SMEs. One of the ways to reduce the inefficiencies is by replacing the conventional/old/obsolete technology with feasible and adaptable energy efficient technologies. This would not only contribute towards reduction in production cost, but would also improve the quality and productivity of MSME products. However, while knowing the way out, there are still numerous barriers (as listed below) and market failures that have prevented widespread adoption of new energy efficient technologies.

Key barriers in promotion and adoption of EE technologies in Indian SME sector:

- Lack of awareness and capability on the part of SMEs to take up energy conservation activities
- Lack of scientific approach on monitoring and verification of performance assessment of installed equipments and utilities.
- Non availability of benchmark data for various equipments/process
- Low credibility of the service providers such as equipment suppliers and their technologies
- The SME owners are more concerned on production and quality rather than energy efficiency and conservation
- The key technical personnel employed in the SME units are based on their past experience in similar industries rather than technically qualified personnel and hence, they are not aware of the latest technologies or measures which improve energy efficiency

Lower priority to invest in improving efficiency than in expansion (this may be due to lack of knowledge on cost benefit)

Majority of SMEs are typically run by entrepreneurs and are leanly staffed with trained technical and managerial persons to deploy and capture energy efficiency practice to reduce manufacturing cost and increase competitive edge. Therefore, it will be useful to build energy efficiency awareness in the SMEs by funding/subsidizing need based studies in large number units in the SMEs and giving energy conservation recommendations including short-term energy conservation opportunities, retrofit/replacement options and technology up-gradation opportunities.

In this context, the Bureau of Energy Efficiency (BEE) has laid adequate emphasis on the SME sector as presented in the Working Group on Power for 11th Five-Year Plan (2007-2012)-Sub-Group 5. Consequently, the Bureau has initiated the Energy Efficiency Improvement program in 29 SME clusters in India.

1.1 PROJECT OBJECTIVES:

The BEE SME Program aims to improve EE (Energy Efficiency) in SME sector by technological interventions in the various clusters of India. The EE in SMEs is intended to be enhanced by helping these industries in the 29 energy intensive SME clusters of India by:

- Technology interventions
- Sustaining the steps for successful implementation of EE measures and projects in clusters, and
- Capacity building for improved financial planning for SME entrepreneurs.

The program also aims at creating a platform for dissemination of the best practices and the best available technologies available in the market for energy efficiency and conservation, to create awareness in the clusters, and to demonstration of the new technology interventions/ projects to stimulate adoption of similar technology/projects in the clusters.

The BEE SME program has been designed in such a way so as to address the specific needs of the industries in the SME sector for EE improvement and to overcome the common barriers in way of implementation of EE technologies in cluster through knowledge sharing, capacity building and development of innovative financing mechanisms. The major activities in the BEE SME program are:

- Energy use and technology studies
- Capacity building of stake holders in cluster for building EE projects
- Implementation of energy efficiency measures
- Facilitation of Innovative financing mechanisms for implementation of energy efficiency projects

The brief objective of each of these activities is presented below:

Energy use and technology studies

An in-depth assessment of the various production processes, energy consumption pattern, technology employed and possible energy conservation potential and operational practices in cluster by means of conducting detailed energy audits and technological gap assessment studies were conducted in the cluster. The energy audit study shall include analysis of the overall energy consumption pattern, study of production process, identification of energy intensive steps/sub-processes and associated technology gap assessment for the individual units. The study has also focused on identifying the best operating practices and the EE measures already implemented in the units.

Capacity building of stakeholders

The aim of this activity is capacity building of the enrolled LSPs to equip them with capacity to carry on the implementation of the EE technology projects in cluster on a sustainable basis. It would be ascertained that the needs of the LSPs is identified as a preparatory exercise to this activity, as in what they expect from the BEE Program in terms of technical and managerial capacity building.

Implementation of EE measures

To implement the EE and technology up-gradation projects in the clusters, technology specific Detailed Project Reports (DPRs) for five different technologies for three scales of operation will be prepared. The DPRs will primarily address the following:

- Comparison of existing technology with feasible and available EE technology
- Energy, economic, environmental & social benefits of proposed technology as compared to conventional technology
- Details of technology and service providers of proposed technology
- Availability of proposed technology in local market
- Action plan for implementation of identified energy conservation measures
- Detailed financial feasibility analysis of proposed technology

Facilitation of innovative financing mechanisms

The program aims to develop innovative and effective financing mechanisms for easy financing of EE measures in the SME units in the cluster. The easy financing involves following three aspects:

- Ease in financing procedure
- Availability of finance on comparatively easy terms and relaxed interest rates
- Compatibility and availing various other Central/ State Governments' incentive schemes like CLCSS, TUFF etc.

1.2 EXPECTED PROJECT OUTCOME

Expected project outcome of BEE SME program in clusters are:

Energy Use and Technology Analysis

The outcome of the activity includes identification of the EE measures, assessment of potential of renewable energy usage, fuel switching, feasibility analysis of various options, and cost benefit analysis of various energy conservation measures including evaluation of financial returns in form of payback period, IRR and cash flows. The cost liability of each measure, including the capital and operational cost will also be indicated.

The identified EE measures will be categorized as per the following types:

- Simple housekeeping measures/ low cost measures
- Capital intensive technologies requiring major investment.

The sources of technology for each of the suitable low cost and high cost measures, including international suppliers as well as local service providers (LSPs)/ technology suppliers, in required numbers shall be identified. It is envisaged to create a knowledge bank of detailed company profile and CVs of key personnel of these technology sources. The knowledge bank will also include the capability statements of each of these sources.

The EE measures identified in the energy use and technology audit study will be prioritized as per their energy saving potential and financial feasibility. Inventorization survey was done to establish details like the cluster location, details of units, production capacity, technologies employed, product range, energy conservation potential along with possible identified EE measures and respective technology suppliers.

The specific outcomes of this activity are as follows:

- Determination of energy usage and energy consumption pattern
- Identification of EE measures for the units in cluster
- Development and preparation of case studies for already implemented EE measures and best operating practices in the units
- Evaluation of technical & financial feasibility of EE measures in terms of payback period, IRR and cash flows.
- Enlisting of Local Service Providers(LSPs) for capacity building & training including creation of knowledge bank of such technology suppliers
- Capacity building modules for LSPs
- Development and preparation of cluster manuals consisting of cluster details and EE measures identified in cluster.

Implementation of EE measures

The aim of this activity is development and finalization of bankable DPRs for each of the EE projects, which would be presented before the SME units for facilitation of institutional financing for undertaking the EE projects in their respective units.

The activity will ensure that there is close match between the proposed EE projects and the specific expertise of the Local Service Providers (LSPs). These DPRs will be prepared for EE, renewable energy, fuel switching and other possible proposed measures during course of previous activities. Each DPR will include the technology assessment, financial assessment, economic assessment and sustainability assessment of the EE project for which it has been developed. The technology assessment will include the details of the design of equipment/ technology along with the calculation of energy savings. The design details of the technology for EE project will include detailed engineering drawing for the most commonly prevalent operational scale, required civil and structural work, system modification and included instrumentation and various line diagrams. The LSPs will be required to report the progress of the implementation of each such project to BEE PMC. Such implementation activities can be undertaken by the LSPs either solely or as a group of several LSPs.

Capacity Building of LSP's and Bankers

The outcome of this activity would be training and capacity building of LSPs so as to equip them with necessary capacity to undertake the implementation of proposed EE projects as per the DPRs. Various training programs, training modules and literature are proposed to be used for the said activity. However, first it is important to ascertain the needs of the LSPs engaged, as in what they expect from the program in terms of technical and managerial capacity building. Another outcome of this activity will be enhanced capacity of banking officers in the lead banks in the cluster for technological and financial feasibility analysis of EE projects that are proposed by the SME units in the cluster. This activity is intended to help bankers in understanding the importance of financing energy efficiency projects, type and size of projects and ways and means to tap huge potential in this area. Different financing models would be explained through the case studies to expose the bankers on the financial viability of energy efficiency projects and how it would expand their own business in today's competitive environment.

Concluding workshop

The outcome of this activity will be the assessment of the impact of the project as well as development of a roadmap for future activities. The workshop will be conducted for the representatives of the local industrial units, industry associations, LSPs and other stakeholders so that the experiences gained during the course of project activities including implementation activities of EE project can be shared. All the stakeholders in the project will share their experience relating to projects undertaken by them as per their respective roles. Effort from industrial units as well as LSPs to quantify energy savings thus achieved would be encouraged. This would lead to development of a roadmap for implementing similar programs in other clusters with greater efficiency and reach.

1.3 PROJECT DURATION

The mentioned activity of the project (in paragraph – 2/chapter – 1) was initialized in August 2009. The expected successful completion of the project is December 2010.

