PRODUCTIVITY IMPROVEMENT OF GRID CASTING IN A BATTERY MANUFACTURING COMPANY – A CASE STUDY

By

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A project work submitted to the Department of Industrial and Production Engineering, Bangladesh University of Engineering and technology in partial fulfillment of the requirements for the degree of Masters of Engineering in Advance Engineering Management

DEPARTMENT OF INDUSTRIAL & PRODUCTION ENGINEERING

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TO

ALL THOSE to WHOM

I'M A DEAR

ONE

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ABSTRACT

Productivity is very important to every industry because it helps a company respond quickly to customer demand as well as to optimize the resource usage, which is an important issue of competitive strategy. High productive rate can help a company to complete the production cycle in a much shorter time than it would otherwise be possible. Utilizing the allocated resources properly lead to better productivity and enhance the efficiency as well as effectiveness.

Grid are considered the core & the heart of the battery industry. So focusing on that to improve its productivity is the main concern. Productivity in casting is a very important measure in manufacturing operations as well as it contributes in turnover & profit, besides it provides insight into the efficiency & effectiveness of operations. Improved efficiency bears a positive impact on the direct costs of products of a company, as same output is produced consuming less input or provides same inputs to produce more output.

Considering the incredible demands on tight schedule, no activity is worth doing unless it promises to add value to the central part of an operators work and make it more successful and satisfying. However, a problem remains in industries to identify appropriate method to achieve that. Thus, selecting a focus, the first step in the process & it is vitally important.

Kaizen events are sometimes referred to as rapid improvement events. It involves small groups of individuals in the company that are brought together to address a particular area of the company.

The present study focuses on improving grid casting productivity and reducing the problems related to low productivity and efficiency. Other sections regarding plate preparation are also highlighted for observation. Capacity study of individual processes and production procedure will be considered for improvement.

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LIST OF ABBREVIASSION

AVG- Average

CNG- Compressed Natural Gas

DM- De mineralized

HR – Human Resource

IGO – Inert Gas Oven

M/C- Machine

UTL – Utilization

QTY- Quantity

PF – Power Failure

MCR – Mold Corking

MBD – Maintenance Break down

H - Heating

MCC – Machine Cutter Change

OTR – Other

IGO – Inert Gas Oven

PDO – Positive Dry Oven

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

In today’s increasingly competitive world, it is important to constantly improve, be it a manufacturing or service industry. In this modern and competitive world, manufacturing industry is one of the sectors which can takes turns under all types of economic systems such as free market economy and collectivist economy. All of the products generated is competing to gain demand and satisfactory from customers. Dealing with continuous competition, company not only needs to produce quality products but excellence production systems and management also plays an important role.

At the present stage of economic development, one of the main components of successful industrial organizations is planning productivity. Study of the productivity growth is becoming more important against a backdrop of market relations, because it allows company to stay competitive on the market and strengthen the social component in the development of society.

The term productivity can be used to examine efficiency and effectiveness of any activity conducted in an economy, business, government or by individuals. Efficiency, effectiveness and productivity can also be evaluated for performance, business in service sector. Productivity however, is broadly evaluated mostly through service volume, delivery processes and customer-perceived quality in services/ goods offered. In the context of the real world, productivity is mostly examined and evaluated with reference performance and resource utilization. Increased productivity reduces the cost of work on the production unit or an increase in output and prevent waste.

Productivity is also confused with terms like efficiency and effectiveness and these terms are wrongly considered synonymous to productivity. Efficiency and effectiveness are two different terms such that efficiency indicates how well the resources are utilized to accomplish a result. Alternatively, effectiveness refers to the degree of accomplishing the objectives. Productivity becomes the dominant issues in the market place where customer demand is high, sometimes they are willing to pay more for what they required in timely manner.

Manufacturing has a new business task but continues the old manufacturing policies and structure. Managers in manufacturing have no clear, consistent definition or understanding of the manufacturing task facing the organization. The manufacturing policies and the infrastructure being employed are inconsistent. Taken together, there is a distortion in coordination. The organization lacks a focus. It is attempting to cover too many technologies or too many products and markets, too wide a range volume, and more than one manufacturing task. The organization has the wrong equipment &process technology for the present manufacturing task. Selection of products and processes for each plant in a multi-plant setup results in mixing together, somewhat at random, a product organization, a process organization, and a volume-focused organization (or any two of the three) instead of focusing around one type of organization.

The main intention is to study the current capacity, analyze it to find areas of improvement, identify the flaws and make an improvement proposal to meet the forecasted increase in demand and improve the productivity in an industry of battery manufacturing production floor. This thesis presents the current performance of outputs and capacity of the plant calculated using continuous data collected in shop floor. In each workstation the processing time and pattern is different and various industrial engineering technique and tools is implementing in this study in order to investigate and recommend actions.

Different organizations within the same industry have different strengths and weaknesses and choose to compete in different ways. Dissimilar production "systems" have altered operating characteristics and each involves a different set of trade- offs. A production system must have a customized design that reflects the priorities and trade-offs inherent in the firm’s own competitive situation and strategy.

Therefore, no one operating system is universally superior under all competitive situations and for all companies. Every operating system embodies a set of trade-offs. Some will be particularly good at producing standardized products in high volume at low cost; others will excel at responding quickly to shifting demand for more customized products.

Process Mapping & Process Layout is quite important to identify and analyze the situation in production floor. Besides it can serve as a starting point to help management, engineers, production associates, schedulers, suppliers, and customers recognize waste and identify its causes. The process includes physically mapping "current state" which is the current scenario, while also focusing on "future state" which is the ideal scenario, which can serve as the foundation for other improvement strategies in shorten process and improve the capacity utilization which leads to a better productivity.

The research process begins with serious reflection directed toward productivity and identifying a topic or topics worthy of a plate preparation. Considering the incredible demands on tight schedule, no activity is worth doing unless it promises to make the central part of an operators work more successful and satisfying. The thesis aims to analyze and give suggestions of improvements on the production and monitoring procedure of grid casting of X Battery Ltd, in order to improve the productivity. This chapter helps to introduce the reader to this case study and give an introduction to the subject and the company.

1.2 OBJECTIVE'S

The specific objectives of this project work are:

1. To enhance Grid casting productivity through monitoring approach, team based approach, process mapping, designing performance appraisal, 5S sustainability.

2. To alleviate the response time through reducing waiting time, excess processing, eliminating unnecessary work and process rating etc.

The possible outcomes of the work are the proposed development an improved scenario of plate preparation which can operate and follow work practices.

1.3 METHODOLOGY

1. Data collection from factory production floor.
2. Establishment of current state map based on existing data.
3. Assessment of current state map to identify potential areas for improvement.
4. Development of future state map and recommend potential improvement considering
    a. Proper utilization of actual capacity.
    b. Enhance monitoring and working method development.
5. Implementation of Kaizen events for future state map.
6. Evaluation of proposed improvement and comparison with current state scenario.

CHAPTER TWO

LITERATURE REVIEW

2.1 HISTORICAL BACKGROUND

The lead acid battery was invented at the advent of electricity. The discovery of electricity as a form of energy is the greatest achievement of mankind, which has changed human life dramatically. For over 150 years, the lead acid battery technology has developed driven by the accumulation of new knowledge and the invention of new materials. The lead acid battery has become one of the main portable sources of electric power with wide application in man's everyday life (transport vehicles, telecommunications, information technologies, etc.). It has won a dominating position in energy storage and load-levelling applications (reserve electric power supply and remote area energy systems). Lead acid batteries are cheap, easy to produce and easy to recycle, and the resources for their manufacture are practically unlimited. This is why the lead acid battery industry has reached annual turnovers of tens of billions of US dollars on a worldwide basis.

The lead acid battery is a complex dynamic system, or shall I call it 'a complex dynamic world', in which various processes proceed continuously, at different rates, no matter whether the battery is on charge, discharge or open circuit. This 'living' organism exists due to the simultaneous operation of two electrochemical systems: the lead system ($Pb/PbSO_4$ and $PbO_2/PbSO_4$) and the water system (H_2O/H_2 and H_2O/O_2). The latter is thermodynamically supported, but kinetically suppressed. These two systems are in continuous competition with each other, the lead system playing the dominating role, which makes the lead acid battery functional and useful to mankind. This dynamic world is governed by the laws of chemistry and electrochemistry, physics and physical chemistry, metallurgy and corrosion science. This 'world' is a meeting point for the kinetics and thermodynamics of chemical and electrochemical reactions, crystal nucleation and growth with diffusion and migration processes, mechanical and corrosion processes in lead alloys, as well as a number of phenomena of efficient transformation of chemical energy into electrical energy and vice versa [1].

Their collaborators and he have been studying this 'world' for many years now. We have advanced step by step, overcoming numerous barriers, towards identifying the processes and phenomena that proceed during lead acid battery manufacture and operation, disclosing the mechanisms of these processes and elucidating the structures of the obtained intermediate and end products. It is really rewarding when someone gain all this knowledge. Every production need a strategy, defining the goals the company and the production are striving towards. Measurements have to be done to support the strategy and from the information gathered by the measurements, improvements can be made.

19th-century illustration of Planté's original lead-acid cell up to this point, all existing batteries would be permanently drained when all their chemical reactions were spent. In 1859, Gaston Planté invented the lead–acid battery, the first-ever battery that could be recharged by passing a reverse current through it. A lead acid cell consists of a lead anode and a lead dioxide cathode immersed in sulphuric acid. Both electrodes react with the acid to produce lead sulfate, but the reaction at the lead anode releases electrons whilst the reaction at the lead dioxide consumes them, thus producing a current. These chemical reactions can be reversed by passing a reverse current through the battery, thereby recharging it.

Planté's first model consisted of two lead sheets separated by rubber strips and rolled into a spiral. His batteries were first used to power the lights in train carriages while stopped at a station [citation needed]. In 1881, Camille Alphonse Faure invented an improved version that consisted of a lead grid lattice into which a lead oxide paste was pressed, forming a plate. Multiple plates could be stacked for greater performance. This design was easier to mass-produce [2].

Compared to other batteries, Planté's was rather heavy and bulky for the amount of energy it could hold. However, it could produce remarkably large currents in surges. It also had very low internal resistance, meaning that a single battery could be used to power multiple circuits. The lead-acid battery is still used today in automobiles and other applications where weight is not a big factor. The basic principle has not changed since 1859. In the early 1930s, a gel electrolyte (instead of a liquid) produced by adding silica to a charged cell was used in the LT battery of portable vacuum-tube radios. In the 1970s, "sealed" versions became common (commonly known as a "gel cell" or "SLA"), allowing the battery to be used in different positions without failure or leakage.

Today cells are classified as "primary" if they produce a current only until their chemical reactants are exhausted, and "secondary" if the chemical reactions can be reversed by recharging the cell. The lead-acid cell was the first "secondary" cell [3].

The process of making changes in a company, is usually slow, regarding the layout, the machines or the organization. Therefore, it is important that all the choices which is made, strives towards the same goal, this is where the manufacturing strategy plays its part. By clearly stating a manufacturing strategy, it is possible to make the right choices, at the right time. It is also possible to see if the decisions and choices fit the chosen strategy, if they don't they are probably the wrong choices and should be rethought. It has become a widely held premise that people provide organizations with an important source of sustainable competitive advantage and that the effective management of human capital, not physical capital, may be the ultimate determinant of organizational performance. The value of human capital may be especially apparent in modern manufacturing organizations that have invested heavily in production innovations such as advanced manufacturing technology, statistical process control, and computer numerically controlled machine tools. Such initiatives tend to depend heavily on employee skills and commitment as key components in the value creation process. Accordingly, it is instrumental for manufacturing firms to harness the productive potential of their employees in order to achieve superior performance.

Although on the surface the universal and contingency perspectives may appear to be competing, we would argue that they can be complementary. A good deal of evidence suggests that individual HR practices, as well as internally consistent systems or bundles of HR practices, can indeed directly influence organizational performance. Going beyond these direct HR-performance relationships, however, other evidence suggests that the impact of HR practices on firm performance may be further enhanced when practices are matched with the competitive requirements inherent in a firm's strategic posture. In short, the universal approach helps researchers document the benefits of HR across all contexts, ceteris pariahs, and the contingency perspective helps us look more deeply into organizational phenomena to derive more situationally specific theories and prescriptions for management practice. Although support for one perspective over another is ultimately an empirical issue, the two perspectives are not necessarily mutually exclusive [4].

Productivity is commonly defined as a ratio between the output volume and the volume of inputs. In other words, it measures how efficiently production inputs, such as labor and capital, are being used in an economy to produce a given level of output. Productivity is considered a key source of economic growth and competitiveness and, as such, is basic statistical information for many international comparisons and country performance assessments.

For example, productivity data are used to investigate the impact of product and labor market regulations on economic performance. Productivity growth constitutes an important element for modelling the productive capacity of economies. It also allows analysts to determine capacity utilization, which in turn allows one to gauge the position of economies in the business cycle and to forecast economic growth. In addition, production capacity is used to assess demand and inflationary pressures.

The only way to quantify the performance of a production, is to measure different parts of the system, these measurements are called performance indicators and show how well the different parts of the system perform. Based on the strategy, it is possible to determine the most important measurements. If measured properly, it shows the improvement potential in the different areas, allowing strategic choices to be made. If it continuously measured, it is possible to show the effects of changes in the production, and which choices have the desired effect [5].

One of the most important thing for measure production is the productivity. Productivity is, according to Hannula, defined as how well a company uses its resources, which can be expressed by the formula following, where the output is the output from the system and the input is all the resources that has been used [6].

To standardize a work method, is to specify which operations and in which order they should be performed to complete a work task. The reason this is important is that without a standardized work method it is impossible to improve it. When the method is standardized, it is possible to determine the time it takes to perform the task, making it possible to balance the different work tasks between operators. Another effect of standardized work is a reduction of the variance in both quality and operation time.

When implementing standardized work, it is important that the operators are involved when creating and maintaining the standard, since the operators knows the process best and because they are the ones who will be using it. Also, by involving the operators from the beginning, increases the likelihood that the standard will be followed, and the standard is useless if the operators do not use it.

