UNIDO ICAMT PROJECT ON TECHNOLOGY UP-GRADATION AND PRODUCTIVITY ENHANCEMENT OF FOUNDRY INDUSTRY AT COIMBATORE AND BELGAUM

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Abstract

The UNIDO ICAMT project on Technology Upgradation and Productivity Enhancement of Foundry industry in Belgaum and Coimbatore supported by Department of Industrial Policy and Promotion (DIPP), Ministry of Commerce and Industry, Government of India, has 50 SME foundry units comprising 25 at each of the two clusters at Belgaum and Coimbatore. The project was initiated after a detailed diagnostic study undertaken in each of the selected units followed by a perspective and action plan addressing key areas such as productivity, technology, skills, quality up-gradation etc.. Currently the implementation of the action plans both at the individual level and at the level of the cluster is underway and is focusing on several areas including casting development process, gating systems, casting defects, rejection data/analysis/actions. Energy efficiency measures including expertise on induction furnace lining life and efficient melting practice, etc. Furthermore, improvements on cupola design and performance is also being addressed. Marketing strategies to expand domestic and export markets including domestic and international missions have been organized. Process changes, parameters & control, product costing, CNC machining, plant layout, equipments selection, IPR awareness, supervisory skill development, HR practices, etc. are other areas of interventions. Several other interventions addressing family management program and technical seminars on key foundry technologies are also being planned. The ultimate aim of the project is to bring about necessary incremental and effective changes in the foundry units and be a catalyst for the firms to become a quality producer with technological and profitable volume growths.

Introduction

United Nations, established in 1966 UNIDO (United Nations Industrial Development organization) as an autonomous body within it and it was converted in to a specialized agency in 1979. The mandate of UNIDO is to promote and accelerate inclusive sustainable industrial development in developing countries and economies in transition. In recent years, UNIDO has assumed an enhanced role in the global development agenda by focusing its activities on poverty reduction, inclusive globalization and environmental sustainability. The Organization draws on four mutually reinforcing categories of services: technical cooperation, analytical and policy advisory services, standard setting and compliance, and a convening function for knowledge transfer and networking. The additional new focus areas are gender equality and empowerment of women, south-south and triangular cooperation and 48 least developed countries.

UNIDO ICAMT (International Center for Advancement of Manufacturing Technology), headquartered in Bangalore and a project office in New Delhi, works closely with micro, small and medium enterprises (MSMEs) in the manufacturing sector, government institutions, R & D institutions, universities, professional societies to diffuse technological knowledge, innovations and build technology partnerships to bridge the technology divide. UNIDO ICAMT provides it's services by developing and implementing demonstrative, tailor made projects and programs, for upgrading technology of industrial sectors of high importance and relevance. Currently three programs are on going for technology up-gradation and productivity enhancement in machine tools (6 clusters), plastics (5 clusters) and foundries (2 clusters). The project deliverables are being regularly monitored through key performance indicators (KPI) which have been fixed for each project.

Selection of foundry units

Early in 2012, UNIDO ICAMT organized sensitization programs along with its partners in the project, COINDIA in Coimbatore and BFC in Belgaum. The project details were explained and interested foundry units were requested to apply through pre assessment forms. After receipt of applications, UNIDO ICAMT's expert visited each applicant foundry and after initial assessment as per it's standard criteria, 25 SME sector foundry units at each location for the project were selected. Diagnostics studies were done on each of the firms and an action plan was drafted for each one. All firms were obligated to provide data as requested for, to enable UNIDO ICAMT to evaluate the firm's performance and also to update the project stakeholders on the progress of the project. Salient base line statistics of the cluster units at the start of the project is given in annexure A. It indicates the wide spectrum of the foundry units across various parameters. A number of intervention training sessions were conducted and are being followed up in each cluster unit.