1.4 IDENTIFIED CLUSTERS UNDER THE PROGRAM & TARGET CLUSTER FOR IMPLEMENTATION

29 most energy intensive MSME clusters across different end use sectors have been identified to implement the BEE SME program for EE improvement. The details of industrial sectors and identified clusters are provided in Table 1 below:

Table 1.1: List of clusters identified for BEE SME Program

S. No.	Cluster Name	Location
1.	Oil Milling	Alwar; Rajasthan
2.	Machine Tools	Bangalore; Karnataka
3.	Ice Making	Bhimavaram; Andhra Pradesh
4.	Brass	Bhubaneswar; Orissa
5.	Sea food processing	Kochi, Kerala
6.	Refractories	East &West Godavari, Andhra Pradesh
7.	Rice Milling	Ganjam, Orissa
8.	Dairy	Gujarat
9.	Galvanizing	Howrah, West Bengal
10.	Brass& Aluminium	Jagadhari, Haryana
11.	Limestone	Jodhpur, Rajasthan
12.	Tea processing	Jorhat, Assam
13.	Foundry	Batala, Jalandhar & Ludhiana, Punjab
14.	Paper	Muzaffarnagar, Uttar Pradesh
15.	Sponge iron	Orissa
16.	Chemicals& Dyes	Vapi, Gujarat
17.	Brick	Varanasi, Uttar Pradesh
18.	Rice Milling	Vellore, Tamil Nadu
19.	Chemical	Ahmedabad, Gujarat
20.	Brass	Jamnagar, Gujarat

S. No.	Cluster Name	Location
21.	Textile	Pali, Rajasthan
22.	Textile	Surat, Gujarat
23.	Tiles	Morbi, Gujarat
24.	Textile	Solapur, Maharashtra
25.	Rice Milling	Warangal, Andhra Pradesh
26.	Coir	Alleppey, Kerala
27.	Textile	Tirupur, Tamil Nadu
28.	Roof Tiles	Mangalore, Karnataka
29.	Glass	Firozabad, Uttar Pradesh

As a part of BEE SME program, one of cluster identified was the Bangalore Machine Tool cluster. It was proposed to carry out energy use and technology audit studies in 30 units in the Bangalore Machine Tool cluster covering all types and sizes of the industries to understand/give valuable insight into the process of developing energy efficiency solutions relevant to the SME industries in the Bangalore Machine Tool cluster.

CHAPTER2

2.0 Bangalore Machine Tool Cluster Scenario

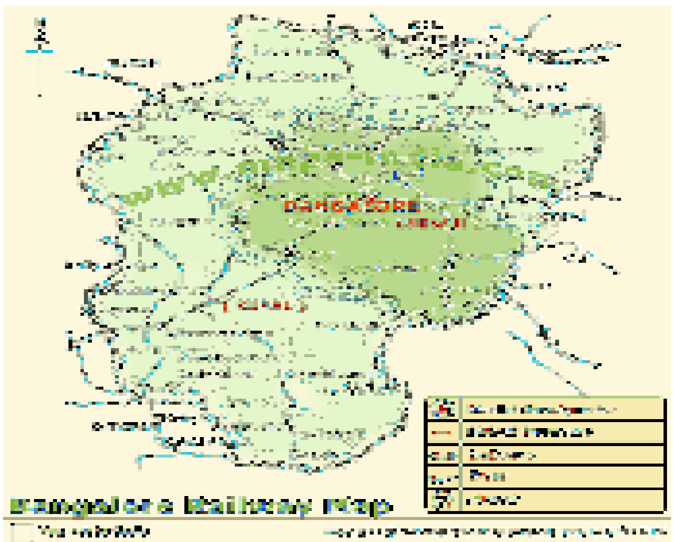
2.1 OVERVIEW OF BANGALORE MACHINE TOOL CLUSTER

The Machine Tools Cluster of Bangalore is located in the Bangalore district. Bangalore, also known as Bengaluru is the capital of the Indian state of Karnataka, located on the Deccan Plateau in the south-eastern part of Karnataka. Bangalore was inducted in the list of Global cities and ranked as a "Beta World City" alongside Geneva, Copenhagen, Boston, Cairo, Riyadh, Berlin, to name a few, in the studies performed by the Globalization and World Cities Study Group and Network in 2008.

Table 2.1 Bangalore at a Glance

Geographical Location	12°58′0″N 77°34′0″E
Geographical Area	741 km²
Average Annual Rainfall	859 mm
Temperature (2004)	23. °C
Population	5,438,065 (2009)
Literacy (2001)	85.74%

Today as a large city and growing metropolis, Bangalore is home to many of the most well-recognized colleges and research institutions in India. Numerous public sector heavy industries, software companies, aerospace, telecommunications, and defence organisations are located in the city. Bangalore is known as the Silicon Valley of India because of its position as the nation's leading IT exporter. A demographically diverse city, Bangalore is a major economic and cultural hub and the fastest growing major metropolis in India



2.1.1 Cluster Background:

Bangalore is the "HUB" for machine tools in India. The cluster accounts for 60% of the value of production of machine tools in the country. Bangalore is predominantly a metal cutting cluster. The structure of machine tool industry in Bangalore has at its apex 6 large machine tool manufacturers, about 100 small and medium machine tool manufacturers, their suppliers and vendors in large numbers.

The units of Bangalore machine tool cluster located in Peenya Industrial estate, Abbigere Industrial estate and Bommasandra Industrial estate are manufacturing components, machine accessories and special purpose machines catering to different sectors of economy such as automobile industry, aerospace industry, and CNC Machine industry across the globe. Heat treatment units are also located in the cluster catering to the needs of the machine tool units. What is apparently seen as a unique feature of the cluster is the other industrial unit does not replicate the products manufactured for machines by an industrial unit. Though there are a large number of units located in the cluster, many of them are of insignificant magnitude in size and operation. It was observed from the data collected from various sources that the total number of units in the cluster is around 100 falling in the purview of the above-mentioned classification. The study was conducted in 30 units to identify the energy efficient technologies that result eventually in saving of energy.

All units studied are registered as small scale industries under the Government of Karnataka and many of them have entrepreneurship memorandum number issued by department of MSME. Most of the industries identified for this project are registered with Karnataka Small Scala Industries Association, Bangalore Machine Tool Manufacturer Association and Peenya Industrial Association. Geographical distribution of units in Bangalore machine tool cluster are as shown in the figure 2.1

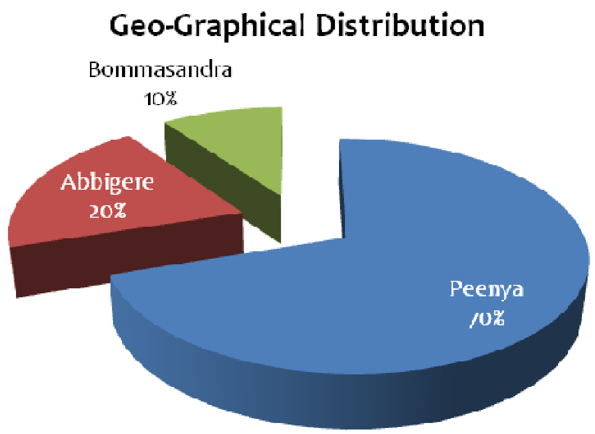


Figure 2.1: Geographical distribution of Machine tool units in Bangalore cluster

The above associations are providing the member industries abreast of the latest developments with necessary technical know-how. Also, they support them in capacity building, training and skill updation. Indian Machine Tool Manufacturers Association is located in Bangalore and is catering to the requirements of medium and large-scale industries. However, there is not much of awareness among the industries about energy efficient measures as energy constitutes a small part of the overall expenditure. Raw material for these industries is Steel and Cast Iron.

2.1.2 Product manufactured

In SME cluster of Machine Tools at Bangalore, there are varieties of products manufactured that include spindles, centre grinding machines, ID grinding machines, Self centering Steady Rests, Bar feeding attachments, Rotary tables, Index tables, Special purpose machines, Co-ordinate Measuring machines, aerospace fixtures, CNC Machine enclosures, Sound proofs, armature rewinding machines etc. There are supporting industries like heat treatment are also located in the cluster. These products/ machines are usually utilized in automobile industry, aerospace industry, CNC Machine industry across the globe. These are products custom made to suit the requirements of ISRO,HAL, BEML,MICO,BHEL, Kirloskar Electric, Bayforge Ltd etc.

2.1.3 Classification of Units

Type of Product

Major products being manufactured in the cluster are classified in to four major categories including heat treatment, which is a supporting activity of the cluster. The other product categories are components (which are generally used in aerospace, automobile, electrical & electronic and other machineries), Accessories (which are used in conventional and CNC machine tools) CNC Machines and Special Purpose Machines. The percentage of the units in each of the categories is indicated in the figure 2.2.

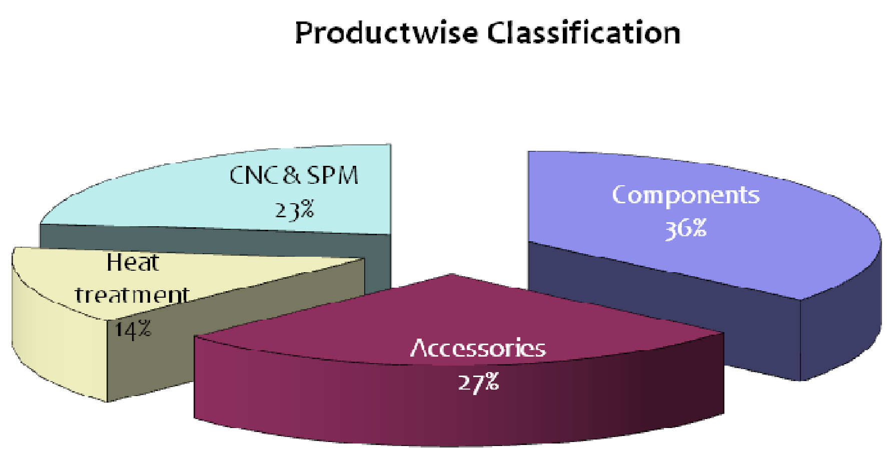


Figure 2.2: *Product wise classification of Machine tool units*

Production capacity

Production capacity of machine tool units in Bangalore cluster depends on the type of product being produced in unit. Production capacity of machine tool units in Bangalore cluster is in the range of 1500 kg per Annum –1050000 kg per Annum. The following figure shows the classification of machine tool units in Bangalore cluster based on production capacity. The production capacity as the weight of the metal removed in case of components, accessories and SPM making industries. In case of Heat treatment, weight of the material treated has been considered as the production capacity. The above methodology is adopted as major energy is spent towards removing the metal, as per the specifications of the product, while carrying out jobs such as milling, turning, grinding and drilling. In case of heat treatment units, major energy is spent in the heat treatment furnaces. Hence, the weight of material processed is taken as production capacity.