There are several factors that needs to be considered to achieve a standard, these factors are: all the operations required to complete a task, all safety procedures needed in each operation, a visual representation of where each operation takes place, the timing for each operation, and proper method of doing that. By using standardized work and constantly improving it, the productivity will be improved, which also leads to reduced costs. A maintained standard enables the possibility to distribute the best practice among to operators, it also helps with the introduction of new operators [7].

Kaizen is a system of continuous improvement in quality, technology, processes, company culture, productivity, safety and leadership. Kaizen is a system that involves every employee - from upper management to the cleaning crew. Everyone is encouraged to come up with small improvement suggestions on a regular basis. This is not a once a month or once a year activity. It is continuous. In most cases these are not ideas for major changes. Kaizen is based on making little changes on a regular basis: always improving productivity, safety and effectiveness while reducing waste.

Kaizen involves setting standards and then continually improving those standards. To support the higher standards Kaizen also involves providing the training, materials and supervision that is needed for employees to achieve the higher standards and maintain their ability to meet those standards on an on-going basis [8].

Maintenance is an important factor in quality assurance, which is another basis for the successful competitive edge. Inconsistencies in equipment's lead to variability in product characteristics and result in defective parts that fail to meet the established specifications. Beyond just preventing break downs, it is necessary to keep equipment's operating within specifications (i.e. process capability) that will produce high level of quality. Maintenance can be viewed as a combination of actions carried out in order to replace, repair or modify the components, items, and units of a plant so that it will continue to operate at specified availability over a specified time. It means that people waits until equipment fails and repair it. Such a thing could be used when the equipment failure does not significantly affect the operation or production or generate any significant loss other than repair cost. It is a daily maintenance (cleaning, inspection, oiling and re-tightening), design to retain the healthy condition of equipment and prevent failure through the prevention of deterioration, periodic inspection or equipment condition diagnosis, to measure deterioration. It is further divided into periodic maintenance and predictive maintenance. Just like human life is extended by preventive medicine, the equipment service life can be prolonged by doing preventive maintenance.

Good maintenance management is important for the company's cost control. As companies go in for automation to become more competitive, they increasingly rely on equipment's to produce a greater percentage of their output. It becomes more important that, equipment's operate reliably within specifications. The cost of idle time is higher as equipment becomes more high-tech and expensive e.g. NC/CNC machines and robots.

Dependability of service is one of the performance measures by which a company can distinguish itself from others. To establish a competitive edge and to provide good customer service, companies must have reliable equipment's that will respond to customer demands when needed. Equipment's must be kept in reliable condition without costly work stoppage and down time due to repairs, if the company is to remain productive and competitive.

Many manufacturing organizations, particularly those with JIT (Just-In-Time) programs are operating with inventories so low that, they offer no protection in the event of a lengthy equipment failure. Beyond the cost of idle equipment, idle labor, and lost ales that can result from a breakdown, there is a danger of permanently losing market shares to companies that are more reliable. Maintenance function can help prevent such as occurrence.

Organizations like airlines and oil refineries have huge investments in the equipment. Equipment failure will be disastrous for such companies. They need proper maintenance to keep the equipment in good condition. Time based maintenance consists of periodically inspecting, servicing and cleaning equipment and replacing parts to prevent sudden failure and process problems.

This is a method in which the service life of important part is predicted based on inspection or diagnosis, in order to use the parts to the limit of their service life. Compared to periodic maintenance, predictive maintenance is condition based maintenance. It manages trend values, by measuring and analyzing data about deterioration and employs a surveillance system, designed to monitor conditions through an on-line system.

It improves equipment and its components so that preventive maintenance can be carried out reliably. Equipment with design weakness must be redesigned to improve reliability or improving maintainability. It indicates the design of new equipment. Weakness of current machines are sufficiently studied (on site information leading to failure prevention, easier maintenance and prevents of defects, safety and ease of manufacturing) and are incorporated before commissioning a new equipment [9].

5S is an approach which helps to identify the problems that cannot be clearly seen when the work place is unorganized. Cleaning and organizing the workplace helps the team to uncover problems. Making problems visible is the first step of improvement.

SEIRI - Sort: Seiri means sorting and organizing the items as critical, important, frequently used items, or items that are not currently needed. Unwanted items can be salvaged. Critical items should be kept for use nearby and items that are not needed in near future should be stored someplace else. For this step, the priority of the item should be decided based upon utility and not cost. As a result of this step, the search time is reduced.

SEITON - Organize: The concept here is that "A place for everything, and everything in its place". After usage items should be stored in their designated storage location. To identify items easily, name plates and colored tags can be used. Vertical racks can be used for organization.

SEISO - Shine: Seiso involves cleaning the workplace and ensuring equipment is free of burrs, loose wires, grease, oil, waste, scrap.

SEIKETSU - Standardization: Associates decide together on standards for keeping the workplace, machines, and pathways neat and clean. These standards are implemented for whole organization and are regularly checked.

SHITSUKE - Self Discipline: Accepting 5S as a way of life forms self-discipline among the associates. This includes wearing badges, following work procedures, punctuality, dedication to the organization, etc. [10].

Work Study is the systematic examination of the methods of carrying out activities such as to improve the effective use of resources and to set up standards of performance for the activities carried out. A generic term for those techniques, particularly method study and work measurement, which are used in the examination of human work in all its contexts, and which lead systematically to the investigation of all the factors which affect the efficiency and economy of the situation being reviewed, in order to effect improvement.

Time study is a method of measuring work for recording the times of performing a certain specific task or its elements carried out under specified conditions. An operator does same operation (task) throughout the day. Time study help to define how much time is necessary for an operator to carry out the task at a defined rate of performance [11].

The performance appraisal is the process of assessing employee performance by way of comparing present performance with already established standards which have been already communicated to employees, subsequently providing feedback to employees about their performance level for the purpose of improving their performance as needed by the organization [12].

What does the term performance actually mean? Employees are performing well when they are productive. Productivity implies both concern for effectiveness and efficiency, effectiveness refers to goal accomplishment. However, it does not speak of the costs incurred in reaching the goal. That is where efficiency comes in. Efficiency evaluates the ratio of inputs consumed to outputs achieved. The greater the output for a given input, the greater the efficiency. performance also includes personnel data such as measures of accidents, turnover, absences, and tardiness. That is a good employee is one who not only performs well in terms of productivity but also minimizes problems for the organization by being to work on time, by not missing days, and by minimizing the number of work-related accidents.

Appraisals are judgments of the characteristics, traits and performance of others. On the basis of these judgments we assess the worth or value of others and identify what is good or bad. In industry performance appraisal is a systematic evaluation of employees by supervisors. Employees also wish to know their position in the organization. Appraisals are essential for making many administrative decisions: selection, training, promotion, transfer, wage and salary administration etc. Besides they aid in personnel research.

Performance Appraisal thus is a systematic and objective way of judging the relative worth of ability of an employee in performing his task. Performance appraisal helps to identify those who are performing their assigned tasks well and those who are not and the reasons for such performance. It is also referred by the systematic evaluation of the performance of employees and to understand the abilities of a person for further growth and development.

Performance appraisal is systematic evaluation of the individual with respect to his or her performance on the job and his or her potential for development. It is a formal, structured system of measuring and evaluating an employee’s job, related behavior and outcomes to discover how and why the employee is presently perfuming on the job and how the employee can perform more effectively in the future so that the employee, organization, and society all benefit. It is the process of evaluating the performance and qualifications of the employees in terms of the requirements of the job for which he is employed, for purposes of administration including placement, selection for promotions, providing financial rewards and other actions which require differential treatment among the members of a group as distinguished from actions affecting all members equally. Performance appraisal includes all formal procedures used to evaluated personalities and contributions and potentials of group members in a working organization. It is a continuous process to secure information necessary for making correct and objective decisions on employees [13].

CHAPTER THREE

CURREENT STATE MAPPING

3.1 PLATE PREPARATION

To comprehend the working procedure & scenario of production procedure observation were done for specific period. As a part of that production data of grid casting of 6 consecutive months (August'15 to January'16) were considered for study. It helps to identify data pattern, current production condition, production quantity & the existing capacity of grid production. Then the loss time, production losses & other reasons of less productivity are identified & studied. The analysis was done on the production floor and therefore not hindering the current production flow. The description of the current situation is based on data gathered during this 12-week period and so any changes in the production system past that time will not be considered, for future reference this period will be called the data gathering period.

The plates of cells are prepared and managed in this section. Plate is the most significant part of a battery. The plate preparation processes are most perilous and creative process of XBL. This process requires the maximum lead time to produce a complete battery. The different sections of plate preparation are here as follows

a) Grid Casting
b) Cylinder & Oxide Production
c) Paste Mixing & Plate Pasting
d) Curing
e) Formation
f) IGO & PDO
g) DM water plant
h) Acid Dilation
i) Plate Parting

Among all these section, thesis work undergoes concentrating on the production process of grid casting. This represent the grid casting production zone and manufacturing of grids which are the skeleton of the plates.

Here, it was observed that total 9 casting machines (7 Writzs, YUSA & DIAM) are in the production floor. Three shifts on each day and 1 operator required for each shift/ machine. Every machine is not running regularly regarding to the production plan.

Observation was done bearing in mind the following criteria.

1. Data collected primarily from floor and verified with secondary data.
2. Grid types were minimized for identifying pattern and better understanding.
3. All grid (most of) types are considered as same for the ease of calculation.
4. General shift is monitored and used as the data collection period. Analysis and recommendation are also constructed on that basis may contrast on different time span.
5. XBL Organization maintains strict policy on information sharing and confidentiality, thus a lot of information cannot be included in this report to protect confidentiality.

3.2 GRID CASTING

The plates of cells are produced and prepared in this section. Plate is the most important part of a battery. It is considered as the bone or skeleton of battery construction. The plate preparation processes are most critical and creative process of XBL. This process requires most of the time compared to other process of battery manufacturing. Grids are prepared in different steps which are briefly described in this section.

In a conventional battery grid casting mold where hot liquid alloys are poured into the mold, the inner faces of the two mold half sections (in which the grid cavity is machined) heat up and tend to warp the mold sections. A battery grid having grid wire mesh directed between crossbars enclosed by a rim or peripheral bead on the outer periphery of the grid. In casting articles of this type by a continuous process. First portion of the mold is made of a material having a low diffusivity factor for preventing solidification of molten material before the mold has been completely filled and a second portion of a high diffusivity factor for reducing the surface tension of the molten material to assure accurate reproduction of the mold contour in the fine detailed portions thereof.

For this reason and also because it is desirable to maintain the mold as a whole within a selected close range of temperatures in order to produce sound castings efficiently, it is common practice to heat the back side of each mold section. Normally electric heaters are mounted on or within the back portion of the mold sections to maintain the mold at the desired casting temperature. Likewise, coolant lines are frequently formed in the vertical mid-plane of each mold section to cool the grid faces of the mold to the temperature desired for causing solidification of the grid casting within a relatively short time period.

At the present time battery grids are normally cast individually in molds having separable mold sections, the grid pattern cavity being machined as shallow grooves in the opposed faces of the mold sections. The mold faces in which the grid cavity is machined are periodically coated with a thin layer of powdered cork or acetylene smoke which acts as an insulator to prevent the lead from chilling before all of the grooves defining the grid pattern are completely filled. The production of individual battery grids in this manner is a relatively slow process and requires a considerable amount of skill on the part of the operator [14].

Table 3.1 shows here the manpower requirement for each shift & individual machine. It requires 9 operators in each shift & the total daily requirement is 27 operators in all three shift. It was found that total 30 operators for the grid casting section including shift changing and weekly allowed leave allocation.

Table 3.1: Manpower Requirement each shift for Grid Casting.

Manpower Required for Grid Casting	
No of Grid Casting Machine	9
Operator Required/ MC/ Shift	1
Total Operator Required/ Shift	9

Lead bar & Alloy Lead Bar according to specification was melted in the Lead pot at certain temperature and considering other parameters. After that the melted lead was pumped through a lead pump and feed it to the dispense valve maintaining proper amount of liquid lead for specific designed grid. The lead feeding is controlled by a pneumatically operated poppet valve, synchronized with the gravity casting m/c. Then the dispense valve pour the liquid lead into the ladle that stores the liquid lead for an adequate amount of time and then deliver it to the mold for grid casting in gravity casting method. Mold opening and closing and grid ejection pneumatically operated. The grids cast from the mold are conveyed by a continuous belt, provided with two steel rollers for decelerating and aligning them after ejection. Then it passes the cutter where it gets its desired size and a catch plate after that receives the plate and helps to stack it in the grid stack.

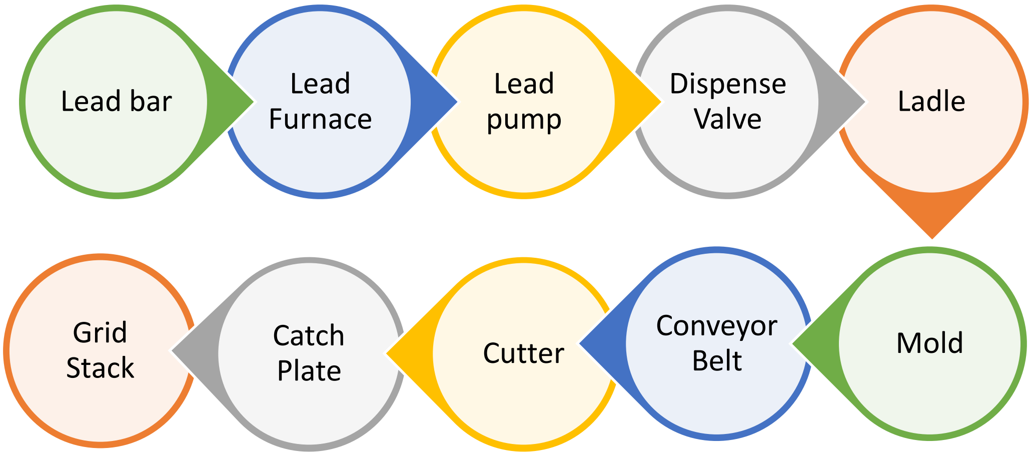


Figure: 3.1: Sequential Process Layout for Grid Casting.