UNIDO ICAMT Interventions

Sample casting development:

Once an enquiry is received, the whole sample development process to be followed until the casting is cleared for bulk production was explained. Feasibility to meet all requirements of the customer and the part's functioning in the final product should be understood before quoting for the product. Commercial terms should be clearly specified and mutually agreed upon before acceptance of an order. In many of the small cluster firms in Coimbatore, especially those catering to the local pump industry, mounted patterns are with gating systems by the customers, who have little knowledge of yield, productivity, rejections, etc. Such foundry units have been reluctant to make any changes even for quality and productivity improvements. Customer should be advised to get the pattern done as per the layout given by the foundry or give the order to the foundry itself, which in turn will get the pattern done as per it's layout. All pattern equipment should preferably done only through the CNC route to ensure dimensional accuracy. After doing optimum methoding, including usage of solidification software where required, the sampling process methodology, which was explained, has to be followed strictly. It involves issue of sample and method sheets, production of first sample, trial lot and final production lot, all cleared after full machining. Production personnel will be involved at all stages of development. The concept is 'RIGHT THE FIRST TIME'. No shortcuts during development quoting 'customer's urgency' is acceptable. This enables the foundry to deliver a new item in a short time and will have least problems at later regular production stages including rejections due to pattern equipment. The complete procedure has to be redone whenever there is any modifications in the design of the component, metal grade or any methoding/process change.

Scientific gating systems:

The principles of scientific pressurized and unpressurised gating systems were explained at each cluster unit for not only development staff but also to production staff. Many of the cluster units have taken this exercise very seriously. One steel casting unit had good orders for item; but was unable to fulfill the demand due to high inclusions, leading to rejection or rework. Annexure B indicates the flow of castings after implementation of new gating systems which in turn increased their turnover. The same unit developed 27new steel castings with scientific gating systems along with the use of solidification software and all them were developed 'RIGHT THE FIRST TIME'.

One foundry, which has more than 300 items, is implementing scientific gating systems at one item almost every two days and reaping rich benefit in the form of yield improvement and rejection reduction. The use of filters have been eliminated in most cases. It has already completed more than 90 items. Annexure C 1 and C 2 gives a glimpse of the approximate savings achieved by one foundry from only 14 items and another foundry from only 26 items. There is a problem in Coimbatore in implementing it in pump items due to customers insisting on the units not to alter the systems given by them. A way has to be found out to over come it.

Defects and it's causes, Rejections – it's recording, root cause analysis and corrective actions:

Training was given to explain various types of defects and the main causes for their occurrence. Many of the defects were not even being identified properly. A number of cluster foundry units were not even maintaining the data of rejection percentage. Some units were

maintaining some sort of data and invariably, most of the rejections were attributed to faults of the operators. It has to be stated here that only 10% of the rejections is normally due to operators and 90% is due to pattern equipment and improper process controls. The first task was to see that all the cluster units start maintaining accurate data of rejections – a. foundry stage - date wise, heat wise, item wise and cause wise, b. customer end/machine shop stage – heat wise and cause wise. This enables the unit to first focus on the repeated rejections. The units were advised to start analyzing the defects to determine the root cause. This might require going back from the rejection yard to the pattern, core box, core/mould station, laboratory, melting, fettling section, etc. Sometimes, the causes may not be quite apparent and one may have to resort to the use of statistical methods. Once the root cause is established, the decided corrective actions has to be undertaken by a designated person and see it through. If the defect persists even afterwards, it means that the corrective action taken is not correct and the process has to be restarted once again. UNIDO ICAMT is happy to state that the total cluster rejection was brought down from 9.52% to 8.1% in the year 2012-13. This translates to substantial cost saving to the cluster units.

Induction furnace lining procedure, sintering, lining life and efficient melting:

Induction melting section is one of the major areas of power consumption and it was focused. A training session was conducted on the selection of a furnace and lining materials, correct lining methodology, sintering procedure, etc. Efficient melting practice to achieve lower power consumption and higher output was explained. Units were asked to charge foundry returns after cleaning of any adhering sand. Preheating of ladles with ladle preheater, covering of ladles and furnace whenever possible to reduce temperature loss, procedure for shut down and restart of furnace, cleaning of lining after each heat, etc. were emphasized. The inputs are being followed up at regular intervals in the units. One of the first problems faced was the non-availability of power consumption recording meters for the furnaces and axillaries. A benchmark target (for furnaces working round the clock) of 1 ton of liquid metal (CI and SG) production for every kilogram of ramming mass used was specified. One unit has achieved 1.4 tons of liquid metal in one campaign and several have crossed bench mark. One foundry's performance indicates that it will reduce by half the number of linings and sintering in a year. Many units have achieved considerable improvement of lining life and reduction of energy consumption per ton of liquid metal.