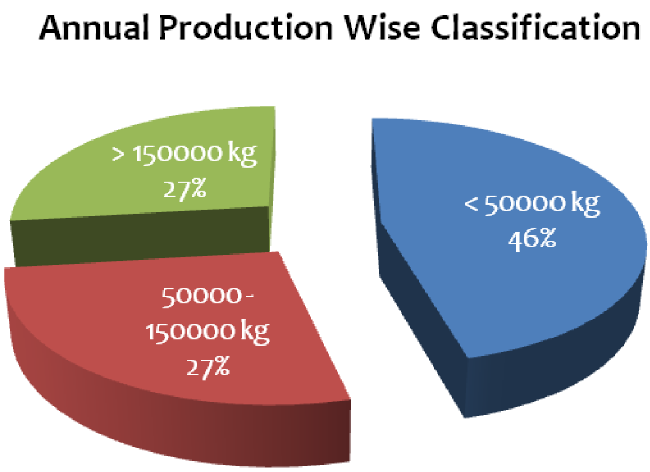


Figure 2.3: Annual Production Wise classification of Machine tools units

Energy consumption pattern

In Bangalore machine tool unit cluster, the amount of electrical energy consumed varies from 6000 kWh to 1600000 kWh per annum. Energy consumption is the lowest in case of SPM making units, medium in case of component/ accesaries making units, and the maximum in heat treatment units. The following figure shows the classification of percentage of machine tool units in Bangalore cluster based on consumption of electrical energy per annum.

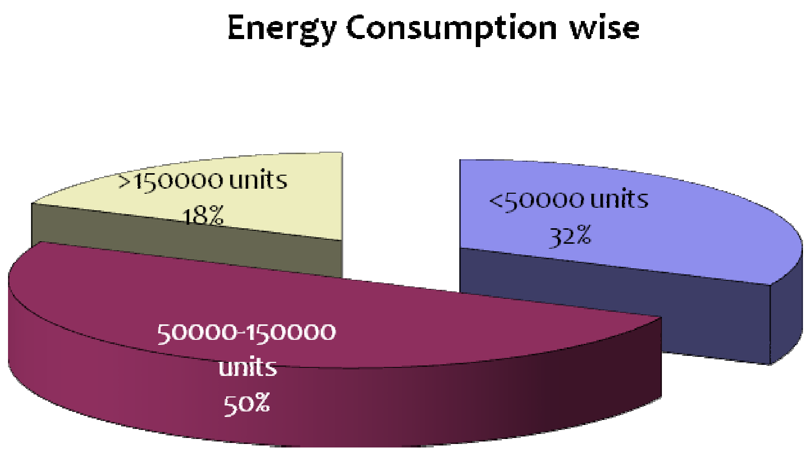


Figure 2.4: Energy Consumption Wise classification of Machine tools units

Turn over

These industries are classified based on their turnover into small and medium enterprises. Small industries have a turn over of less than 5 crores and medium industries have a turnover of 5 crores and above. Turn over of the machine tool units surveyed in this cluster range from Rs. 75 lakhs to Rs. 8 crores. The following figure shows the classification of machine tool units in Bangalore cluster based on turn over.

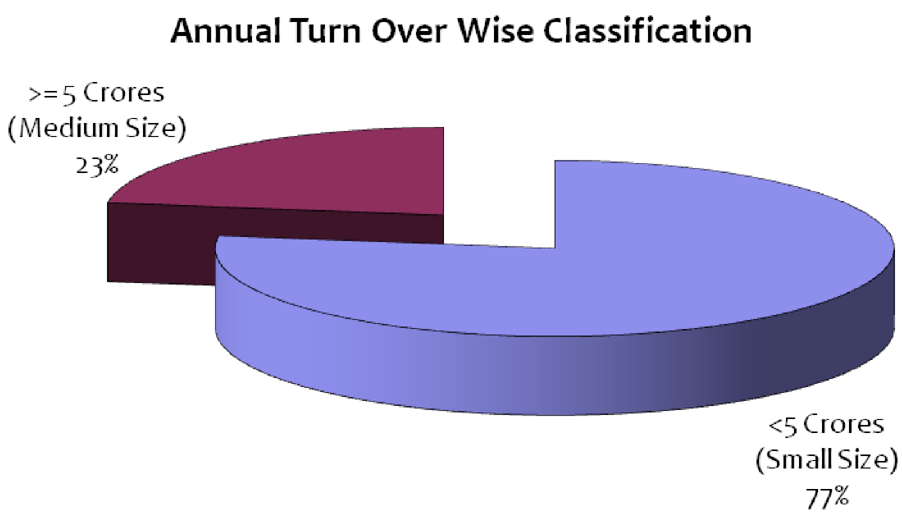


Figure 2.5: Annual Turn Over Wise Classification of Machine Tool Units

2.1.4 Installed Production Capacity

These industries do not have a standard design or nameplate capacities per say. This is due to the nature of industry, which makes different types of products in large numbers catering to variety of industries cutting across all sectors. The production capacity is considered as the weight of the metal removed in case of components, accessories and

SPM making industries. In case of Heat treatment, weight of the material treated has been considered as the production capacity. The above methodology is adopted as major energy is spent towards removing the metal, as per the specifications of the product, while carrying out jobs such as milling, turning, grinding and drilling. In case of heat treatment units, major energy is spent in the heat treatment furnaces. Hence, the weight of material processed is taken as production capacity.

2.1.5 Raw Material used

Raw Material for these industries is Steel, Cast Iron and Pig Iron. Requirement of raw material is chosen as per the requirements of the end products of the customer. In the category of component industry, the raw material is supplied by the client along with the drawing to complete finishing and machining jobs. Most of the industries make use of steel as raw material.

2.2 ENERGY SITUATION IN THE CLUSTER

2.2.1 Energy Type & Prices

The machine tool industries in this cluster use electricity from grid to meet their electrical energy requirement. Some of the industrial units having the backup power generator (Diesel Based) to meet the demand in case of grip power supply failure or scheduled power cut from the grid. The main and primary energy for machine tool industries is the electricity for operation of production and utility services. In manufacturing of some category of products, heat treatment process required to achieve the desired material properties. In heat treatment units of the clusters, which are very few in numbers (only 14 %) are using electricity as the main source of energy even in the process of heat treatment, which is usually outsourced. The percentage segregation of used energy in the cluster is given in figure 2.6, which reveals that the 95.9% of energy used in the cluster is drawn from the Bangalore Electricity Supply Company Limited (BESCOM) grid whereas only 4.1% of total energy required is being generated by thermal energy (High Speed Diesel) using DG sets. Electrical Tariff is given in **annexure – 4**.

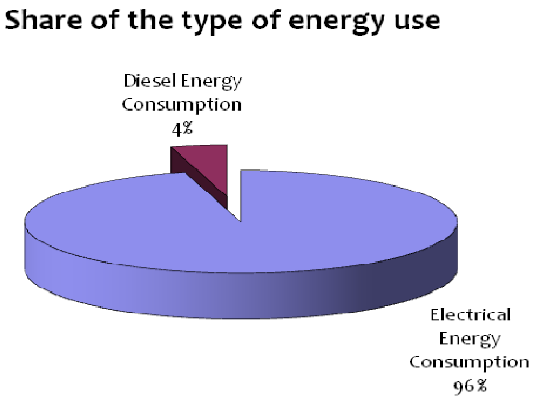


Figure 2.6: Share of Energy Type used in the Machine Tool Units

2.2.2 Energy consumption in a typical industry

Electricity from the BESCOM grid is the primary source of electrical energy, constituting 96% of the energy requirement of the cluster. The cluster in general does not use any thermal energy except for diesel, which is used for generating the power through D.G. sets as back up power. Total energy cost constitutes 5 - 8% of the total production cost. The share of thermal energy (HSD) in the total energy consumption is estimated to be 4%. The major units having the LT connection from the BESCOM at 440 volt supply whereas some of the units have taken HT connection at 11 kV. The average electrical energy cost is Rs.4.57/- per unit (kWh). As the machine tolls units has been classified into four segments depending on the product type such as components, accessaries, SPMs and heat treatment. The typical energy consumption pattern of these four types of units is given in table 2.2. Electrical tariff is given in annexure-4.

Table 2.2 Energy Consumption Pattern of Typical Units

Type of units	Electrical Energy, kWh/Year	Diesel, Lt/Year	Total Energy, GJ/Year
Components	77891	1757	343
Accessories	114863	786	442
Machines	34704	648	148
Heat Treatment	1141109	0.1	4109

The electrical energy and diesel energy consumption of the Bangalore Machine Tools cluster is given in table 2.3.