Figure 3.1 illustrates the sequential process flow of grid casting. It includes each steps required for lead bar transform into grid. Whereas the Lead bar is the input of the process and after completing each steps it converts into grid.

Table 3.2 displays the process mapping of Grid casting which includes the detail information of each and every steps and their major following criteria. The table is in the following page where it can be understand & described clearly.

Table 3.2: Process Mapping of Grid Casting.

Lead Bar	• According to specification lead bar are booked and poured to the lead furnace.
Lead Pot/ Furnace	• Heated by Gas burner. • Temperature: 485º-520º +/-10º C
Feed line	• Heated for the smooth flow of liquid lead. • Temperature: 485º-535º +/- 10º C
Dispense Valve	• Constantly heated & pours the liquid lead in Ladle. • Temperature: 500º-535º +/- 10º C
Laddle Pot	• Store liquid lead & pour it to Mold. Key element for gravity casting method. Temperature: 500º-540º C
Mold	• Consist of two part called lower & upper mold. • Mold Corking required for better grid casting. • Temperature: Lower 180º-200º C Upper: 170º-175º C
Tray	• Catch the casted plate and guide it to next phase.
Short Conveyor Belt	• Receive the casted plate deliver to next phase.
Finishing Plate	• Align the grid and deliver for cutting.
Finishing Roller	• Guide the grid to cutter.
Cutter	• Cut grid according to specification. • Oil/ Collent Spray required for smooth operation.
Catch Plate	• Catch the plate and deliver it to the grid stack.
Grid Stack	• Atomatically arranged grid to collect [15].

3.3 ESTABLISHMENT OF CURRENT STATE

- To get the actual monthly production data a data collection format is created to collect monthly data, analyze, identify pattern, scenario & understanding the fact.
- All grid types are considered same to reduce the complicacy of calculation. This is done under the assumption of considering after analyzing and identifying all the production quantity for various grid type is almost same.
- An excel format is generated where on the Production sheet, production data was collected, analyzed on different issues to compare & study the pattern to identify the current & critical scenario. Shift & Machine wise production quantity is summarized & graphical representation is along with that for easy observation as well as for better understanding.
- In the Production sheet data section, 1 represent the Schedule off & 0 represent Nil production on that particular shift. This is done to calculate & improve the accuracy in Machine Utilization time. Monthly production can be viewed in lower section of particular sheet.
- Now on the Loss Time Sheet, loss time was collected for each machine in six categories the way it reported in Grid Casting Activity Report. Here Shift wise, categorized & Machine wise loss time was classified & calculated. Graphical representation is also provided for better visual understanding.
- Efficiency of overall grid casting is also cumulated & updated instantly to pursue & take necessary actions to improve.
- Machine capacity study was done under current circumstances which are compared to other monthly production data & used to estimate the overall production capacity & production quantity.
- Reasons are accumulated for the low productivity of Grid castings on FBD sheet.
- Overall comparisons are done in the Overview sheet. In this the Capacity portion the total capacity of grid casting is calculated considering the average production found by machine capacity study. This is tentative & may vary with the actual production capacity. That's why secondary verification is done with the factory actual data.

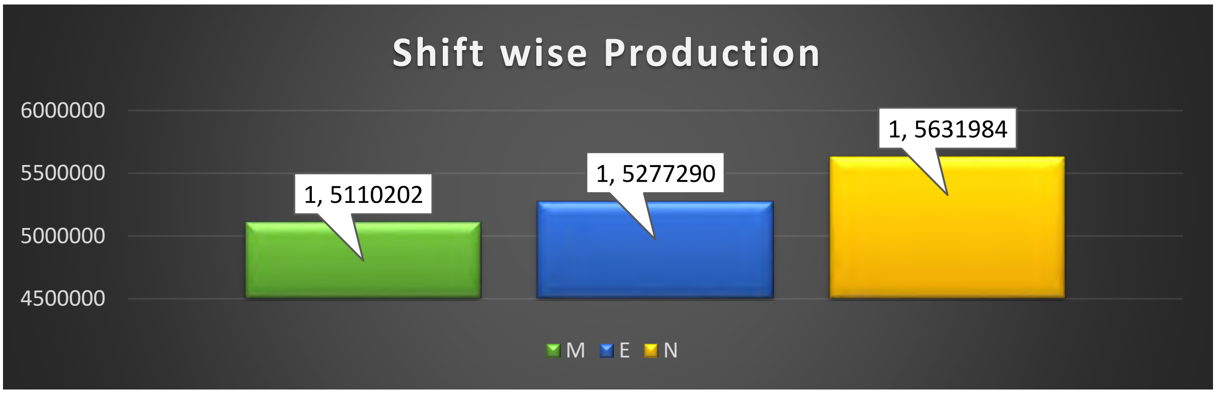
3.4 OVERVIEW OF SIX MONTHS

The capacity is identified considering & calculating the average scenario of the collected data and presented in Table 3.3.

Table 3.3: Production Capacity of Grid Casting.

Production Data			Production/ Machine				Total Capacity
			Min	Prod/Hr	Prod/Shift	Wt/AIW	
Time	480	Min/shift	12	1407	11257	8443	7066817
Shift	3	Shift/ day					
Days	31	Days/month					
Machine	9	Each Shift					
Average Prod	12	Mc/ min					
Allowance	15	Min/Hour					

Figure 3.2 displays the production & loss time during that period is cumulated to for establishing a scenario.



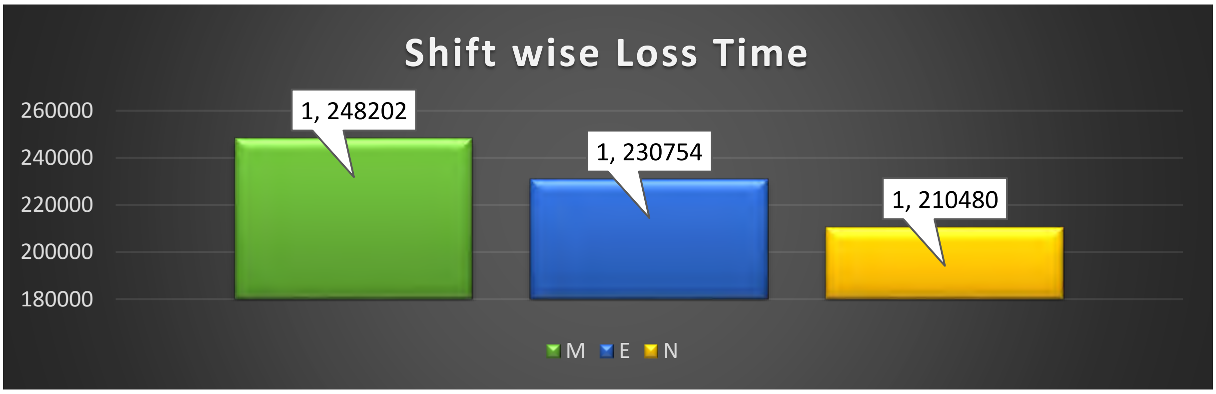


Figure 3.2: Shift Wise production & Loss Time.

Table 3.4 represents the production comparison of six months of Actual & Expected production conditions. Where Individually days of production are considered for each month and according to the monthly production average the expected production was obtained here.

Table 3.4: Production Comparison Actual Vs Expected.

Month	Actual Production		Days Considered	Machine Utilized	Expected Production		Difference
August	3494078	Pcs	30	8	4052655	Pcs	558577
September	1738300	Pcs	21	6	2127644	Pcs	389344
October	2841700	Pcs	31	6	3140807	Pcs	299107
November	2863670	Pcs	30	6	3039491	Pcs	175821
December	1859650	Pcs	20	6	2026327	Pcs	166677
January	3221300	Pcs	31	8	4187743	Pcs	966443

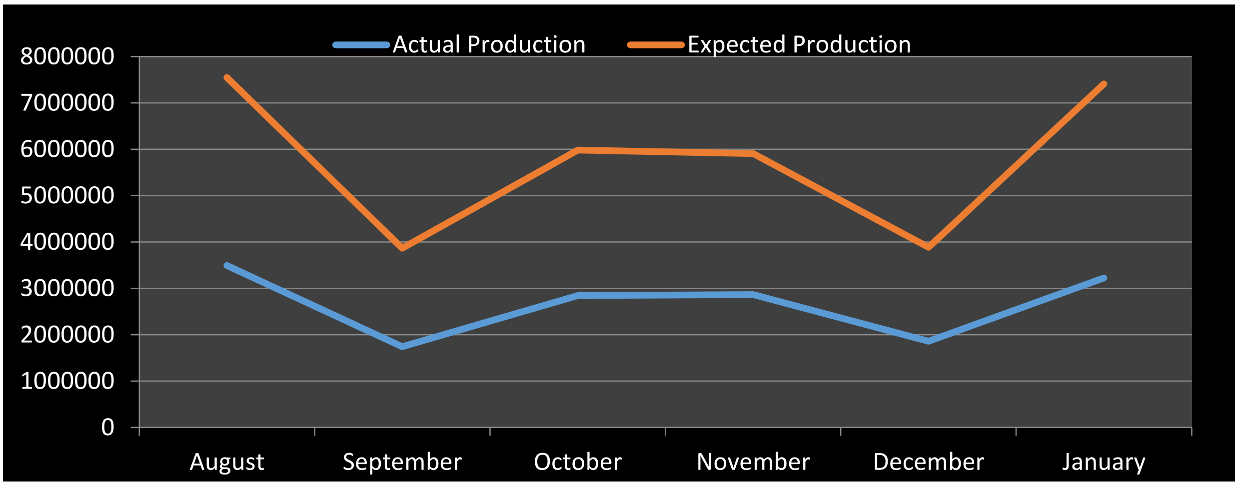


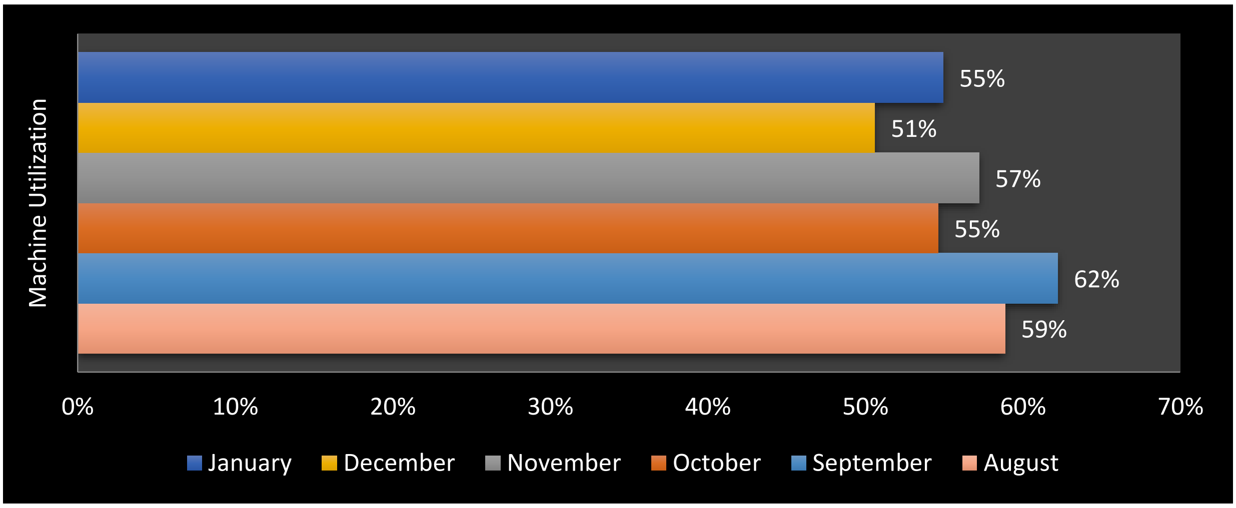
Figure 3.3: Production Comparison: Expected Vs Actual.

Figure 3.3 visualizes the clear 14% overall deviation in expected production considering average production/ Hour (each machine output/ min) and machine utilization time.

Table 3.5 & Figure 3.4 both shows the Machine utilization time, Loss time, Monthly efficiency & Productivity.

Table 3.5: Monthly Efficiency of Six months.

Month	Available time	Loss Time	MC Utilization	Efficiency		Productivity	
				Considering LT	Considering MC Utiliz	Considering LT	Considering MC Utiliz
August	345600	142150	203450	41%	59%	10	17
September	181440	68575	112865	38%	62%	10	15
October	267840	121555	146285	45%	55%	11	19
November	259200	110890	148310	43%	57%	11	19
December	172800	85356	87444	49%	51%	11	21
January	357120	160910	196210	45%	55%	9	16



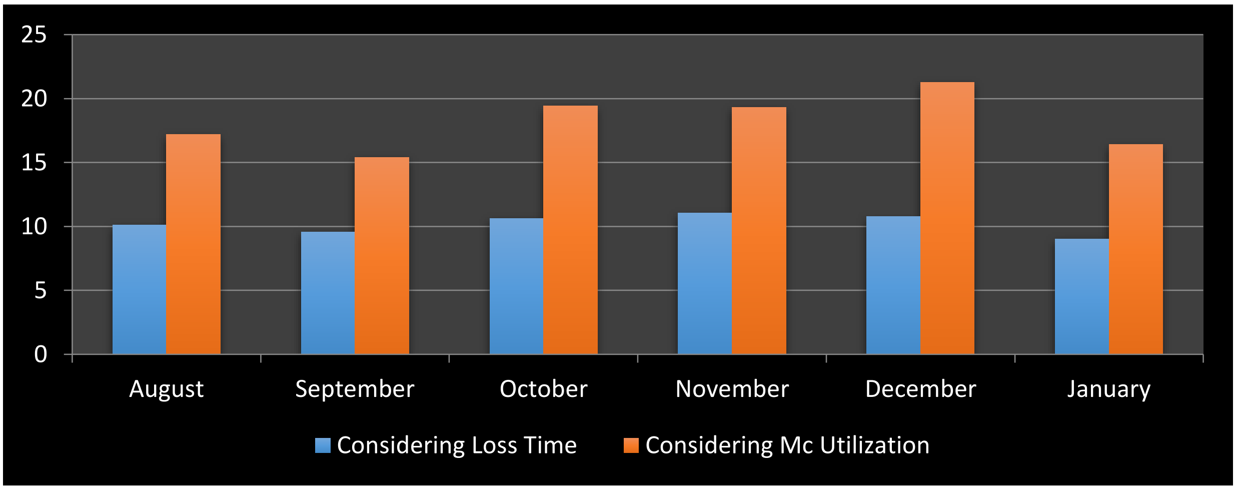


Figure 3.4: Monthly Efficiency & Output.