Marketing strategies:

In Coimbatore, bulk of the iron foundry units are supplying castings to the local pump and motor market which is highly competitive and in many cases, the prices are determined by market forces. Many a time, the customer withdraws the patterns and bring them back after some weeks. The margins are very low. The aluminum foundry also caters to the competitive two wheeler market. In Belgaum, the bulk of the supplies is to the automotive and diesel engine industry. Most of the foundry units cater to the very few industry segments and customers. Hence the SMEs are totally dependent on the fortunes of it's frugal customer range. In 2012-13, many of the units faced production downtrend due to these reasons. Unfortunately, marketing activity is almost non-existent. UNIDO ICAMT is advocating it's cluster members to focus on this activity to widen their exposure to more industries and customers. Emphasis is also on exports. This is the only way one can reduce the impact of a recession. Various techniques of using the web and net was explained. Once a potential customer was identified, the way of approach with a good profile, web site, presentation, etc. was indicated. The way one should go about during personal visits of customer to the foundry or the foundry owner/marketing person to the customer was demonstrated. A high emphasis was placed on the house keeping of the foundry at all times and organized way of working on the shop floor, which in turn will give a good impression for any visiting customer. UNIDO ICAMT is happy to state that some of the cluster firms have taken this exercise seriously and have started reaping the benefits of the exercise. Some of the cluster units in Coimbatore have started to look for customers outside the city. In 2012 – 13, the number of cluster firms who export rose from 7 to 11. Two units are focusing on increasing their export share of turnover year after year. One of the units sent a container load of castings to **China** and wants to be known as an exporter to all parts of the world. It is the desire of UNIDO ICAMT that every cluster foundry decides on a business strategy and starts focusing on it to grow and prosper.

Many induction melting units are not working round the clock, thus underutilizing their capacities. The main lacuna for the situation was poor marketing. Overhead and power costs can come down if they work round the clock. One cupola foundry in Coimbatore is working round the clock with two cupolas, each one of them working on alternate days. Another foundry has installed the second cupola and is focusing on marketing to generate the load to work round the clock.

The bane of the foundry industry is the concept of rate per kg for quoting and invoicing. Today, programs are available to arrive at the weight of the casting easily from a 3 D model. In fact, UNIDO ICAMT is propagating the idea of offering only machined castings on a rate per piece basis. It is already catching up in majority of the units in Belgaum and very slowly in Coimbatore.

Product costing:

Costing is practiced mostly in bigger units in a general way. In many foundry units, the price is one for a single customer irrespective of the yield of the casting. Sometimes, process grouping are made for pricing. These will not reflect the correct cost incurred for a particular casting. Many items would be incurring losses or at low margins. All these are forgotten as long as the foundry is showing an overall profit. UNIDO ICAMT conducted an awareness program on the way the foundry has to go about costing each and every casting and it will take some time to take roots in foundry units. A simple excel sheet concept was proposed for it and the cost figures are automatically updated when any price or process changes are updated.

Awareness of energy efficiency:

Apart from energy efficiency in induction furnaces, there are various other areas of energy consumption. One major area is compressed air production and distribution. There are a number of pumps, motors, D G set, furnaces, etc. An awareness program was held to address as to how to assess energy efficiency at each energy consumption location and take action.

Foundry casting technology:

Inputs were given by an international organization on metallurgy, sand control and process controls. This is a subject that is too vast and only fundamentals were touched. However, each of the foundry units do come across with different problems. UNIDO ICAMT experts help with any problems or doubts in the various areas so that the units are able to meet the customer requirements.

Many of the cluster foundry units are following the cake moulding method with green sand. Some make the cake moulds manually or by using the jolt squeeze moulding machines. Many have not gone into moulding with mould boxes mainly due to it's high cost of investment. The cake moulds are kept on the floor and the gap between the moulds is packed with sand. This whole process is low on productivity and also with high rejection levels inherent with the process itself. One unit successfully implemented pouring of the cake moulds using jackets and some more are contemplating going in for it. This increases productivity, reduces handling of sand and avoids rejections occurring due to the packing process. The cake mould with jacket kept while metal pouring is nothing new; but had gone out vogue. In fact, many modern high pressure moulding lines with cake moulds use jackets with weights!