Table 2.3 Energy Consumption Pattern of Machine Tools Cluster

Parameters	Unit	Components	Accessories	Machines	Heat Treatment	Total Cluster
Annual Electrical Energy Consumption	kWh/year	28,04,067	31,01,301	7,98,201	1,59,75,531	2,26,79,100
Annual Electrical Energy Consumption	GJ/Year	10,096	11,167	2,874	57,522	81,659
Diesel consumption for Electricity generation	Lt/Year	6,32,52	21,214	14,909	1.10	99,376
Annual Diesel consumption	GJ/Year	2,251	755	531	0.04	3,537
Total energy consumption	GJ/Year	12,347	11,922	3,405	57,522	85,196
% of total energy consumption	%	14.5	14.0	4.0	67.50	100

The annual electrical energy consumption and fuels in Bangalore Machine Tools cluster is estimated to be around 2,26,79,100 kWh and 99,376 litres respectively. Total energy consumption in the cluster is around 85,196 GJ.

Total annual energy consumption in Bangalore Machine tool cluster is around 85,196 GJ. The percentage share of energy consumption in the classified units of the Bangalore Machine tools cluster is given in figure 2.7.

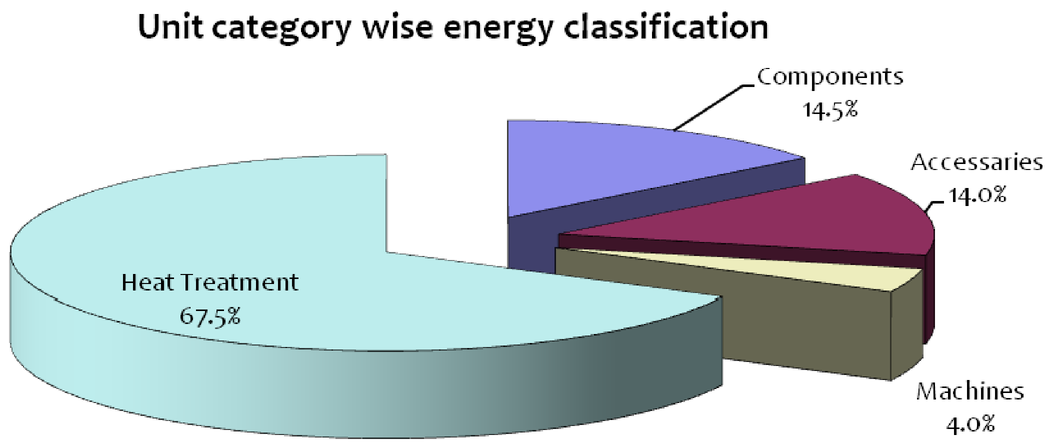


Figure 2.7: Share of various types of units in annual energy consumption

2.2.3 Specific energy consumption in Bangalore Machine Tool cluster:

The specific energy consumption depends on the final product being manufactured by the machine tool units, therefore SEC has been classified according to the types of products produced in the cluster. Details of the SEC depending on the type of products is shown in the following table

Table 2.4 Energy Consumption Pattern of Machine Tools Cluster

Type of units	Specific Energy Consumption, GJ/Tonne	Specific Energy Consumption, kWh/Tonne
Components	24.8	6472
Accessories	19.7	5118
Machines	2.2	600
Heat Treatment	64.2	15057
Average	27.7	6811.8

2.3 MANUFACTURING PROCESS/TECHNOLOGY OVERVIEW

2.3.1 Process Flow Diagram

Typically, process for machine tool units in Bangalore is not the same for all industries involving various activities, as the end products of the industry are different for each industrial unit. Therefore, there is some variation in the flow of activities depending on the customized requirement of the products. However, these activities could be grouped together as shown below, though not in the same order as mentioned.

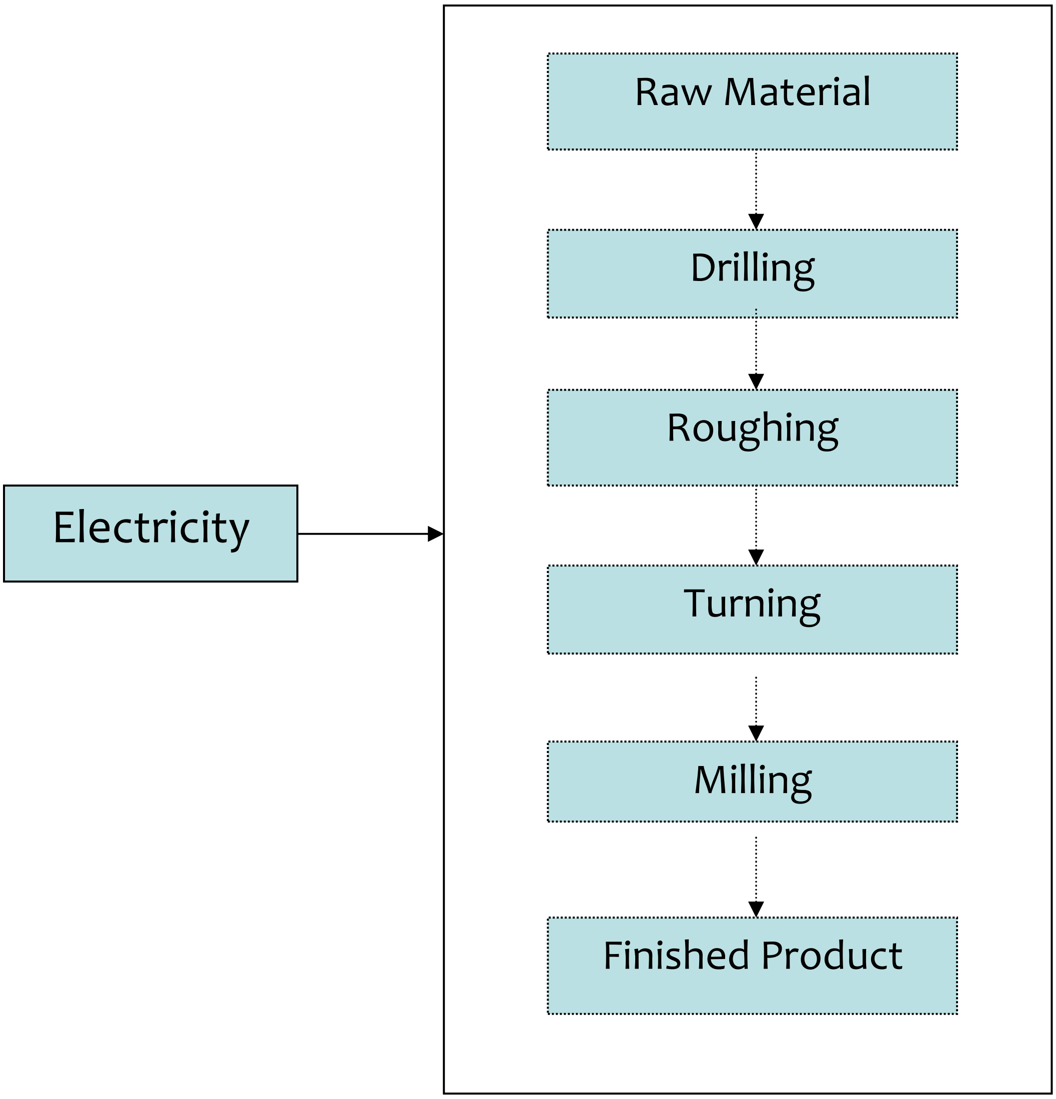


Figure 2.8: General Process Flow Diagram of Bangalore Machine Tools Cluster

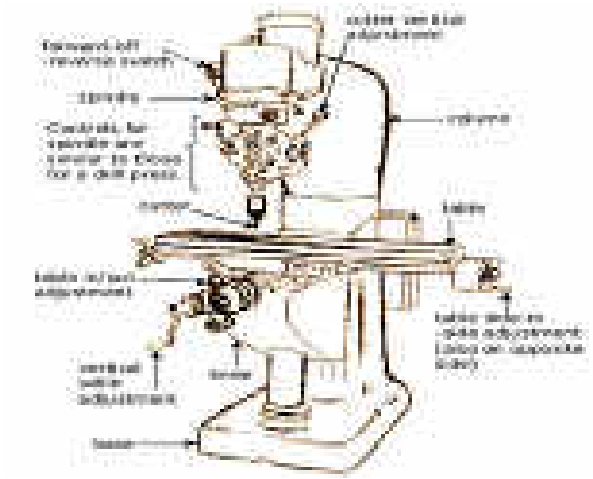
From the above figure, it is clear that major energy consuming process in typical manufacturing industry are stirring and drying operation. Drying operation will consume around 55% of total energy and stirring operation (including steam circulation in vessel) will consume around 45% of total energy.

2.3.2. Process Technology

Milling Process

Milling is the most common form of machining, a material removal process, which can create a variety of features on a part by cutting away the unwanted material. The milling process requires a milling machine, work piece, fixture, and cutter. The work piece is a piece of pre-shaped material that is secured to the fixture, which itself is attached to a platform inside the milling machine. The cutter is a cutting tool with sharp teeth, which is also secured in the milling machine and rotates at high speeds. By feeding the workpiece into the rotating cutter, material is cut away from this work piece in the form of small chips to create the desired shape.