Table 3.6 shows category wise loss time for the six months here. It is classified in particular measure.

Table 3.6: Monthly categorized LOSS TIME.

Loss Time	Aug	Sept	Oct	Nov	Dec	Jan	Total
Power Failure/ Low Gas Pressure	1970	3840	5128	11920	3340	3830	30028
Mold Corking	61290	21400	36190	42940	22731	55335	239886
Maintenance Breakdown	33985	24295	35822	32240	18050	55590	199982
Heating	13400	5210	10085	9680	6345	13025	57745
Mold/ Cutter Change	3800	3290	5440	3340	9920	6680	32470
Others	27705	10540	28890	10770	24970	26450	129325
Total (Min)	142150	68575	121555	110890	85356	160910	689436

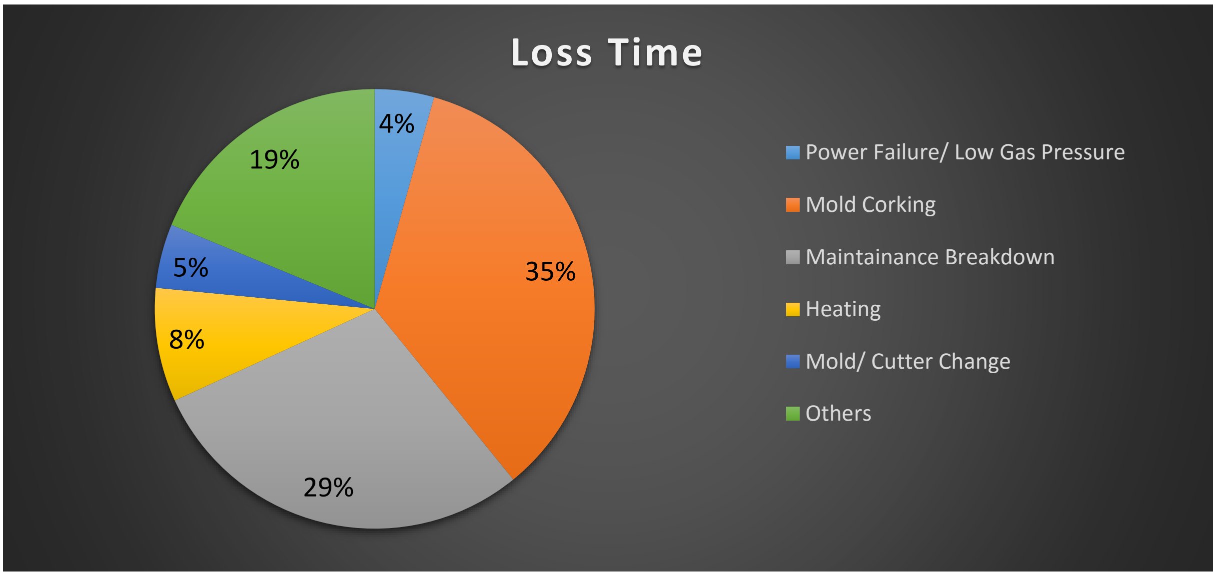


Figure 3.5: Loss Time percentage.

Figure 3.5 shows mold corking issues consuming 35% of total loss time and 29% machine breakdown. Other issues are also contributing 19% & significantly Heating & cutter related issues.

3.5 MOLD CORKING

A coating for the internal cavity of a mold for forming objects such as battery grids and the like including a perfluorocarbon film (e.g., tetrafluoroethylene) having dispersed therein heat-insulating particles (e.g., - talc). The thickness of the film and the size and amount of the heat-insulating particles are maintained within defined limits to allow formation of complete grids with easy release from the mold.

3.6 MBD ANALYSIS

Table 3.7 shows the Machine Breakdown frequency analysis which was collected for 3 months to understand the actual scenario & that helps to identify the problem which occurs most frequently. This can help to care and minimize the problem while preventive & breakdown maintenance going on.

Table 3.7: MBD Frequency Analysis.

MBD Problem	Code	Frequency	Relative Frequency
Cutter Problem	C	101	19%
Dispense Valve	DV	108	20%
Mold Issues	M	30	6%
Mold Heating	MH	63	12%
Mold Change	MC	23	4%
Mold Pin	MP	64	12%
Heating	H	38	7%
Ladle	LD	37	7%
Lead Pump	LP	21	4%
Conveyor Belt	CB	21	4%
Machine Issues	MI	26	5%
Other	O	7	1%

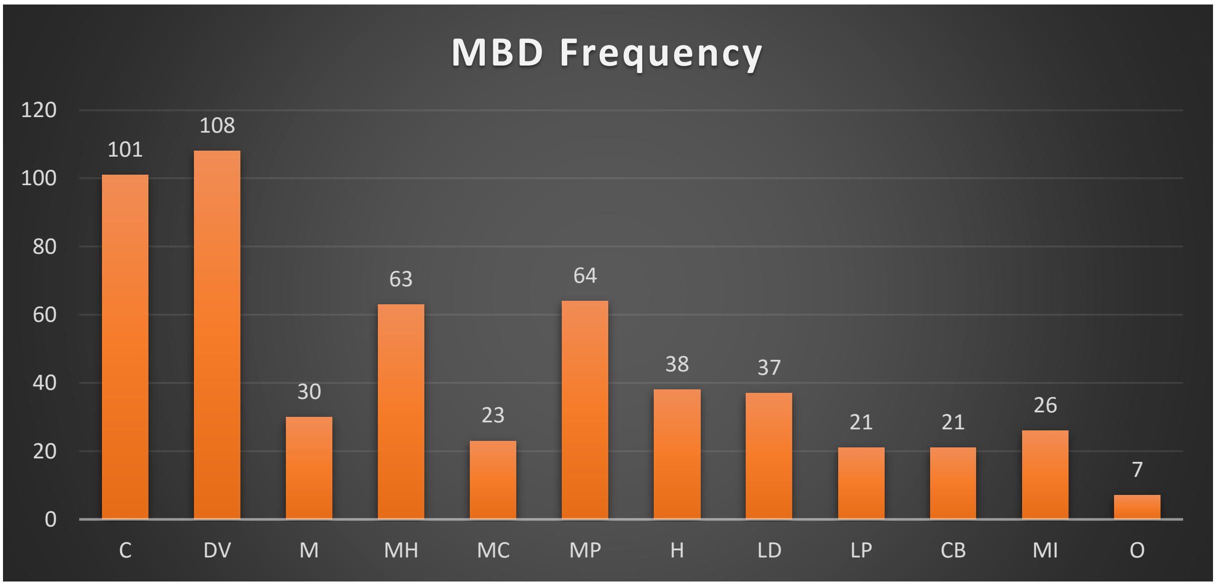


Figure 3.6: MBD Frequency Distribution.

Figure 3.6 shows the Cutter related problem and Dispense Valve relates issues are high in occurrence and about 19% & 20 % in cumulated relative frequency.

CHAPTER FOUR

FUTURE STATE MAPPING

4.1 PROCESS CAPACITY STUDY

Based on the collected data mentioning the time span the future state was developed. Production condition, production quantity & the area of small and medium improvements was identified considering existing capacity of grid production.

Compared the actual & existing scenario observations are made. Made those as suggestions which are under consideration and verifying with the existing procedure. All detailed work done are enclosed here and the detailed calculations are attached at the groceries.

According to the data and observation, suggestions are made for monitoring production floor, tracking work, productivity & preventive maintenance work.

The aim of the current work is to provide information on how to improve the productivity and quality in the, an experimental investigation has been carried out to validate numerical results. Some casting parameters have been measured and collected. The study results lead to a correlation between the current casting conditions and the future casting state. To obtain the best, a set of suggestions has been proposed.

There is a very good agreement between the current results and earlier numerical results. Also based on the results, one can gain an insight on the productions of each casting machine and the method of maintaining proper working condition [16].

Table 4.1 shows the actual initial capacity study of each machine here a time study is done in all machines to portray the actual scenario and identify the production capacity. In this phase of time study timing was taken for 15 grids and computed considering the parameters.

Table 4.1: Machine Capacity Time study.

M/C wise capacity data									
M/C	**Time/15**	**Average/15**	**Prod/Min**	**Average /Min**	**Prod /Hour**	**Average /Hour**	**Shift Prod**	**Daily Prod**	**With AlW**
W1	1.1424	1.161395	12.12	12.12	727	727	5819	17457	15130
	1.1425		12.12		727				
	1.1422		12.13		728				
	1.1427		12.12		727				
	1.1421		12.13		728				
DIAM	1.3352	1.33448	9.62	9.63	577	578	4623	13869	12020
	1.3337		9.64		578				
	1.3348		9.63		578				
	1.3345		9.63		578				
	1.3342		9.63		578				
W7	1.0862	1.08528	13.12	13.13	787	788	6304	18912	16390
	1.0839		13.16		790				
	1.0857		13.13		788				
	1.0848		13.14		789				
	1.0858		13.12		787				
W2	1.0835	1.08344	13.17	13.17	790	790	6321	18963	16435
	1.0828		13.18		791				
	1.0843		13.15		789				
	1.0827		13.18		791				
	1.0839		13.16		790				
W3	1.3438	1.34458	9.54	9.53	572	572	4573	13720	11891
	1.3453		9.52		571				
	1.3447		9.53		572				
	1.3442		9.53		572				
	1.3449		9.52		571				
W6	1.1032	1.10454	12.80	12.77	768	766	6132	18395	15942
	1.1055		12.76		765				
	1.1038		12.79		767				
	1.1045		12.78		767				
	1.1057		12.75		765				

Average Production/Mc	**Prod/Hour**	**Prod/Shift**	**Prod/Day**
	1407	11257	33772

Table 4.2 shows better accuracy in the calculation of a second time study. In this phase of capacity study 20 observation are considered for accuracy and production pattern. Some type of Grid is mentioned for reference and output was shown considering 5% process loss.

Table 4.2: Capacity Study Individual Machine.

			Timing for 20 Observations						Production			
Machine	**Grid**	**Weight**	**1**	**2**	**3**	**4**	**5**	**Average**	**Min**	**Hr (45 Min)**	**Shift**	**5% P L**
W1	Tx 1.4	126	96.82	96.75	96.85	96.8	96.78	111.41	11	485	7755	7367
W2	Tx 1.2	106	98.07	98.25	98.17	98.13	98.21	102.04	12	529	8468	8044
W3	Tx 1.9	152	120.44	120.7	120.6	120.6	120.5	136.22	9	396	6343	6026
W4	Tx 1.7	142	111.1	111.1	111.4	111.2	111.2	126.53	9	427	6828	6487
W5	Tx FL 1.6	90	91.69	91.56	91.85	91.73	91.79	90.85	13	594	9511	9035
W6	CHN FL 1.35	79	78.19	78.35	78.11	78.29	78.47	78.6	15	687	10993	10443
W7	CHN FL 1.35	79	78.24	78.09	78.33	78.23	78.15	78.62	15	687	10989	10440
YUSA	Tx 1.4	126	92.82	92.98	92.73	92.85	92.89	109.41	11	494	7897	7502
DIAM	Tx 1.4	126	104.8	104.8	104.7	104.9	104.8	115.38	10	468	7489	7114

To obtain this calculation 9 machines were studied and each time 20 observation was taken. Whreas sample size is 20 and it was done for 5 times for more accuracy of calculation. After that average were taken for each type of grids and productivity for each machines were accounted.

4.2 CAPACITY IDENTIFICATION:

From the standpoint of economy, it is desirable to operate a grid casting machine on the shortest time cycle which is practical. This time cycle may be generally divided into three successive intervals; namely, filling the mold, solidification of the grid and mold opening and closing. The grid is ejected from the mold during the mold opening and closing interval. Accordingly, the quicker the grid can be ejected from the mold and out of the path of travel of the movable mold half, the shorter the time interval required for opening and closing the mold. The machine utilization is considered 45 min/ hour but if we can maintain such pace regulating other factors to monitored properly we can achieve more in this specific time bound.

As the production rate on a grid casting machine is increased the temperature of the mold tends to increase as does the tendency for the mold to warp. Mold warpage is minimized to some extent by utilizing large anti-warping coat on the mold sections. Conventional molds have produced generally satisfactory results when grids are cast at a rate of not more than about 15 per minute.

Table 4.3 shows the estimation of capacity considering the average production found in the previous study. Where the other parameters and considerations remains same. Afterwards, the comparison is also shown in here.

Table 4.3: Estimated capacity calculation.

Capacity								
Production Data			**Production/ Machine**				**Total Capacity (Grid Casting)**
			Min	**Prd/Hr**	**Prd/Shift**	**Wt/AlW**	
Time	480	Min/shift	15	1800	14400	10800	9039600
Shift	3	Shift/ day					
Days	31	Days/month					
Machine	9	Each Shift					
Avg Prod	15	Mc/ min					
Allowance	15	Min/Hr					

Earlier capacity:	7066817 Pcs. Obtained from the average output/ min considering previous 6 months' production data.
Estimated Capacity:	9039600 Pcs. Considering Mc utilization time and proper monitoring on each shift.
Capacity Escalation:	1972783 Pcs. each month 15 pcs/ min with improved productivity and proper machine utilization. Which shows 27.916 ~ 28% capacity improvement can be possible.