Casting Machining:

As stated earlier, UNIDO ICAMT is encouraging its cluster members to gradually change in order to supply castings mainly in machined condition. There are certain customer problems about this issue particularly in Coimbatore. Some units have machine shops with or without CNC machines. Some get the castings machined through sub contract process. Towards this end, a program was conducted on the basics of selection of a CNC machine and also basic programming methodology for CNC turning and vertical machining centers. Possibility of improvement of cycle times was also explained, which can in turn lead to improved productivity.

Core process and its productivity:

Many of the cluster foundry units are following the oil sand process for core making – self setting in Coimbatore and oven baking in Belgaum. The process was more prevalent in Coimbatore. The process is labour intensive, requires large space, has low productivity, poor dimensional accuracy, non-uniform baking and finally, as such, could lead to high rejections. The main reason for the continued use of the process was not thinking of a change of a process that has been in use for a long time. There was also a thinking that the process was cheaper than all other processes. UNIDO ICAMT explained the advantages of

change over to cold box process in counteracting the problems of the oil sand process. Intensive lobbying by UNIDO ICAMT persuaded most of the firms to either change over or order for the cold box core shooters. Even rejection percentage of cores itself was also reduced.

Many units who had cold box core shooters, were utilizing the machines with available core boxes. Some of the machines had only a round manifold for single point shooting. Such units were asked to ask the shooter manufacturer to supply a rectangular manifold for multipoint shooting along with required changes in air supply. The possibility of higher productivity by going in for better designed multi cavity core boxes utilizing the full capacity of the machine, with the return on investment (ROI) of the new core box being only a month/months was explained and it is gaining ground in many of the cluster firms.

Shell core making is also prevalent in many units. The process is costly due to high sand and tooling cost. It is also energy intensive and has low productivity. It also suffers from variations in curing due to dependence on operators. There was a reluctance to even consider change in process to cold box. Use of mandrels for some of the cores to make them hollow, assured higher productivity and possibility of lower rejections due to consistent core quality, etc., were also explained. Slowly the units are accepting the advantages of the changeover. One foundry which had only shell core process procured one vertical cold box core shooter. Immediately, the available core box being used in the shell core shooter was used and subsequently a new core box was designed. The details given in Annexure D indicates the huge increase in productivity.

Suggestion has been given to replace the shell mould process with cold box cake moulds made in the cold box core shooter. The core box for the cake mould is under process and will be tried shortly. This will not only reduce the cost but also improve productivity. Both vertical and horizontal stacking is possible. Let us be clear that not all shell cores and shell moulds can be replaced by the cold box process.

Sodium silicate – CO2 process is also being used by some units to produce bigger size cores. The main reason quoted was easy production and lower cost. The advantages of switching over to no bake process was explained. A few units have discontinued the CO2 process and obtained the advantage of easy knockout, better finish and lower rejections. There is no need for throwing out all the no bake sand as is the case with the CO2 process sand.

Equipment selection and layouts:

Inputs are given to the cluster firms on the selection of equipments. For those who wish to go for partial or full mechanization of the plant or even a new green field proposition, inputs are given on the layout. Layout changes to improve productivity is also being suggested in some of the units. Two units have expanded with new units in an industrial area location in Coimbatore. One of them has installed a high pressure green sand moulding line, which has been manufactured for the first time by a local manufacturer. Mechanization of sand plant and moulding is on in two units. Two units have switched over from cupola to induction melting to cater to more value added castings. Two more

units are proposing for expanding with additional new units and one unit intends to modernize the existing facility. Four units who wanted to go in for spectrometers came together and procured them at a low price indicating the power of a group negotiation.

National and international missions:

Two international missions were conducted in 2013. The first one was a delegation of cluster members to CASTEXPO 2013 held in April at St. Louis, USA. The objective of the mission was to expose the delegates to modern technology. The second one was to MIDEST 2013 held in November at Paris, France. Two of the cluster members exhibited their products taking a stall while the others visited the exhibition. The objective of the mission was to expose the members to explore possibility of exports to Europe. Work visits was arranged to two foundry units to showcase to the delegates the use of modern technologies, plant layout and work ethics.