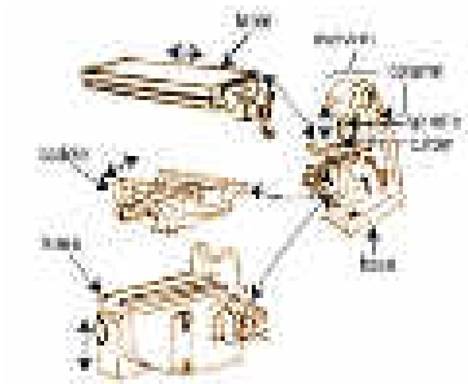
Milling is typically used to produce parts that are not axially symmetric and have many



features, such as holes, slots, pockets, and even three-dimensional surface contours. Parts that are fabricated completely through milling often include components that are used in limited quantities, perhaps for prototypes, such as custom designed fasteners or brackets. Another application of milling is the fabrication of tooling for other processes. For example, three-dimensional molds are typically milled. Milling is also commonly used as a secondary process to add or refine features on parts that were manufactured using a different process. Due to the high tolerances and surface finishes that milling can offer, it is ideal for adding precision features to a part whose basic shape has already been formed.

Milling is as fundamental as drilling among powered metal cutting processes. Milling is versatile for a basic machining process, but because the milling set up has so many degrees of freedom, milling is usually less accurate than turning or grinding unless especially rigid fixturing is implemented. For manual machining, milling is essential to fabricate any object that is not axially symmetric. Below is illustrated the process at the cutting area. A typical column-and-knee type manual mill is shown. Such manual mills are common in job shops that specialize in parts that are low volume and quickly fabricated. Such job shops are often termed 'model shops' because of the prototyping nature of the work.

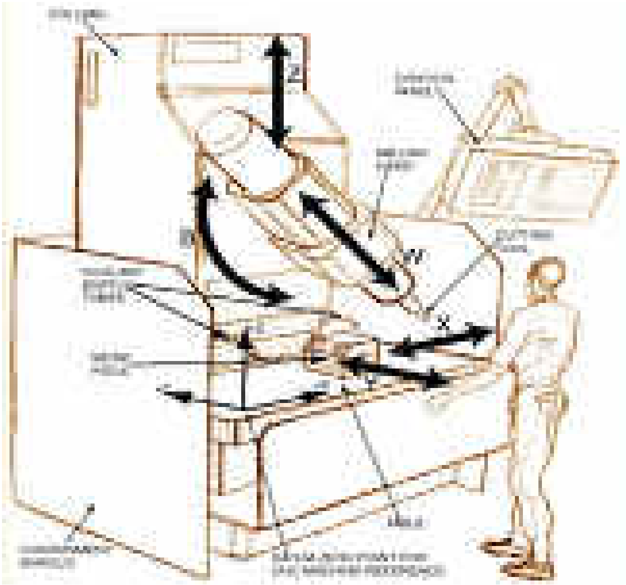
The parts of the manual mill are separated below. The knee moves up and down the



column on guide ways in the column. The table can move in x and y on the knee, and the milling head can move up and down.

CNC Milling: Computer Numerical Control (CNC) Milling is the most common form of CNC. CNC mills can perform the functions of drilling and often turning. CNC Mills are classified according to the number of axes that they possess. Axes are labeled as x and y for horizontal movement, and z for vertical movement, as shown in this view of a manual mill table. A standard manual light-duty mill is typically assumed to have four axes: Table X, Table Y, Table Z and milling head Z.

A five-axis CNC milling machine has an extra axis in the form of a horizontal pivot for the milling head. This allows extra flexibility for machining with the end mill at an angle with respect to the table. A six-axis CNC milling machine would have another horizontal pivot for the milling head, this time perpendicular to the fifth axis.



CNC milling machines are traditionally programmed using a set of commands known as G-codes. G-codes represent specific CNC functions in alphanumeric format.

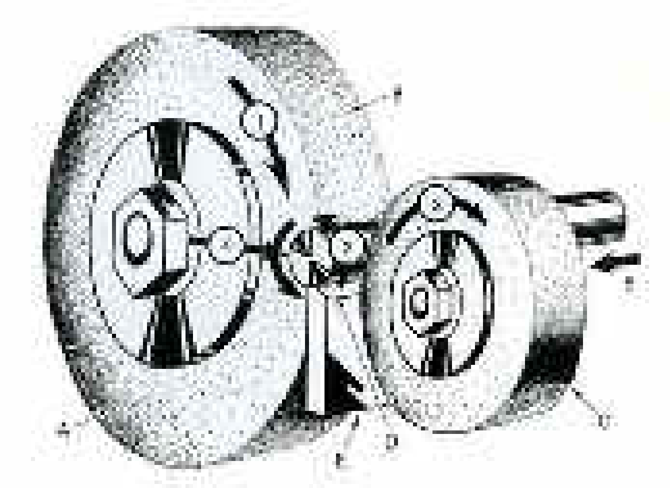
Grinding Process

Grinding is a finishing process used to improve surface finish, abrade hard materials, and tighten the tolerance on flat and cylindrical surfaces by removing a small amount of material.

In grinding, an abrasive material rubs against the metal part and removes tiny pieces of material. The abrasive material is typically on the surface of a wheel or belt and abrades material in a way similar to sanding. On a microscopic scale, the chip formation in grinding is the same as that found in other machining processes. The abrasive action of grinding generates excessive heat so that flooding of the cutting area with cutting fluid is necessary. For material removal, the method used in grinding is called abrasion. In other words, in grinding, an abrasive material rubs against the metal part and clears or removes tiny pieces of material. The process implies that instead of cutting like a lathe bit, the material is slowly and steadily worn away. This is because compared to the material being ground, the abrasive is harder. The grinding wheel actually acts like many hundreds of very small lathe bit, each cutting off some metal. The abrasive must be strong enough to bear any kind of forces acting upon it while grinding. Usually some sort of impact shock occurs when the abrasive comes in contact with the material. Grinding abrades material in a way similar to sanding. The grinding operation is performed on a several machines like the lathe and the mill, with the appropriate add-on accessories, the most important of which is the spindle.

Grinding can be of various types, like as follows:

- Surface grinding
- Centered grinding
- Centerless grinding
- Contour grinding



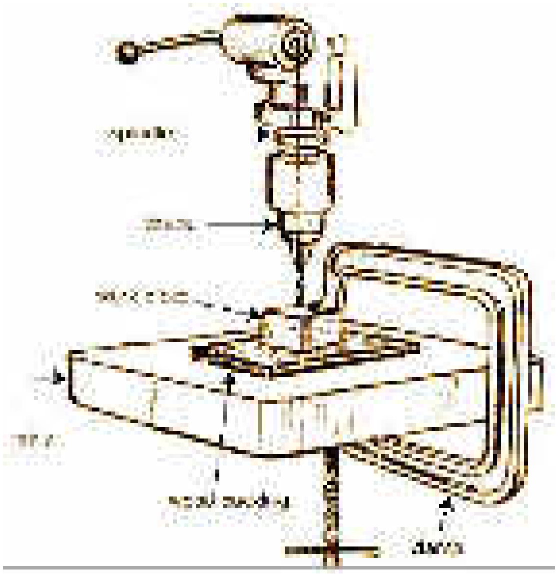
The basic need of the Grinding is the material is too hard to be machined economically. (The material may have been hardened in order to produce a low-wear finish, such as that in a bearing raceway.)

Tolerances required preclude machining. Grinding can produce flatness tolerances of less than ±0.0025 mm (±0.0001 in) on a 127 x 127 mm (5 x 5 in) steel surface if the surface is adequately supported.

Drilling Process

Drilling is the most common machining process whereby the operation involves making round holes in metallic and nonmetallic materials. Approximately 75% of all metal- cutting process is of the drilling operation. Drills usually have a high length to diameter ratio that is capable of producing deep hole, however due to its flexibility, necessary precaution need to be taken to maintain accuracy and prevent drill from breaking.

Drilled holes can be either through holes or blind holes. A through holes is made when a drill exits the opposite side of the work; in blind hole the drill does not exit the workpiece.



Drilled holes are characterized by their sharp edge on the entrance side and the presence of burrs on the exit side (unless they have been removed). Also, the inside of the hole usually has helical feed marks.

Drilling may affect the mechanical properties of the work piece by creating low residual stresses around the hole opening and a very thin layer of highly stressed and disturbed material on the newly formed surface. This causes the work piece to become more susceptible to corrosion at the stressed surface.

For fluted drill bits, any chips are removed via the flutes. Chips may be long spirals or small flakes, depending on the material, and process parameters. The type of chips formed can be an indicator of the machinability of the material, with long gummy chips reducing machinability.

When possible drilled holes should be located perpendicular to the work piece surface. This minimizes the drill bit's tendency to "walk", that is, to be deflected, which causes the hole to be misplaced. The higher the length-to-diameter ratio of the drill bit, the higher the tendency to walk. The tendency to walk is also preempted in various other ways, which include:

Establishing a centering mark or feature before drilling, such as by:

- Spot drilling

The purpose of spot drilling is to drill a hole that will act as a guide for drilling the final hole. The hole is only drilled part way into the work piece because it is only used to guide the beginning of the next drilling process.

- Center drilling

The purpose of center drilling is to drill a hole that will act as a center of rotation for possible following operations. Center drilling is typically performed using a drill with a special shape, known as a center drill. Center drills have a special numbering system.