4.3 HOURLY MONITORING LOG SHEET

To track down the activity during production time an activity check list for each hour is been suggested. Hourly monitoring facilitates the immediate action for achieving the shift target as well as the hourly target. Which allows the organization to fulfill its production requirement within the time bound. This reduces the reaction time of the maintenance team which helps to deride the meantime between failure and mean time to repair. As a result, it enhances the machine utilization time along with reducing the overall loss time.

In contrast with recomandation measures as a suggestion Hourly monitoring for Grid casting production and Performance Index were developed for tracking & monitoring. As they don't tract monitoring approach for hourly basis so this data is calculated and measured to compare with the current collected data to see whether it beneficial or not. So these data are from previous production data which are converted for ease of calculation [17].

4.3.1 WORKING METHOD

- Production data is collected for a machine for 3 shift overall a week.
- Loss time also considered for one week period.
- Target was set by new identified capacity and comparison in done on that consideration.
- Productivity, Efficiency, Utilization was calculated.

4.3.2 BENEFITS

- Track the individual activity during production hour.
- Help to improve machine, labor, resource utilization.
- Provide guideline for target achievement.
- Assist to identify the bottle neck and urge to take necessary steps to solve immidiately.

Table 4.4 represents the comparion found after employng the hourly monitoring log sheet in the grid casting floor for activity measure and target chasing.

Table 4.4: Production Scenario Comparison.

	Previous	Current	Difference
Production (Pcs)	156900	174800	17900
Productivity/ min	8	9	1
Efficiency	65%	72%	7%
Loss time (min/ day)	491	422	69
Utilization (min/ day)	949	1018	69

Table 4.5 shows the scenarion before applying the hourly monitoring log sheet & Table 4.6 shows the condition after applying the hourly monitoring log sheet in the grid casting production floor. From these the clear comparison of both senarios are easily visible. Table 4.7 shows a template of Hourly Monitoring Log Sheet.

Table 4.5: Previous Scenario of Grid Casting Production

Date	Shift	Target	Production Shift	Production Day	Daviation Shift	Daviation Day	Productivity Shift	Productivity Day	Efficiency Shift	Efficiency Day	Loss time Shift	Loss time Day	Utilization Shift	Utilization Day
	M		8100		3400		8		70%		150		330	
1	**E**		8000	24100	3500	10400	8	8	70%	70%	150	440	330	1000
	N		8000		3500		8		70%		140		340	
	M		8000		3500		8		70%		150		330	
2	**E**		8100	24100	3400	10400	8	8	70%	70%	140	420	340	1020
	N		8000		3500		8		70%		130		350	
	M		6600		4900		7		57%		210		270	
3	**E**		8000	20400	3500	14100	8	7	70%	59%	140	560	340	880
	N		5800		5700		6		50%		210		270	
	M		8100		3400		8		70%		150		330	
4	**E**	11500	8000	24300	3500	10200	8	8	70%	70%	140	430	340	1010
	N		8200		3300		9		71%		140		340	
	M		6800		4700		7		59%		190		290	
5	**E**		8000	22800	3500	11700	8	8	70%	66%	150	490	330	950
	N		8000		3500		8		70%		150		330	
	M		3000		8500		3		26%		350		130	
6	**E**		7400	18400	4100	16100	8	6	64%	53%	140	640	340	800
	N		8000		3500		8		70%		150		330	
	M		6800		4700		7		59%		160		320	
7	**E**		8000	22800	3500	11700	8	8	70%	66%	150	460	330	980
	N		8000		3500		8		70%		150		330	
G Total		**11500**		**156900**		**84600**		**8**		**65%**		**491**		**949**

Table 4.6:Improved Scenario of Grid Casting Production.

Sl	Date	Shift	Target	Production Shift	Production Day	Daviation Shift	Daviation Day	Productivity Shift	Productivity Day	Efficiency Shift	Efficiency Day	Loss time Shift	Loss time Day	Utilization Shift	Utilization Day
		M		9400		2100		10		82%		135		345	
1	10/2/2016	E	11500	9350	27400	2150	7100	10	10	81%	79%	120	395	360	1045
		N		8650		2850		9		75%		140		340	
		M		6350		5150		7		55%		240		240	
2	11/2/2016	E	11500	8450	24800	3050	9700	9	9	73%	72%	110	410	370	1030
		N		10000		1500		10		87%		60		420	
		M		6900		4600		7		60%		195		285	
3	12/2/2016	E	11500	9650	26150	1850	8350	10	9	84%	76%	90	360	390	1080
		N		9600		1900		10		83%		75		405	
		M		6400		5100		7		56%		225		255	
4	13/2/2016	E	11500	3750	19550	7750	14950	4	7	33%	57%	320	620	160	820
		N		9400		2100		10		82%		75		405	
		M		6000		5500		6		52%		265		215	
5	14/2/2016	E	11500	9650	25350	1850	9150	10	9	84%	73%	90	415	390	1025
		N		9700		1800		10		84%		60		420	
		M		8650		2850		9		75%		110		370	
6	15/2/2016	E	11500	9400	27400	2100	7100	10	10	82%	79%	135	320	345	1120
		N		9350		2150		10		81%		75		405	
		M		8850		2650		9		77%		130		350	
7	16/2/2016	E	11500	9350	24150	2150	10350	10	8	81%	70%	75	435	405	1005
		N		5950		5550		6		52%		230		250	
Grand Total			**80500**		**174800**		**66700**		**9**		**72%**		**422**		**1018**

Table 4.7: Hourly Monitoring Log Sheet.

X Batteries Limited				Plate Preparation Hourly Production Log Sheet										
Casting M/C:			Grid Type				Shift				Target			Date:
Production			Loss Time							MBD Description				
Time	Production Qty (in pcs)	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
6 am															
7 am															
8 am															
9 am															
10 am															
11 am															
12 am															
1 pm															
Total										Total			Target Daviation		
Casting M/C:			Grid Type				Shift				Target			Date:	
Production			Loss Time							MBD Description					
Time	Production Qty	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
2 pm															
3 pm															
4 pm															
5 pm															
6 pm															
7 pm															
8 pm															
9 pm															
Total										Total			Target Daviation		
Casting M/C:			Grid Type				Shift				Target			Date:	
Production			Loss Time							MBD Description					
Time	Production Qty	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
10 pm															
11 pm															
12 pm															
1 am															
2 am															
3 am															
4 am															
5 am															
Total										Total			Target Daviation		

4.4 PERFORMANCE INDEX

Table 4.8 shows the data collection format for performance index. Here data is represented and calculated considering the following factors for calculating operators performance.

Table 4.8: Data Collection method for performance index.

Sl	Name	Id	Qmt Target	Total Production	MBD	Other	Achievement			1st Week						
										1	2	3	4	5	6	7
1	Mr. Aaaa	10144750	56500	50700	990	140	90%	Daily	Grid Type	TX 1.2	TX 1.4	TX1.2	TX 1.5	TX1.3	TX 1.6	TX1.4
									Target	8500	8500	8000	8500	8500	8500	6000
									Production	8200	7500	7500	8200	7500	6000	5800
									Achievement	96%	88%	94%	96%	88%	71%	97%
									MBD	80	240	60	100	150	240	120
									Others	20	30	10	20	30	10	20
									Machine	W1	W2	W1	W7	W3	W1	W4
									Shift	M	E	N	E	M	N	E
2	Mr. Bbbb	10144751	57000	50500	1250	140	89%	Daily	Grid Type	TX 1.4	TX 1.4	TX1.2	TX 1.2	TX 1.4	TX1.3	TX 1.4
									Target	8500	8500	8500	8500	8500	6000	8500
									Production	7900	8100	6900	5500	8200	5500	8400
									Achievement	93%	95%	81%	65%	96%	92%	99%
									MBD	120	150	240	360	150	150	80
									Others	20	30	10	20	30	10	20
									Machine	W3	W7	W5	W6	W6	W7	W2
									Shift	E	M	N	N	M	N	E

Table 4.9 represents the final calculation and output model of the performance index that was suggested for evaluating operators performance. In this tabe according to operators performance the highranchy was calculated and it is suggested for operators moral boosters and performance recognition/ appraisal.

Table 4.9: Performance index sample.

Sl	Employee Name	Id	Production Achievement (50%)	Rating / Skill (10%)	Behaviour (50%)+ Attandence (50%) = Performance (10 %)	5S & Safety (5%)	MBD (20%)	Others (5%)	Final	Rank
1	Mr. Aaaa	10144750	91	85	90	75	132	32	39	2
2	Mr. Bbbb	10144751	90	90	79	80	173	37	30	3
3	Mr. Cccc	10144752	88	85	85	70	189	36	25	4
4	Mr. Dddd	10144753	92	85	90	85	98	41	46	1
5	Mr. Eeee	10144754	79	75	73	65	184	75	17	5

4.4.1 MEASURING METHOD

- Production Achievement is calculated from the average of Daily Achievement.
- Rating/ Skill which is set by the observer considering the employee's intellect, emotional stability, analytical skills, other psychological traits, Experience of the worker, Method of doing work, Dedication & Target chasing capability. This method makes it easy for the manager in placing the employees in appropriate teams.
- Behavior 50% also be set by the observer considering the worker's actual behavior. The behaviors differ according to the type of job been assessed. This method is considered favorable as the evaluation is done on the basis of individual employee performance without comparisons.
- Attendance 50% is converted the actual days that the employee performed/ assigned the job. His leave will affect this but his productivity or Achievement performance.
- 5S & Safety is considered on the basis of how well he manages his workstation & how respectful towards the safety measures.
- MBD & Others timing are converted to Person/Shift value & Compared with the monthly respective value converted to Machine/ Shift standard.

4.5 PROBLEMS SOLUTION & SUGGESTION

From a fishbone analysis the following problems are identified regarding the less production of grid casting. Among all necessary steps and suggestion are conglomerated here as for consideration. The conventional format was withdrawn here for the details description but we can also do it like wise [18].

Figure 4.1 shows the Fish Bone diagram for the problem classified in the respective manner found around the Grid casting floor for low productivity.

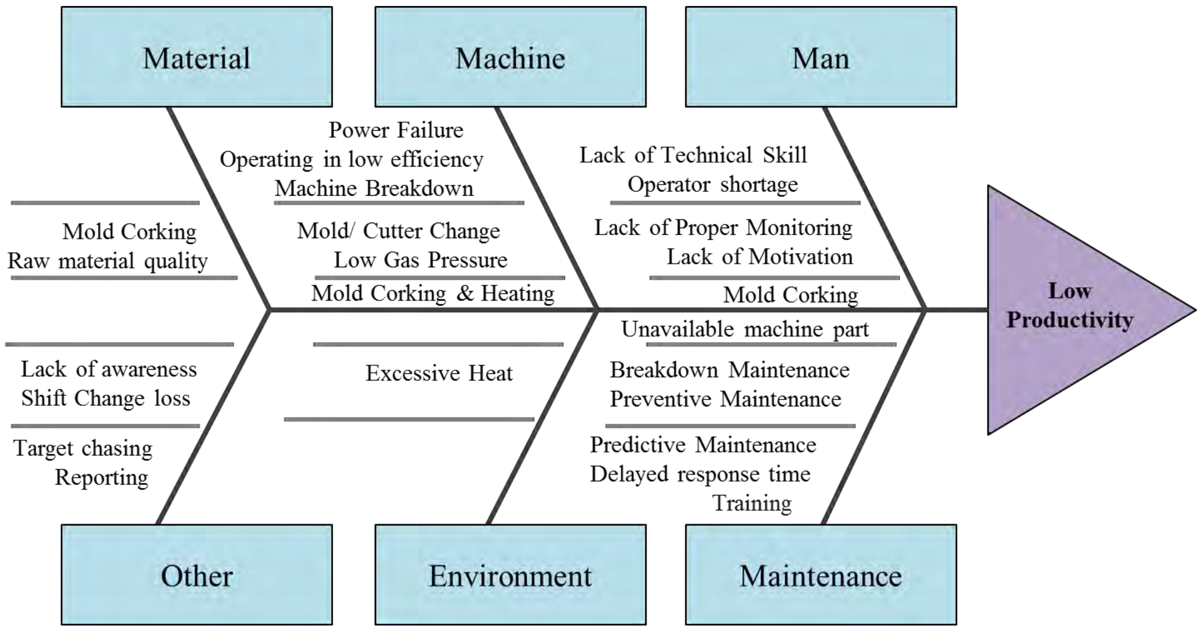


Figure 4.1: Fish Bone Diagram (Low Productivity of grid casting).

The causes and its related effect as well as suggestions are discussed here as follows. Improving the overall productivity is our concern so hampering issues regarded to it needs to minimize for better solution. All issues are considered for improvisation.

Man related Issues: To solve operator shortage ensure operator in each shift & each machine, providing detailed roster considering emergencies & other human factor related issues. To overcome the lack of technical skill related issues technical trainings are need to provide the operator so that they can do small & medium maintenance work without waiting for the maintenance personnel assistance. Besides trainings & other seminar may have held for improving employee understanding. To tackle lack of proper monitoring issues hourly monitoring log sheet should enforce for the pick season to reach the maximum desired capacity level. This improves the accountability of the worker. It will help to trace & track production as well as production related activity. To compensate the lack of motivation it requires to provide individual counselling, encourage contribution & bottom up information shearing, maintain workforce satisfaction, reward & celebrate achievements together. To improve the mold corking issues, ensure better mold corking method to reduce the number of corking in each shift, increase awareness to reduce the overall corking time.

Machine related issues: Machines operating in low efficiency reduces the capacity. Although the machines in floor are old & performing for very long time. So ensure preventive maintenance for smooth operation & work in adequate efficiency. To reduce the overall machine breakdown issues, it needs to reduce the response time of the maintenance personal, Train the operators to handle small & medium breakdown & improve awareness. Power Failure an un avoidable circumstance but providing generator power supply would do so but need to calculate cost benefit analysis & look for other alternative methods. To alleviate the mold corking time, it is mandatory for better quality grids. So appropriate method should be trained to reduce the corking time. Due to power failure & other breakdown, Excess lead bar in lead pot reduces the heat. Being concerned can reduce the heating issues. Decrease the time of changing the mold & cutter with proper monitoring, Reduce the occurrence of cutter & mold related issues. Alternate use of CNG in case of emergency can reduce low gas pressure related issues.