One national mission is now on with a delegation attending the ongoing Foundry congress and visiting the exhibition. UNIDO ICAMT is also participating in the exhibition with a stall showcasing it's cluster program. The objective of the mission is to expose them to technology through presentations at congress and observing the products of exhibitors. Some of them are attending the cast source meet to expand their clientele and some are going on the works visits to see some good foundry units.

Skill development of supervisors:

UNIDO ICAMT felicitated it's members to participate in the certification course on Foundry Technology developed by Belgaum Foundry Cluster (BFC) with a local engineering institution in Belgaum to impart technical training to the supervisors working with their members. The successful completion of the first program has paved the way for another such programme in the near future.

Housekeeping and environment:

UNIDO ICAMT places a high emphasis on housekeeping and work environment. Some of the units have responded positively with right earnest. Concentration is on in areas of dust and fume generation. Focus is also on keeping all areas including gang ways clean and orderly. UNIDO ICAMT will continue to focus on it during the rest of the project. One unit which is quite serious about environment celebrates 'Environment Day' every year and has planted 188 saplings in and around its works.

Human Resource issues:

An exercise was undertaken by UNIDO ICAMT to understand the various H R issues in some of the units at the two clusters. It also included issues like safety, health, compliance with statutory laws and issues, etc. Based on the inputs, a program was conducted for all cluster members. It is also proposed to prepare a HR manual exclusively for the foundry clusters.

Cupola design and performance:

Many of the cluster members who are melting with a cupola, have given data as per the questionnaire given to them. UNIDO ICAMT will study them and come up with suggestions to each unit to improve their cupola performance. Units are being advised to charge all inputs only after weighing and also to charge only clean scrap. Productivity and quality improvement is the focus of this exercise.

Intellectual Property Rights (IPR) :

It is thought that foundry units do not have any IPR issues. Some of the owners of foundry units are also involved in production of other products utilizing the castings produced. IPR programs were conducted in engineering institutions at both clusters to enlighten the audience on patents, copy rights, trade marks, etc. Also, an IPR expert has visited a few foundry units to find out if any IPR products could be available. Gating systems, specific processes and specific process controls could be IPR products. UNIDO ICAMT advises that such data should not be shared with anyone as a lot of efforts would have gone in to obtain quality and productivity.

Other proposed programs and actions:

Action is being initiated to prepare manuals and to see that 15 of our cluster members who do not have quality certifications get certified in the first half of 2014.

Workshops from equipment manufacturers and material supplies is being planned. A technology seminar relevant to the cluster is also being planned.

It is proposed to make a comprehensive study of the funding of each cluster unit for capital

investment and working capital, which is also related to their performance. Interest rates vary from unit to unit. Some of the units are debt free.

More international missions are being planned.

It is proposed to have a program on family business management which is most common in SMEs.

Energy audit is proposed to be done in some of the units.

Conclusion:

During the diagnostic study, SWOT analysis indicated lacunas in not only individual units but also as a common factor in each of the clusters. Many of the units were one man owner shows. Technical knowhow in most units were poor. Some of the processes were age old with poor productivity. However, UNIDO ICAMT recognized that there is a lot of potential and opportunity for improvement to fulfill the core theme of the project – Technology up-gradation and productivity enhancement. UNIDO ICAMT decided to take an overall development approach and towards this end, the cluster project is focusing on developing it's cluster foundry units to be technically competitive, have a growth outlook and be a quality supplier keeping delivery commitments. It expects that at the end of the project, the improvements in the cluster units will percolate to other SME units in the same location.