- Deep hole drilling

Deep hole drilling makes reaching extreme depths possible. A high tech monitoring system is used to control force, torque, vibrations, and acoustic emission. The vibration is considered a major defect in deep hole drilling which can often cause the drill to break. Special coolant is usually used to aid in this type of drilling.

- Gun drilling

Another type of drilling operation is called gun drilling. This method was originally developed to drill out gun barrels and is used commonly for drilling smaller diameter deep holes. This depth-to-diameter ratio can be even more than 300:1. The key feature of gun drilling is that the bits are self-centering; this is what allows for such deep accurate holes. The bits use a rotary motion similar to a twist drill however; the bits are designed with bearing pads that slide along the surface of the hole keeping the drill bit on center. Gun drilling is usually done at high speeds and low feed rates.

- Trepanning

Trepanning is commonly used for creating larger diameter holes (up to 915 mm [36.0 in]) where a standard drill bit is not feasible or economical. Trepanning removes the desired diameter by cutting out a solid disk similar to the workings of a drafting compass. Trepanning is performed on flat products such as sheet metal, granite (curling stone), plates, or structural members like I-beams. Trepanning can also be useful to make grooves for inserting seals, such as O-rings.

- Micro-drilling

Micro-drilling refers to the drilling of holes less than 0.5 mm (0.020 in). Drilling of holes at this small diameter presents greater problems since coolant fed drills cannot be used and high spindle speeds are required. High spindle speeds that exceed 10,000 RPM also require the use of balanced tool holders.

- Drilling in metal

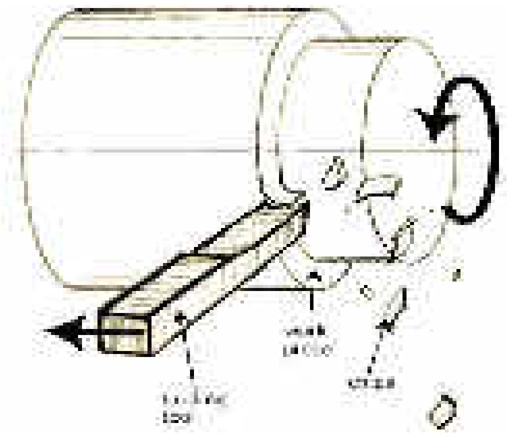
High speed steel twist bit drilling into aluminium with methylated spirits lubricant .Under normal usage, swarf is carried up and away from the tip of the drill bit by the fluting of the drill bit. The continued production of chips from the cutting edges produces more chips which continue the movement of the chips outwards from the hole. This continues until the chips pack too tightly, either because of deeper than normal holes or insufficient backing off (removing the drill slightly or totally from the hole while drilling). Cutting fluid is sometimes used to ease this problem and to prolong the tools life by cooling and lubricating the tip and chip flow. Coolant may be introduced via holes through the drill shank, which is common when using a gun drill. When cutting aluminum in particular, cutting fluid helps ensure a smooth and accurate hole while preventing the metal from grabbing the drill bit in the process of drilling the hole.

For heavy feeds and comparatively deep holes oil-hole drills can be used, with a lubricant pumped to the drill head through a small hole in the bit and flowing out along the fluting. A conventional drill press arrangement can be used in oil-hole drilling, but it is more commonly seen in automatic drilling machinery in which it is the work piece that rotates rather than the drill bit.

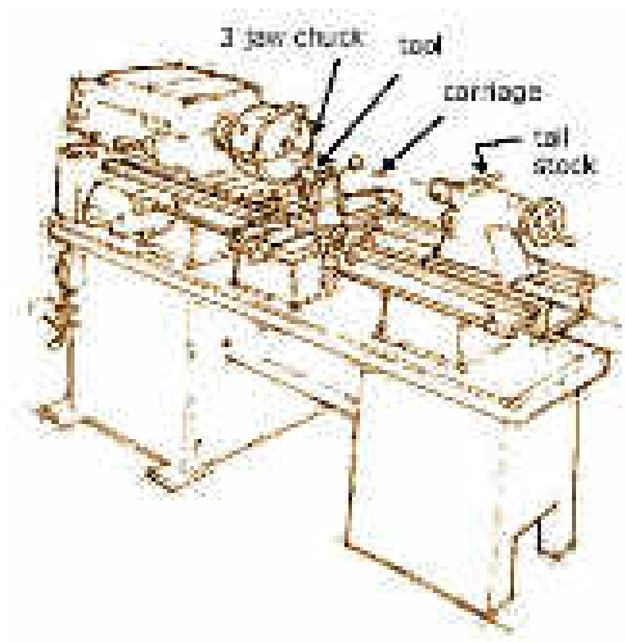
In computer numerical control (CNC) machine tools a process called peck drilling, or interrupted cut drilling, is used to keep swarf from detrimentally building up when drilling deep holes (approximately when the depth of the hole is three times greater than the drill diameter). Peck drilling involves plunging the drill part way through the work piece, no more than five times the diameter of the drill, and then retracting it to the surface. This is repeated until the hole is finished. A modified form of this process, called high speed peck drilling or chip breaking, only retracts the drill slightly. This process is faster, but is only used in moderately long holes otherwise it will overheat the drill bit. It is also used when drilling stringy material to break the chips.

Turning Process

Turning is a form of machining, a material removal process, which is used to create rotational parts by cutting away unwanted material. The turning process requires a turning machine or lathe, work piece, fixture, and cutting tool. The work piece is a piece of pre-shaped material that is secured to the fixture, which itself is attached to the turning machine, and allowed to rotate at high speeds. The cutter is typically a single-point cutting tool that is also secured in the machine, although some operations make use of multi-point tools. The cutting tool feeds into the rotating work piece and cuts away material in the form of small chips to create the desired shape.



Turning is used to produce rotational, typically axi-symmetric, parts that have many features, such as holes, grooves, threads, tapers, various diameter steps, and even contoured surfaces. Parts that are fabricated completely through turning often include components that are used in limited quantities, perhaps for prototypes, such as custom designed shafts and fasteners. Turning is also commonly used as a secondary process to add or refine features on parts that were manufactured using a different process. Due to the high tolerances and surface finishes that turning can offer, it is ideal for adding precision rotational features to a part whose basic shape has already been formed.



Turning is the process whereby a single point cutting tool is parallel to the surface. It can be done manually, in a traditional form of lathe, which frequently requires continuous supervision by the operator, or by using a computer controlled and automated lathe which does not. This type of machine tool is referred to as having computer numerical control, better known as CNC. and is commonly used with many other types of machine tool besides the lathe.

When turning, a piece of material (wood, metal, plastic, or stone) is rotated and a cutting tool is traversed along 2 axes of motion to produce precise diameters and depths. Turning can be either on the outside of the cylinder or on the inside (also known as boring) to produce tubular components to various geometries. Although now quite rare, early lathes could even be used to produce complex geometric figures, even the platonic solids; although until the advent of CNC it had become unusual to use one for this purpose for the last three quarters of the twentieth century. It is said that the lathe is the only machine tool that can reproduce itself.

The turning processes are typically carried out on a lathe, considered to be the oldest machine tools, and can be of four different types such as straight turning, taper turning, profiling or external grooving. Those types of turning processes can produce various shapes of materials such as straight, conical, curved, or grooved work piece. In general, turning uses simple single-point cutting tools. Each group of work piece materials has an optimum set of tools angles, which have been developed through the years.

The bits of waste metal from turning operations are known as chips (North America), or swarf (Britain). In some areas they may be known as turnings.

Turning specific operations include:

- Hard turning

Hard turning is a turning done on materials with a Rockwell C hardness greater than 45. It is typically performed after the work piece is heat treated.

The process is intended to replace or limit traditional grinding operations. Hard turning, when applied for purely stock removal purposes, competes favourably with rough grinding. However, when it is applied for finishing where form and dimension are critical, grinding is superior. Grinding produces higher dimensional accuracy of roundness and cylindricity. In addition, polished surface finishes of Rz=0.3-0.8z cannot be achieved with hard turning alone. Hard turning is appropriate for parts requiring roundness accuracy of 0.5-12 microns, and/or surface roughness of Rz 0.8–7.0 microns. It is used for gears, injection pump components, hydraulic components, among other applications.

- Facing

It is part of the turning process. It involves moving the cutting tool at right angles to the axis of rotation of the rotating workpiece. This can be performed by the operation of the cross-slide, if one is fitted, as distinct from the longitudinal feed (turning). It is frequently the first operation performed in the production of the work piece, and often the last-hence the phrase "ending up".

➥ Parting

This process is used to create deep grooves which will remove a completed or part-complete component from its parent stock.

➥ Grooving

Grooving is like parting, except that grooves are cut to a specific depth by a form tool instead of severing a completed/part-complete component from the stock. Grooving can be performed on internal and external surfaces, as well as on the face of the part (face grooving or trepanning).

Non-specific operations include:

➥ Boring

Machining of internal cylindrical forms (generating) a) by mounting work piece to the spindle via a chuck or faceplate b) by mounting work piece onto the cross slide and placing cutting tool into the chuck. This work is suitable for castings that are to awkward to mount in the face plate. On long bed lathes large work piece can be bolted to a fixture on the bed and a shaft passed between two lugs on the work piece and these lugs can be bored out to size. A limited application, but one that is available to the skilled turner/machinist. In machining, boring is the process of enlarging a hole that has already been drilled (or cast), by means of a single-point cutting tool (or of a boring head containing several such tools), for example as in boring a cannon barrel. Boring is used to achieve greater accuracy of the diameter of a hole, and can be used to cut a tapered hole.