Raw material issues are highly dependable on quality and its dross percentage over the time it remains in air exposure. As Lead is so active material when it gets in contact of air is started to create dross. Better quality lead is already being used is studied organization. Need to concern in workplace to reduce the air exposure. To reduce the mold corking hassle finer grades of cork powder are highly advisable to use as better as possible which will result in reducing the number of corking in each shift.

Maintenance related issues: Unavailability of machine parts can be tackled by keeping in inventory to a significant amount considering the holding & material cost. Besides, training programs will enhance the collaboration between the maintenance workers & production workers. Breakdown maintenance must be done as early as possible setting the priority level. Operators need to be trained to solve small and medium maintenance to reduce the response time. Preventive Maintenance is in action consider the highest level of occurrence such dispense valve, mold & cutter related issues. Predictive Maintenance are those whose magnitude is higher in MBD is identified already so be ready all time when that breakdown occurs. Immediate action will reduce the repair time & increase the overall equipment availability. Improve response time, sometimes shift change of duties delayed the response time.

Excessive heatduring summer all air circulation & ventilation should monitor properly to operating smoothly. New exhaust fan should be installed for better air circulation and heat exit. This is the main concern in the environmental issues in the grid casting production floor. Improved reporting method such hourly monitoring, performance appraisal, loss time & breakdown analysis, production monitoring can increase the productivity. Lack of awareness in target chasing needs to monitor, guide & improve awareness. Shift start & end should monitor to reduce the shift change loss. It can be improved by assigning the duty 15 min before each shift handover. During the shift change it should make mandatory not to stop the machine & handover the responsibility on machine running condition.

Apart from these steps there are few KAIZEN activities are undertaken for the ease of operation and improving the working method as well as the working condition on the production floor. The issues, observation and recommendations are mentioned and illustrated as following.

4.6 ISSUES, OBSERVATION & RECOMMENDATION

4.6.1 Issue1: Manual Lead Bar Casting

Observation: In the small parts molding & Plate Parting extension it has been observed that when workers casting manually the Lead bars they keep the mold in floor and pouring the molten liquid lead in that mold. They collect the liquid lead from lead pot & pour it through a small pot into the lead mold. It's not ergonomically safe & sound for workers. It can injure the operator in the back for long term & reduce the working efficiency as well as effort remarkably [19].

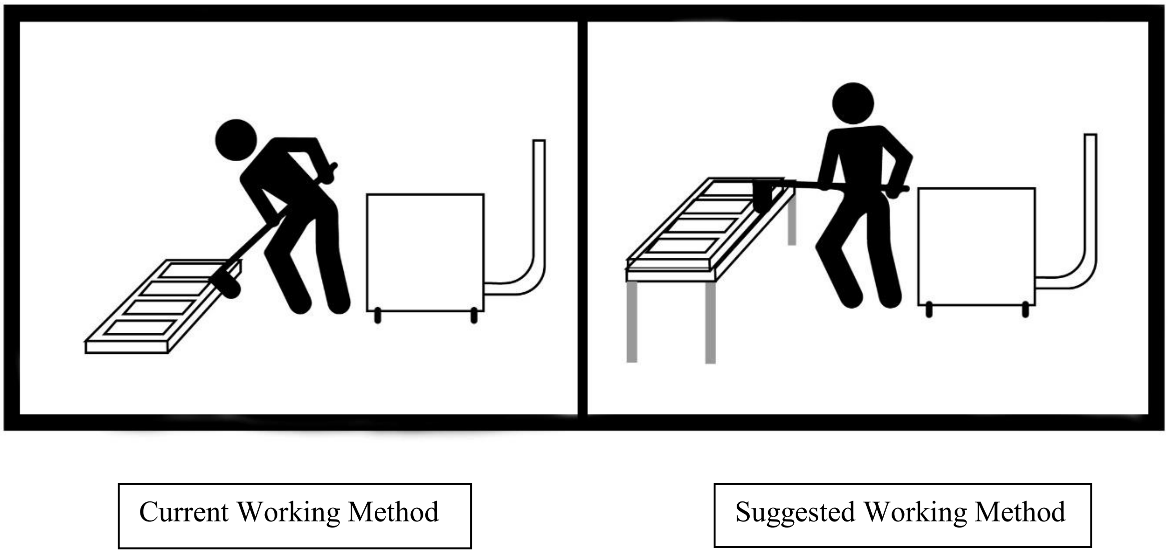


Figure 4.2: Lead bar Casting.

Figure 4.2 shows the previous working method where the worker has to bend his waist to perform his task and suggested working condition which is much more reliable and ergonomic than previous working posture.

Solution: Put those mold in a table adjusted to the worker's height so that it will reduce the working pressure and improve the worker's efficiency. The mold may keep in wet sacks and adjustable fan should keep in a position so that the cooling rate of lead bar gets faster. This will effect in increase of productivity and improved working method.

4.6.2 Issue 2: Excessive Temperature in Grid Casting Zone

Table 4.10 shows the observed temperatures of these factors. Heat is mandatory in this particular region due to furnace burner, ladle heater**,** environmental temperature etc.

Table 4.10: Temperature around the Casting machine.

	Min	Max	Tolerance(+/-)
Lead Furnace/Pot	485	520	10
Lead Pipe/ Feed Line	485	535	10
Ladle	500	540	10
Upper Mold	170	175	10
Lower Mold	180	200	10
Central Cooling Feed line	150	160	10
Cooling Water Temp	50	55	10
Environment (Near Ladle)	34.8	35.6	-
Environment (Around Furnace)	39.4	40.1	-

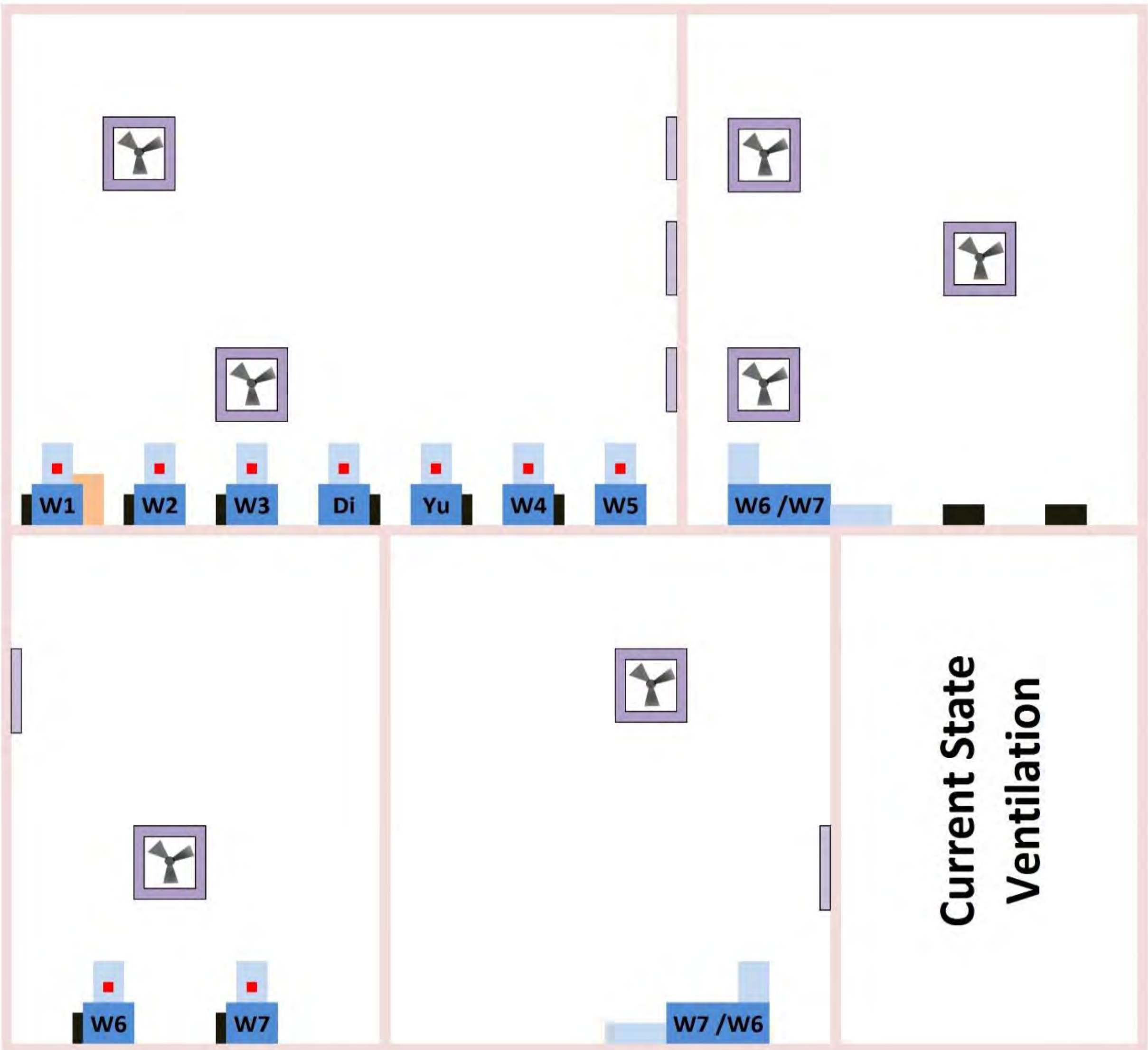


Figure 4.3: Current Ventilation of Grid casting zone.

Figure 4.3 illustrates the current condition of the grid casting zone with the ventilation process. Discussion: It is noticeable that this heat causing improper working environment. I monitored it in the beginning of February and imagine what worse it would be in the summer and pick season. Air ventilation system is not properly working. Exhaust system is in good working condition. It was observed that there are 7 exhaust fan existed in the current Grid casting floor.

Figure 4.4 shows the Proposed state of ventilation for grid casting zone with moderate ventilation.

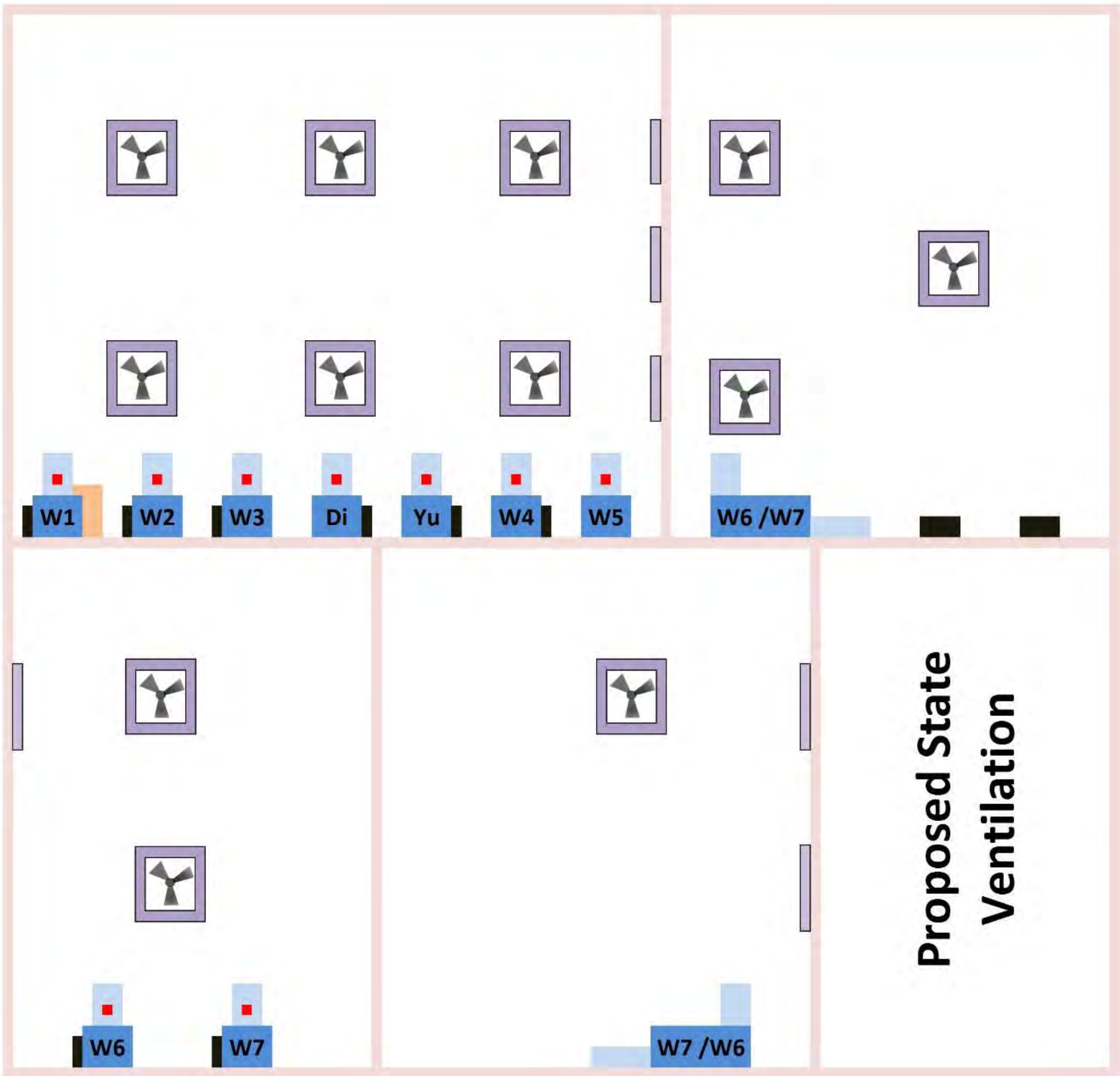


Figure 4.4: Proposed Ventilation for Grid casting zone.