Annexure A			
	Particulars as on 01/04/2012	**Coimbatore**	**Belgaum**
1	**Investment in P & M**		
	Less than Rs 100 lacs	10	10
	Between Rs 100 to 400 lacs	11	7
	More than Rs 400 lacs	4	8
2	**Metal type Distribution**		
	Only grey cast iron	15	10
	Grey cast iron and SG iron	7	13
	Only SG iron & alloyed irons	0	1
	Steel	2	1
	Aluminum	1	0
3	**Melting Facilities**		
	Only cupola	14	6
	Only induction furnace	8	14
	both cupola & induction furnace	3	5
4	**Machining**		
	not being done at all	14	5
	done within the firm	3	11
	done with sister firms or sub contract	8	9
5	**Annual production tons 2011 - 12**		
	Grey iron	20773	44030
	SG iron	1665	10137
	Steel	4089	524
	Aluminum	2417	0
	Others	51	165
6	**Annual turnover 2011 - 12**		
	Not in production during the year	2	2
	less than Rs 5 crores (lowest Rs 1.44/1.64 crores (C/B))	13	8
	Between Rs 5 to 10 crores	5	6
	Between Rs 10 to 50 crores	4	8
	Above Rs 50 crores (highest Rs 67.72/63.00 crores (C/B))	1	1

7	**Direct exporters**	7	7
8	**Foundry stage rej. % 2011 - 12**		
	Data not available/Not in production in the year	5/2	0/2
	Less than 3 % (lowest 1.0/1.4 % (C/B))	2	6
	Between 3 & 5 %	6	5
	Between 5 & 10 %	4	9
	Above 10% (highest 15/12 % (C/B))	4	3
9	**Machine shop/customer end rej. % 2011 - 12**		
	Data not available/Not in production in the year	4/2	0/2
	Less than 1 % (lowest 0.49/0.7 % (C/B))	7	3
	Between 1 & 3 %	3	6
	Between 3 & 5 %	6	4
	Between 5 & 10 % (highest 5.44 % (C))	4	8
	Above 10% (highest 13 % (B))	0	2
10	**Total Rej. % 2011 - 12**		
	Data not available/Not in production in the year	5/2	0/2
	Less than 3 % (lowest 1.49 % (C))	1	0
	Between 3 & 5 % (lowest 3.6 % (B))	3	3
	Between 5 & 10 %	10	10
	Above 10% (highest 15.04/24 % (C/B))	4	10
11	**Entrepreneur education qualification**		
	Post graduate in engineering	2	1
	Graduate in engineering	8	10
	Graduate in other streams (BA, BSc, etc)	4	9
	Diploma in engineering	7	3
	2nd year Pre University	2	1
	SSLC	1	1
	3^{rd} and 9^{th} Standard	1	0
12	**Moulding process**		
	Major green sand with moulding machines	8	8
	Major green sand with hand or snap flask	0	7
	Green sand machine/hand/snap flask combination	11	5
	Combination of shell/no bake/Co2/green	5	5
	Die casting	1	0

Annexure B

FOUNDRY A - CASTING DESPATCHES BEFORE & AFTER UNIDO INTERVENTION

		BEFORE					AFTER		
SL NO	**ITEM**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**
1	CASTING A	125	50	50	50	0	175	100	100
2	CASTING B	75	50	50	50	0	100	110	25
3	CASTING C	50	25	50	90	0	110	175	225
4	CASTING D	70	25	50	0	0	125	100	215
	TOTAL	**320**	**150**	**200**	**190**	**0**	**510**	**485**	**565**

Earlier, due to high rejections and rework, the steel foundry failed to achieve the targeted delivery. After changing over to new gating system, the rejection and re-work of these items are drastically reduced and the foundry was able to achieve the targeted dispatches. It not only increased turnover but also reduced the cost.

Annexure C - 1

Foundry C - Savings due to yield improvement

Sl No	Item	Bunch weight kgs before	Bunch weight kgs after	Difference in weight kgs	Quantity required per annum	Liquid metal saved per annum Kgs
1	A	99.3	95	4.3	120	516
2	B	58.4	57.1	1.3	360	468
3	C	84.6	82.8	1.8	500	900
4	D	79.1	77.3	1.8	350	630
5	E	77.6	75.9	1.7	200	340
6	F	91.15	88.7	2.45	480	1176
7	G	43.8	43.3	0.5	432	216
8	H	138.2	131.9	6.3	60	378
9	I	24.5	23	1.5	500	750
10	J	24.2	23.15	1.05	100	105
11	K	99.95	96.3	3.65	150	548
12	L	80.1	78.9	1.2	250	300
13	M	36.15	33.2	2.95	3000	8850
14	O	36.15	33.2	2.95	3000	8850
TOTAL SAVING						24027 Kgs