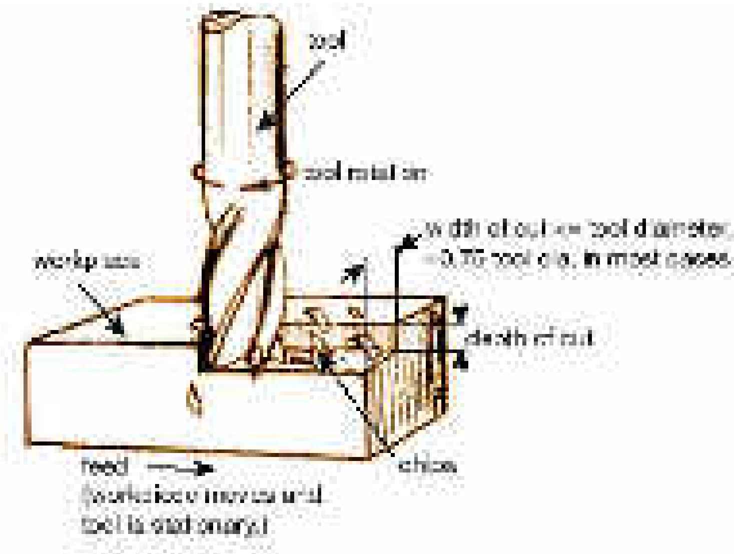
There are various types of boring. The boring bar may be supported on both ends (which only works if the existing hole is a through hole), or it may be supported at one end. Lineboring (line boring, line-boring) implies the former. Backboring (back boring, back-boring) is the process of reaching through an existing hole and then boring on the "back" side of the workpiece (relative to the machine headstock).

➥ Knurling

The cutting of a serrated pattern onto the surface of a part to use as a hand grip using a special purpose knurling tool.Threading both standard and non-standard screw threads can be turned on a lathe using an appropriate cutting tool. (Usually having a 60, or 55° nose angle) Either externally, or within a bore. [Generally referred to as single-point threading. tapping of threaded nuts and holes a) using hand taps and tailstock centre b) using a tapping device with a slipping clutch to reduce risk of breakage of the tap threading operations include a) all types of external and internal thread forms using a single point tool also taper threads, double start threads, multi start threads, worms as used in worm wheel reduction boxes, lead screw with single or multi start threads. b) by the use of threading boxes fitted with 4 form tools, up to 2" diameter threads but it is possible to find larger boxes than this.

Machining Process

Conventional machining, one of the most important material removal methods, is a collection of material-working processes in which power-driven machine tools, such as lathes, milling machines, and drill presses, are used with a sharp cutting tool to mechanically cut the material to achieve the desired geometry. Machining is a part of the manufacture of almost all metal products, and it is common for other materials, such as wood and plastic, to be machined. A person who specializes in machining is called a machinist. A room, building, or company where machining is done is called a machine shop. Much of modern day machining is controlled by computers using computer numerical control (CNC) machining. Machining can be a business, a hobby, or both.



2.4 CURRENT POLICIES AND INITIATIVES OF LOCAL BODIES

Various incentive schemes of state and central government are available to the units. However, these incentives are available only for capital expenditure and are tied with availing of loan. There are no schemes available exclusively to promote energy efficiency projects. Financial Institutions like SIDBI offer credit at concessional interest rate for Energy Efficiency Projects , under the scheme of KFW line of credit & AFD line of credit. **The detailed schemes for energy efficiency is given in annexure - 5**

2.5 ISSUES RELATED TO ENERGY USAGE AND CONSERVATION AND BARRIER IN TECHNOLOGY UP GRADATION

Typically second tier industrial establishments in India lack the technical expertise to identify and evaluate energy efficiency technologies and products. They also do not have internal financial resources and need external capital to fund EE projects. Further, they need assistance in identifying and managing technical and financial risks. Major barriers in up-gradation of technology in the cluster are:

- Lack of awareness on energy efficiency

- Energy efficiency not on priority list
- Lack of instrumentation and non-availability of data
- Limited technical manpower
- Non availability of funds to implement energy conservation measures

2.5.1 Energy availability

Reliable and quality power is available in the cluster . Power cuts are imposed, mainly in peak season such as the summer. Some units have back up power in the form of emergency DG Sets to have incessant working. Some units operate only during the availability of state power supply.

Major Source of energy for the industry is Electricity. For running DG sets as alternative power supply source, some industries are making use of Diesel. There is no other form of energy usage. Availability of Diesel is not an issue for these industrial units.

2.5.2 Technological issues

Out of all the machinery required by the cluster for milling, turning, drilling etc, most of the machinery in small and medium enterprises is purchased on second hand from Europe at solvent value. When countries in Europe upgrade their technological requirements of the machines, they sell these old machines to India. Some small industries are banking on the locally produced machines for their requirement

None of the outside machinery supplier has any Dealership or Service Point in Bangalore. Thus, after sales service is always a problem for all the machinery.

Further more, non-availability of local quality consultants is the biggest roadblock in penetration of modern technology. There is only one Demonstration Centre under the control IMTMA to exhibit the working of new and modern machinery.

Every unit has different process and products . However, there is strong possibility of taking best practices of one unit to all other units.

2.5.3 Financial issues

The units in the cluster are favourable to the idea of taking loans. However, there are preconceived notions on investments of energy efficient technologies, that they support only economies of scale operations.

The units here are literally free of any encumbrances and are fit case for extension of loans.

It is strongly felt that rather than packaging the finances with incentives like lower interest rates and subsidy etc., the delivery mechanism of loans needs to be facilitated by proactive and transparent methodologies.

Above all, the extension of any such facility needs to be time bound and decision like yes or no should be given immediately and firmly in numerous cases, the banks initially agree for extending loan and then suddenly refuse in the last minute creating a situation of desperation among entrepreneurs.

CHAPTER - 3

3.0 Energy audit and technology assessment

3.1 ENERGY AUDIT AND TECHNOLOGY ASSESSMENT IN CLUSTER

A team of competitive engineers and energy auditors having excellent experience in the machine tools industies and SME clusters was involved in carrying out the study at Bangalore Machine tools cluster. A well planned methodology was followed to execute energy use and technology audit studies and to achieve the desired objectives of project. Major steps which were followed during the energy use and technology studies of the project are mentioned below:

- Identify areas of opportunity for energy saving and recommend the action plan to bring down total energy cost
- Identify areas of energy wastages in various sections and suggest measures for minimizing energy losses or suggest alternative energy saving measures that can effectively replace inefficient process
- Conduct energy performance evaluation and process optimization study
- Conduct efficiency test of equipments and make recommendations for replacement with more efficient equipment with projected benefits
- Suggest improved operation & maintenance practices
- Provide details of investment for all the proposals for improvement
- Evaluate benefits that accrue through investment and payback period

3.1.1 Pre-energy use & technology audit studies

Machine tool units in Bangalore SME cluster have organized themselves into different associations. However, Karnataka Small Scale Industries Association, Peenya Industrial Association, Bangalore Machine Tool manufacturers Association are such associations covering maximum number of industries of the cluster. A brief information and the major activities performed by these associastions is as follows.

Karnataka Small Scale Industries Association, Bangalore

Kassia is a premier voluntary state level non Government Institution of Small Scale Industrialists. It is a registered body under the Kamataka Societies Registration Act and is functioning on democratic lines with regular Annual General Body Meetings, election of Council Members and Office Bearers and adhering to the constitutional Byelaw and conventions.

It is managed by a Council of Management consisting of President, Vice President, the immediate Past President (Ex-officio Member) and 37 members directly elected by the General Body. Past Presidents and Special Invitees are also part of the system.

It is primarily responsible for policy formulation and imparting guidance and direction to the affairs of the Association.

A permanent Secretariat looks after the implementation of policies and day-to-day administration, under the guidance of the Office Bearers.

Kassia is an ISO-9001 -2001 certified organization.

Table 3.1: Details of Karnataka Small Scale Industries Association

Particulars	Information
Contact Person	Mr. S. S. Biradar
Profile	President
Contact Details	Karnataka Small Scale Industries Association, 2/106,17th Cross, Magadi Chord Road, Vijayanagar,Bangalore-560 040 Phone : 080 - 23358698 / 3250 Fax:080-23387279, E-mail:kassia@dataone.in Web: www.kassia.com

Peenya Industrial Association, Bangalore

The Peenya Industrial Complex established in the early 1970's is the biggest and one of the oldest Industrial Estates in the whole of South East Asia, located at the Northern part of the BangaloreCity. This complex comprising of the Peenya Industrial Area formed by KIADB and the Peenya Industrial Estate formed by KSSIDC which was started with a few industries is now spread over an area of about 40 sq.kms comprising about 4,000 Small Scale Industries and a few Medium Scale Industries.

Table 3.2: Details of Peenya Industrial Association, Bangalore

Particulars	Information
Contact Person	Mr. K.B. Arasappa
Profile	President
Contact Details	Peenya Industrial Association, 1st cross, 1st stage, Peenya Industrial Estate, Bangalore-560 058 Phone : 080-28395912/6351/6628 Web:www.peenyaindustries.com

Bangalore Machine Tool manufacturers Association, Bangalore

The association provided a platform for development of mutual understanding among the industries and discussions relating to common problems and identification of viable solution for that. Therefore, as a first step for making inroad in the cluster, the association and its office bearers were approached. Detailed discussions with the association were held on apprising the association about the objective of the project, tentative schedule of the activities being undertaken and expected project outcome.