Solution: Installing adequate amount of ventilation system. Currently there are 3properly working, 3 somehow working and single not working exhaust fans. Increase the number to 12 working exhaust fans would reduce the inside entrapped heat. Improve the air circulation inside the working environment.

4.6.3 Issue 3: Furnace Heat & Ladle Heat

Observation: Furnace & ladle heat is the key source of heat generation in the working environment. This two source get exposed in the environment and contaminated with the air and increase the working floor's temperature. As we have seen earlier that both source results in 34° - 40° C around the environment. This happens due to air exposure of these sources directly.

Solution:

- Redesign: Change the design of Lead bar furnace construction. Reducing the number of joins to the external and internal surface will alleviate the temperature transfer to the external surface.
- Install: A new layer combined of steel wool & heat sensitive cloth should attach around the external surface of the Lead furnace.
- Reduce Air Exposure: Covering up the upper portion of the burner guided to the direct air ventilation would do so. Make sure to keep there is as less as possible ways to get mixed with the direct environmental air.
- Cover: Provide a cover made by steel wool & heat sensitive cloth over the furnace cover. Provide single slot for feeding the lead bar and lead scrap. This will reduce the air contact and might be beneficial in the less dross generation and saving energy.

Discussing and shearing my observation with a worker I came up to that it can reduce the temperature effect drastically in the working floor.

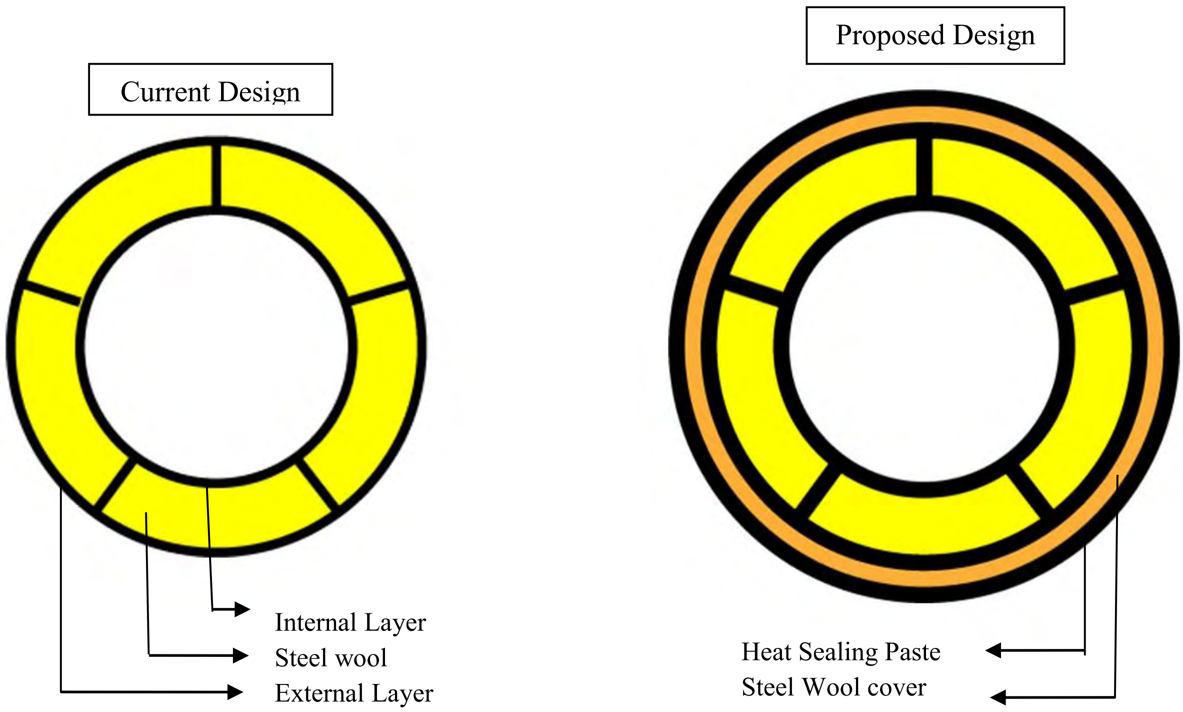


Figure 4.5: Lead Furnace Design.

Figure 4.5 illustrates the comparative furnace exterior design to prevent temperature related issues in the grid casting zone.

4.6.4 Issue 4: Sustainability

Observation: I was happy and amazed at the day one when I see everywhere safety sign and 6S culture. It requires less effort and concentration when somewhere 5S & Safety practices are already established. Due to unwillingness, awareness and other factors sustainability of these practices are pretty low.

Solution: Creating awareness and conduct training regarding necessity of safety measures is the key way to resolve this particular problem. As different health and safety issues related meetings are held here so it would be easy to implement.

4.6.5 Issue 5: Lead Consumption

Observation: Today there is a great desirability for a reduction in weight of lead storage batteries in order to improve the fuel economy in automobiles fitted with a storage battery, to increase the running distance performance of electric powered vehicles, and to improve portability of portable devices. Besides using more than allowance is considered as excess use of materials which is also a waste.

It is observed that in every shift grid casting and pasting production process lead was consumed above the allowed tolerance limit. This actually consume excess raw material compared with planed material requirement. Over uses of material is kind of waste. Most of the time the usage is over the standard value, sometimes even over the tolerance limit.

In spite of efforts to reduce the weight of the grid of the material having a large specific gravity of, for example, 11.3 for pure lead by making the grid thin, technical difficulties are still encountered in the production of a grid of 1 mm or less thickness by casting. In addition, the thin grid tends to be deformed in the subsequent paste filling process or curved during handling. For these reasons, the reduction in weight of the cast grid is limited.

Recommendation: Processes required lead consumption should monitor and design properly and create the awareness among every one regarding production, planning, staffs, workers & officers so that this issue can be minimized in appropriate measure. Need to follow as closer as standard value as well as reduce the tolerance limit.

Table 4.11 provides the sample weight data for a particular shift & Table 4.11 shows the calculation related to count the extra lead consumption during that shift.

Table 4.11: Weight Sample for Grid Casting

	Date:	7/02/2016	Shift	E	Standard	Weight	152+/-4	Gm
	Weight Measurement							
S/N	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM
Sample 1	152	153	153	154	152	153	153	152.6
Sample 2	152.1	153	153.1	154	152	153	153.1	152.6
Sample 3	152.1	152.9	153.2	153.9	152.1	153	153.1	152.6
Sample 4	152	152.9	153.2	153.9	152.1	152.9	153.1	152.7
Sample 5	152	153	155.3	153.4	152.1	152.9	153.2	152.7
Average	152.04	152.96	153.56	153.84	152.06	152.96	153.1	152.64
Extra	0.04	0.96	1.56	1.84	0.06	0.96	1.1	0.64

Table 4.12: Lead Consumption Grid Casting.

Grid Casting		
Production	6200	Pcs
Day Average	0.895	Gm
Required	942	Kg
Extra	6	Kg
Total	948	Kg

For only a grid casting machine it consumed approximate 6 kg in a shift. If we do the math for 9 casting machine it will sum up to 54 kg just in a shift.

4.6.6 Issue 6: Corking Method suggestion

Observation: Although it consists 35% of total loss time so this issue need to be in concern. This method of applying cork relates to forming objects and, more particularly, to a coating for molds such as are used in the forming of battery grids.

Battery grid casting is typically carried out on a semi continuous basis; and, from an economic standpoint, it is desirable to employ a method of grid casting which allows formation of the grid with a minimum cycle time yet which controls the freezing or solidifying of the metal so that a complete grid is formed. Typically, the cycle time may vary from perhaps one grid per minute for a large industrial battery grid to grids per minute for automotive batteries. Another requirement in casting operations of this type is that the formed grid must be able to be readily released from the mold surface. For this purpose, an appropriate technique and method has been suggested to do so.

Recommendation: Each kind of mold & casting types varies with its coating method. to standardize suggestion were made to make the coating solution in different pots so that no waiting time to make the solution exist. Besides for cooling the mold when ejected has to be done by air blower attached with the casting machine. Proper training is maintained for the appropriate method of coating in order to reduce the total corking time per shift. With major concern and willing ness to reduce the corking time employee and management coordination should be developed.

4.6.7 Issue 7: Floor Layout

Observation: The existing Floor layout all the process and machines were placed according to task but not in a way like process flow/ material flow.

Recommendation: It is time consuming as well as costly to bring any changes in existing floor layout but Suggested and Proposed Future layout is done based on VSM & Process/ Material flow for consideration.

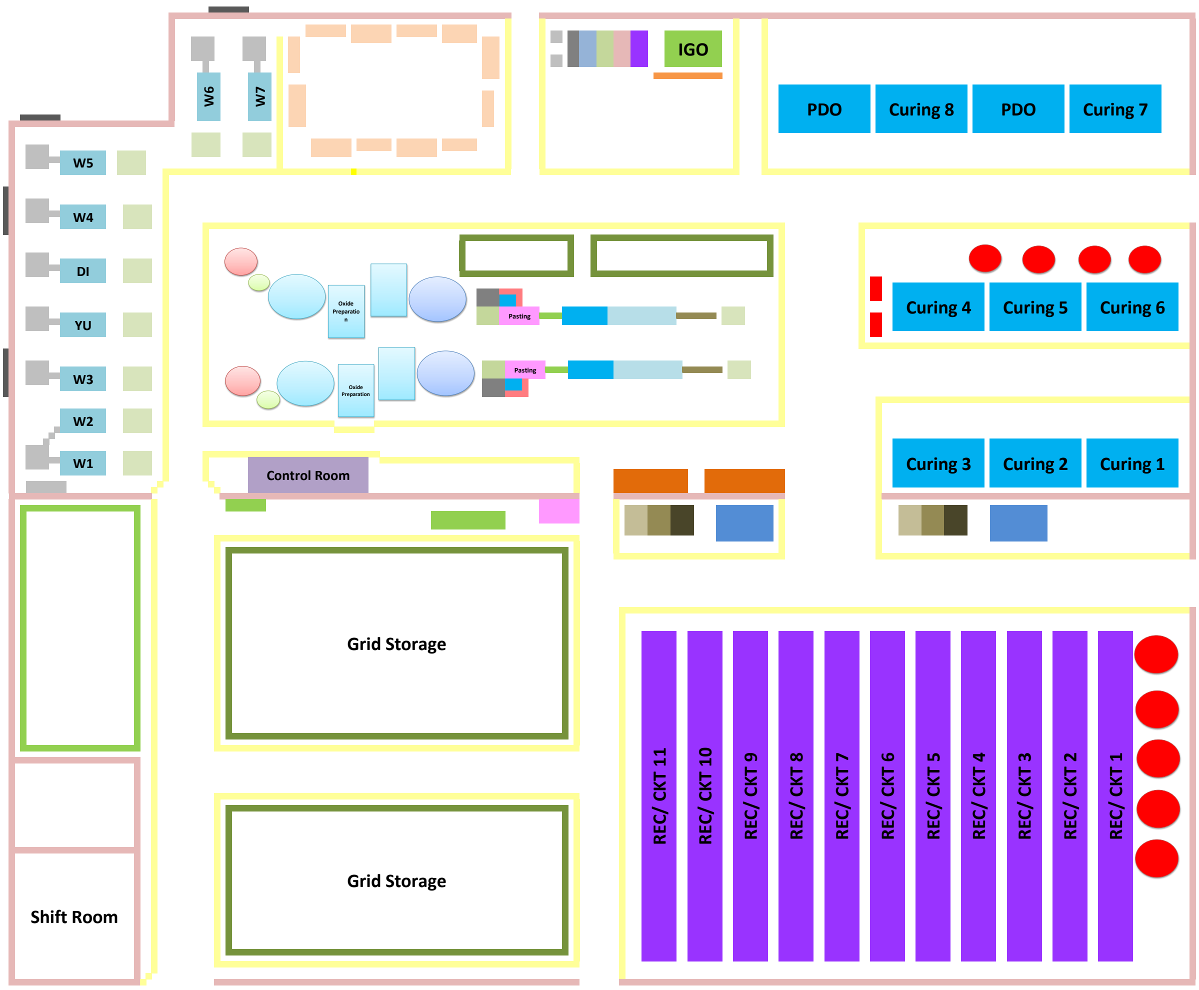


Figure 4.6: Plate Preparation Floor (Current Layout).

Figure 4.6 shows the present the current working floor scenario. Where workstations are arranged according to work flow.

Figure 4.7 shows the suggested floor layout considering material flow, work sequence, reducing over material handling and better monitoring. Besides compensating the environmental heat issues.