Annexure C - 2										
Foundry B - Total Savings Due to Gating System Changes and avoiding other materials like filters/sleeves										
Sl.No.	**Item**	**Gross Wt. Kgs Old**	**Casting Wt Kgs**	**Old Yield %**	**Gross Wt. Kgs New**	**New Yield %**	**Weight saved in kgs**	**Quantity required per annum**	**Liquid Metal saved per annum in kgs**	**Other Savings Rs**
1	A	8	5.3	66.25	7	75.71	1	500	500	0
2	**B**	6.5	4.15	63.85	5.35	77.6	1.15	500	575	0
3	**C**	6.5	4.6	70.77	5.1	90.2	1.4	500	700	0
4	D	8.15	5.8	71.17	7.15	81.1	1	400	400	0
5	E	38.7	35.5	91.73	36.9	96.3	1.8	600	1080	20400
6	F	78	63	80.77	68	92.6	10	1000	10000	68000
7	G	112	88	78.57	92.8	94.9	19.2	900	17280	61200
8	H	55	45.3	82.36	51.2	88.5	3.8	25	95	900
9	I	110	92.15	83.77	103	89.5	7	5	35	360
10	J	196	168	85.71	186	90.3	10	50	500	3600
11	K	179	153	85.47	177	87	2	20	40	0
12	L	118	95.1	80.94	112	84.6	6	50	300	3600
13	M	170	145	85.29	164	88.4	6	50	300	1700
14	N	64	45	70.31	55	81.8	9	50	450	0
15	O	95	69.65	73.32	86.6	80.5	8.4	35	294	1190
16	P	69.8	49.6	71.06	60.9	81.5	8.9	150	1335	5600
17	Q	6.5	4.9	75.38	5.5	89.1	1	1750	1750	0
18	R	12.5	9	72	11.9	75.6	0.6	550	330	0
19	S	15.5	13	83.87	14.5	89.7	1	6200	6200	0
20	T	35	24.5	70	31	79	4	600	2400	0
21	U	18	12.3	68.33	14.5	85.1	3.5	400	1400	0
22	V	23	17.6	76.52	21	83.8	2	300	600	0
23	W	200	158	79	191	82.7	9	50	450	0
24	X	25	16	64	20.5	78	4.5	450	2025	0
25	Y	38	28	73.68	32.6	86	5.4	650	3510	0
26	Z	176	146	82.95	166	88	10	150	1500	0
Total Savings									54049 Kgs	166550 Rs

Annexure D	
FOUNDRY D - CHANGE OVER FROM SHELL CORE PROCESS TO COLD BOX PROCESS ENERGY SAVING, PRODUCTIVITY & QUALITY IMPROVEMENT	
The unit employed only energy reliant shell core process. The process also requires rigid controls in curing. The set up time for a core box change is about 4 hrs. UNIDO ICAMT suggested to replace the process with the more efficient cold box core process. First item to be developed was the one which required the maximum quantity	
Benefits accured	
1	Production Increase with available 4 core impression core box
	Shell resin core Output per hour: 140 nos (35 shots)
	Cold box core output per hour : 240 nos (60 shots)
	71 % increase in production
2	Productivity Increase
	Successful Trials completed with the new 14 impression core box with 50 shots per hour giving 700 cores per hour. Productivity increase is 400% over the shell process with old core box. Core box set up time in cold box core shooter reduced to 10 minutes
3	Labour Productivity
	The one core shooter with new core box can eliminate four shell core shooters, thus improving labour productivity
4	Energy Saving
	Shell Core Shooter consumed 1 KWHr Energy per hour for curing the cores from the four impression core box through the heating process. But the Cold Box Core Shooter consumes the lower cost Amine Gas to cure the cores.
5	Core quality Improvement
	From 1/2/2013 to 23/8/2013, out of 77592 shell cores inspected, the core rejection was 2806 nos giving a 3.59 % core rejection
	From 24/8/2013 to 25/8/2013, out of 2502 cold box cores inspected, the core rejection was 38 nos giving a 1.52 % core rejection. By improving core box vents, the rejection was reduced to almost zero
All the above will lead to very high cost reduction.	