The office bearers of associations were apprised about benefits of the project for the industries and the cluster. The association took up the task of dissemination of all this information among their respective member units. The outcome of this activity was introduction of project concept to the association and later on to the industry. This helped in identification of progressive and interested entrepreneurs out of the whole lot.

Table 3.3: Details of Bangalore Machine Tool Manufacturers' Association

Particulars	**Information**
Contact Person	Mr. Narendra. M. Dube
Profile	President
Contact Details	Bangalore Machine Tool Manufacturers' Association, 477/A ,4th Phase, Peenya Industrial Estate, Bangalore-560 058 Phone : 080-4080 5555, Fax:080-40805510 Mob.no:09343806661

3.1.2 Preliminary energy audit studies

21 numbers Preliminary Energy Audit studies were conducted in Bangalore machine tool cluster. The methodology followed in preliminary energy audit study is as presented below:

- Collection of past energy consumption details and energy bill
- List out major energy consuming areas of the plant
- Existing technology of various processes and utilities (latest or old, crude or efficient, local or reputed company make etc)
- Identification of the areas for special attention for low cost measures with quick payback period
- Understanding the detailed process with energy and material balance
- Establish specific energy consumption, if possible for the each typical equipment/process

- Identify the areas for detailed energy audit study and measurements required

3.1.3 Detailed energy audit studies

9 numbers Detailed Energy Audit studies were conducted in Bangalore machine tool cluster. Methodology followed in detailed energy audit study is presented below:

- Collection of past energy consumption details and energy bill
- List out major energy consuming areas of the plant
- Existing technology of various processes and utilities (latest or old, crude or efficient, local or reputed company make etc)
- Status of instruments installed in the plant and necessary instrumentation required for the detailed study
- Identification of the areas for special attention for low cost measures with quick payback period
- Understanding the detailed process with energy and material balance
- Monitoring & measuring of different parameters of various equipment / machines to evaluate performance
- Collection of operational data from various measuring instruments / gauges installed in the plant
- Compilation of design data/name plate details of various equipment from design manuals and brochures
- Discussions with concerned plant personnel to take note of operating practices and shop-floor practices being followed in the plant and to identify specific problem areas and bottlenecks if any with respect to energy consumption
- Critical analysis of data collected and parameters monitored
- Identification of energy wastage areas and quantification of energy losses
- Identification of suitable energy conservation measures for reducing energy consumption

3.2 OBSERVATIONS MADE DURING ENERGY USE AND TECHNOLOGY AUDIT

3.2.1 Manufacturing process and technology/equipments employed

The Bangalore machine tools cluster is having the mixed type of process machinery at all. In general, units in the cluster are having the conventional as well as the high-end CNC machinery for the various processes of tooling. The common process diagram for machine tools cluster is given and discussed in chapter – 2 in detail. The utility in the machining is not contributing significant therefore; it has been observed that the most of the units are using the old technologies in very inefficient manners. The compressed air system, electrical motors and lighting system mainly contributes to utility sections. The major observations in utility area is given in table 3.2

Table 3.4: Details of Peenya Industrial Association, Bangalore

Technology/Equipments	Major Observations
Air Compressors	The air compressors used in the cluster are reciprocating type with very old technology. The efficiency of these compressors found between 60% and 80% with the loadings also being rather low at times. The higher generation pressure was also observed.
Electrical Motors	The motors used in the cluster are normal motors of efficiencies between 60% and 80% with the loadings also being rather low at times. The power factor of these motors was observed to generally lower than the best operating 0.87.
Lighting System	The present lighting system of the units are conventional and using the FTL with conventional ballast, GLS and MVL which are consuming high electricity.

Major energy consuming equipments installed in typical machine tools units in Bangalore clusters are:

- Conventional Milling
- CNC Milling
- Conventional Turning Machine
- CNC Turning Machine
- Surface Grinding Machine
- Mixing Mill
- Vertical Turret Lathe
- Horizontal Boring Machine
- Drilling Machine
- Crane
- Hydraulic Press
- Heat Treatment Furnaces

3.2.2 Energy consumption profile & availability:

Electricity from the BESCOM grid is the primary source of electrical energy in general and does not use any thermal energy except for diesel for generating the power through Diesel generator. The detailed observation and analysis of the collected and measured data revels that the energy cost comprises about 5 - 8% of the total production cost. The major units having the LT connection from the BESCOM at 440 volt supply whereas some of the units have taken HT connection at 11 kV. The average electrical energy cost is Rs.4.57/- per unit (kWh).

The energy consumption profile of the Bangalore machine tool cluster is given in table 3.2.

Table 3.5: Energy Consumption Profile

Parameters	Unit	Energy Consumption Profile
Annual Electrical Energy Consumption	kWh/year	2,26,79,100
Annual Electrical Energy Consumption	GJ/Year	81,659
Diesel consumption for Electricity generation	Lt/Year	99,376
Annual Diesel consumption	GJ/Year	3,537
Total energy consumption	GJ/Year	85,196

The major energy consumption of the unit is in production area (Grinding, turning, milling and drilling) whereas utility (compressed air system) and general facility (Lighting and Computers) consumed a little fraction of total annual consumption. The process machinery consumes about 77% of the total energy consumption whereas utility section is consuming merely 23%.

Percentage energy consumption of various utilities in typical machine tool indusry, in overall energy consumption is furnished in the figure below:

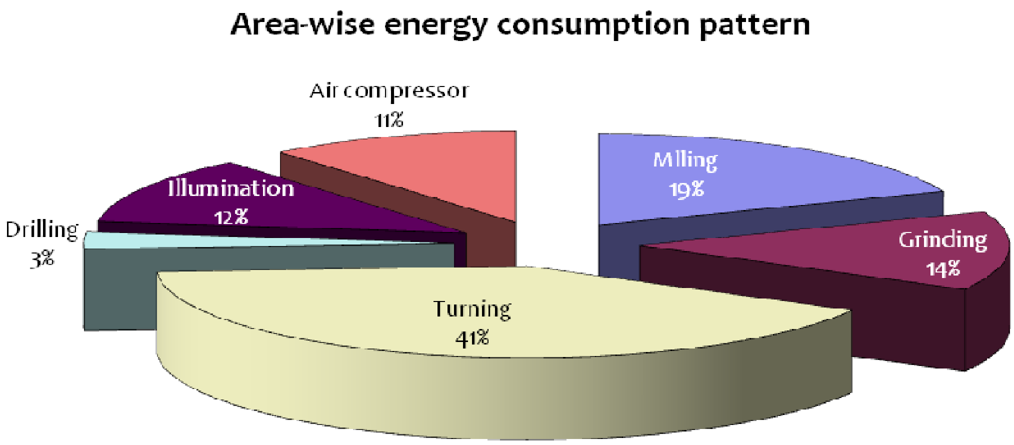


Figure 3.1: Energy consumption of different sections/utilities in Bangalore SME Cluster

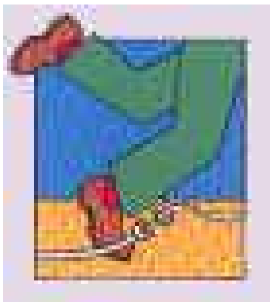
3.2.3 Capacity utilization factor

These industries do not have a standard design or nameplate capacities per say. This is due to the nature of industry, which makes different types of products in large numbers catering to variety of industries cutting across all sectors. The production capacity is considered as the weight of the metal removed in case of components, accessories and SPM making industries. In case of Heat treatment, weight of the material treated has been considered as the production capacity.

Therefore, it is not possible to estimate the capacity utilization factor for these type of units in the cluster, however the plant operation or plant load factor is about 55%.

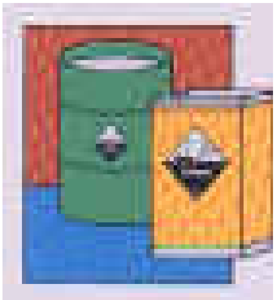
3.2.4 House keeping Practices

Majority of the Machine tool units in Bangalore Cluster maintain very poor operational practices in different utilities. There are no specific procedures to be followed in any of the units for the operation of the various equipments.



Good housekeeping is the best method of controlling the risks of injury and fire within a facility. Operating experience clearly indicates a significant increase in mishaps related directly to poor housekeeping practices. To be an effective risk management tool, housekeeping must include the following considerations:

- Storage space must be physically adequate for the volume of materials being stored. If it is inadequate, and adequate space cannot be obtained, dispose of the material.
- Stored materials must be in a stable configuration in order to permit safe access, avoid clutter, and minimize the hazard of falling materials.



- Materials stored together must be compatible. Materials must not contribute to, or cause ignition of, other materials, nor enhance their rate of combustion once ignited.
- The fuel load (amount of combustible material) within a storage area must be consistent with the fire detection system and the risk management criteria for the area and the building. Questions can be referred to the Ames Fire Marshal or the Safety Division.
- Working and walking surfaces should be dry, smooth, and free of general clutter and provide good traction for walking.
- Equipment and tools, especially those with sharp surfaces, must be kept in their designated storage location when not being used.