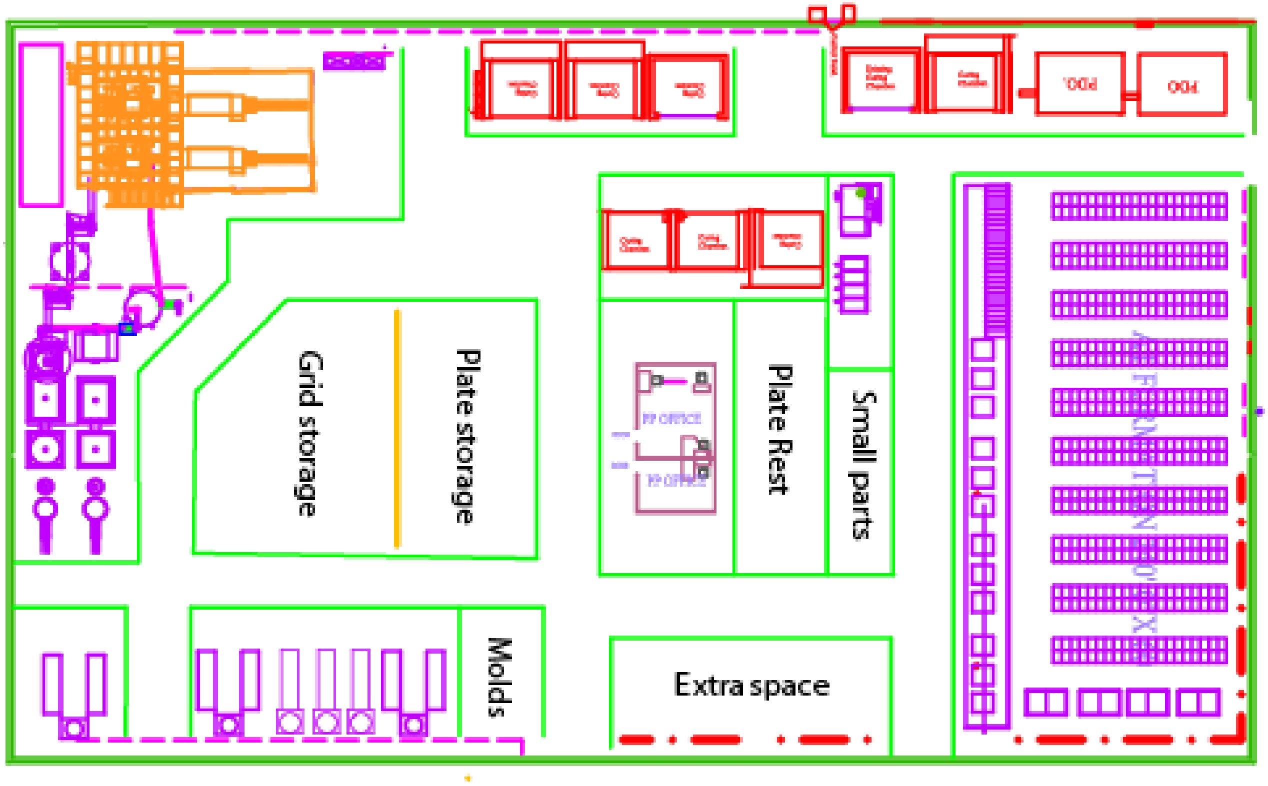


Figure 4.7: Plate Preparation Floor (Suggested Layout).

4.7 BENEFITS

- It provides sequential material flow in the production floor.
- It reduces the temperature effect in the working condition as the casting section remains in one corner which allows to eliminate heat easily.
- Maintaining adequate temperature will allow the grids aging time which can be reduce as 6-8 hours without Detroit the material solidification properties.
- Provide easy access to all section in the production floor.
- Provide better ventilation access.

CHAPTER FIVE

RESULTS & DISCUSSIONS

5.1 RESULTS

When it comes to the final decision there where a lot of possible routes to take as a prime finding; the one we started with, was not the one we ended up with. From the beginning the goals included, optimizing the resource utilization of the work floor in the production line. However, after the proper monitoring & guidance the production floor, these goals did not seem as relevant, when the utilization was measured to about below 12%. Because of this, the project changed towards becoming more of a general analysis, in order to assist the company with this problem. Since there were data available from the production, a lot of effort were put into acquiring machine data, in order to create an accurate picture of the grid casting production.

We know higher productivity leads to sustainable growth. Since none of the improvements have been tested in the system directly, the exact effect of them is not known yet. But by having breaks in shifts and making sure that the external part of the calculations is done in time, it would be possible to increase the utilization of the machine and resource 7~8 % and productivity about 21 % which may cause an overall improvement by 28 %; it does not include any improvements to the other stops or ramp up rather than grid casting, which also should be reduced by using the standardized work division and the standardized worksheets. As from the machine utilization time we get that the capacity is much higher than what we are getting in production. To enhance that production rate must be improved to atleast15 grids/ min which will lead to a capacity escalation to 1972783grids/ each month. However, it is not possible to calculate how much exactly for such bound.

Besides there are significant other fact which can't be neglected in the findings. They already practice 5s but sustainability wasn't found in person. So maintaining these for a 5 min daily basis will help to organize their work and generate a better working condition. Apart from that, corking method consumes a great degree of time in the daily working time. It is found that 35% of total loss time is consumed by corking and 29% machine breakdown as well as contributing 19% to other issues. It has been clearly seen that 14% overall deviation in expected production considering average production/ Hour (each machine output/ min) and machine utilization time. The average overall efficiency was found around 56%.

5.2 DISCUSSIONS

The work undergone in this thesis have also been focused on technical improvements, since there is a larger improvement potential in the organizational and method categories. However, there are investments which could help the production. By making small investments in the form of better tools for the Furnace, such as a protective cover, for used reducing the environmental temperature effect and enhance the working condition, it would be possible to reduce heat affect. Also as explained, there are a lot of different sources of information for the operator to observe. By collecting all the information and displaying it in one place, might make the operator notice stops earlier. Besides the performance index will help the operators to track their performances and work as motivating factor as well.

As described in the method, a choice was made to not trust the automatically generated data from the casting machines, because it showed contradictions to reality. Which is why the data was gathered by the more time consuming method, using the time study from the machines. The method used, resulted in data with higher quality, however, the production generated data from the machines, was not very far of. Moreover, if the data from the machines was used instead, more time could have been spent on analysis.

Therefore, clocked times were used instead. The clocked times for some activities were unreasonably long, because operators explained the work tasks while performing them. Therefore, the work tasks should be able to be performed quicker; this could result in a larger increase of utilization than calculated.

XBL makes a lot of different improvement projects, and some are left only partly finished. It is our belief that XBL needs to have a person continuously working with analyzing and improving the production, to drive improvement project from start to end. To utilize the full potential of the created standardized work division and worksheets, it is important to continue with the development. Consequently, this person could be the one responsible for this. Another benefit from adding a person responsible for improvements, is to establish a better contact between the production and the administrative departments. Apart from these changes there are a lot of other ones which possibly could be made. However, it is important that it is proven by actual measurements, that the specific investment is needed, and that the problem is not possible to solve with either method or organizational procedures first. The implementation of the improvements should be carried out with the operators, in order to get them involved in the change process. However, it is equally important that the production management is involved and do not hand over all responsibility to the operators. In the starting stages of the change process, it is important to gather a lot of feedback from the operators and make changes accordingly. It is also important to give the operators enough time and training, to be able to perform the new work methods.

If the operators are left on their own without sufficient support from the production management, the risk is higher that the project fails. When the changes have been implemented, it is important to analyze the results to make certain that the desired effects are reached. There are few other things observed which can't be overlooked for workers concern. A systematic working method may help to prevent this which should be taken care of. Environmental temperature issues should be considered for the well-being of working environment covering the ventilation issues, melting pot design.

Although there are few limitations of this study which are compared to be negligible and provide a scope for future study. Here, Grid types were minimized for identifying patterns and better understanding. All grid (most of) types are considered as same for the ease of calculation. For visual illustration no images were taken from working area and any kind of acquisition are inadmissible. Data collection is done primarily and may not verified/ matched with secondary data. Observation is done for specific period of time (General shift). Analysis and recommendation are also constructed on that basis may contrast on different time span. Studied organization maintains strict policy on information sharing and confidentiality, thus a lot of the information could not be included in this report to protect confidentiality. No implementation was done practically so exact improvement can't be defined as standard.

Therefore, to achieve the maximum level of integration of management and workers few recommendations were made here for consideration. To ensure operator in each shift & each machine pre planed work distribution should be maintained properly. Providing detailed roster considering emergencies & other human factor related issues which is prior to individual. Technical trainings sessions need to set up for the operator so that they can do small & medium level of maintenance work without waiting for the maintenance personnel assistance. Trainings & other seminar may hold for improving employee understanding and to promote team work.

Improved reporting method such hourly monitoring log sheet should enforce for the pick season to reach the maximum desired capacity level. This improves the accountability of the worker performance appraisal, loss time & breakdown analysis, production monitoring. It will help to trace & track production as well as production related activity. Provide Individual counselling, encourage contribution & bottom up information shearing. To continue workforce satisfaction, reward, recognition for performance should be implemented & celebrate achievements with everyone. Advance level of studies should be undergone to ensure a better mold corking method to reduce the number of corking in each shift, corking time and generate awareness to utilize the corking time wisely. This is mandatory for better quality grids. So appropriate method should be trained to reduce the corking time. Each kind of mold & casting types varies with its coating method. to standardize suggestion were made to make the coating solution in different pots so that no waiting time to make the solution exist. Besides for cooling the mold when ejected has to be done by air blower attached with the casting machine. With major concern and willing ness to reduce the corking time employee and management coordination should be developed.

Although the machines in floor are old & performing for very long time. So ensure preventive maintenance for smooth operation & work in adequate efficiency. Along with to reduce the response time of the maintenance personal, training should be provided to the operators to handle small & medium breakdown and improve awareness by counselling.

Those magnitude is higher in MBD is identified already so be ready all time when that breakdown occurs and an immediate action will reduce the repair time & increase the overall equipment efficiency. Improve response time regarding shift change of duties delayed the response time. So start & end of shift should monitor to reduce the shift change loss. It can be improved by assigning the duty 15 min before each shift handover. During the shift change it should make mandatory to keep running the machine & handover the responsibility to eliminate the shift change loss.

As the comparison and interpretation is done considering short period of time so it might show in greater magnitude or differ to some extent in contrast of a long period of time. Few of the suggestion isn’t possible to apply within this time bound for other sort of restrictions inside the organization and work floor. So it’s hard to represent those results as major findings of this study. Recommendations were made after understanding and observing the actual situation. Most of them were appreciated and the organization management showed enthusiasm toward applying those findings.

CHAPTER SIX

CONCLUSIONS & RECOMMENDATIONS

6.1 CONCLUSIONS

This report has tried to raise and solve the problems that exists in the production floor of grid casting at XBL Limited. The problems derive mostly from the lack of standardization and the lack of measurements. In order to have standardized work methods, the staffing needs to be the same in both shift teams. For the Grid casting department to reach its full potential, it is important that the rest of the supportive departments also start working with standardization. If the standardized work division and worksheets are used; it should be possible to improve the current scenario from an average of 12 grids/ min to 15 grids/ minutes; this reduction of maintenance time would increase the productivity by 21 %. If the operators also would have the breaks in shifts and proper work monitoring an additional 7 % could be added, leading to a total production increase of 28 %.

However, the production increase is only possible if there is a viable production plan and the needed components are available. After the standardization changes, the largest losses remaining are, mold corking related issues. It remains the key obstacle which hinder the productive time. Therefore, it exists for further improvement.

Both the suggestions and observation are remaining as a guideline to follow but it should be a benefit if applied as a standardize change, however, the effect is not measurable while the changes are not implemented. Therefore, this improvement is not included in the results. In order to minimize the remaining losses, it is necessary to measure and document the occurring stops, to find the underlying reasons. If the reasons behind the stops are known, it may be possible to prevent them. There is a large improvement potential at XBL, even after the suggested changes. By continuously improving the standardized work division and updating the standardized worksheets, it is possible for XBL to increase the competitiveness.

6.2 RECOMMENDATIONS

Throughout this study it is always coherent with its objectives to achieve the enhanced solutions for each & individual problem findings. Though there are few margins which are associated to be trivial and offer a scope for future study. Here, Grid types were abated for identifying patterns and better understanding which can be done in vast range of data interpretation and study discretely to have a better scenario. All grid (most of) types are considered as same for the ease of calculation that makes this less critical to get a plot of current condition. Time is a restriction for data collecting it would have been more precise if concentrated studies are done with this approach. Observation is done for specific period of time (General shift). Analysis and recommendation are also constructed on that basis may contrast on different time span. Studied organization upholds strict policy on information sharing and concealment, thus a lot of the information could not be included in this report to protect confidentiality. Besides, for visual illustration no images were taken from working area and any kind of acquisition are inadmissible. Not every suggestion was implemented practically so exact improvement can't be defined in the first place.

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APPENDIX

Monthly Data analysis for six months is provided here as follows & detail data collection are attached with Excel file.

Table A1: August'15 Production Scenario.

Machine	7	Shift	3	Days	31
Production Data Analysis					**Total Quantity**
Expected Total Production Considering 13 Grid/ Min					8124480
Total Production Based on Mc Utilization					1749490
Actual Total Production based on current Condition					3494078
Based on Average Prod/Hour Total Month					7508304

Table A2: August'15 Shift wise Production.

	Production	**Productivity**	**Average**
M	1127321	32%	33%
E	1120956	32%	
N	1246016	36%	

Figure A1: August Shift Wise Production Scenario.

Table A3: August'15 Machine wise Production.

	Production	**Productivity**	**Average**
W1	599319	17%	11%
W2	484706	14%	
W3	372156	11%	
W4	245046	7%	
W5	229133	7%	
W6	541731	16%	
W7	513118	15%	
YUSA	275036	8%	
DIAM	234049	7%	

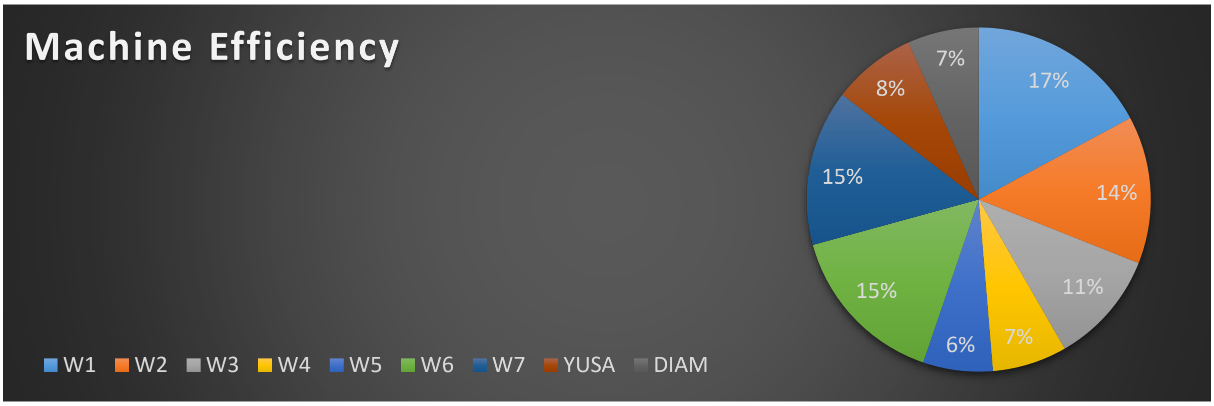

Figure A2: August'15 Machine Wise Efficiency.

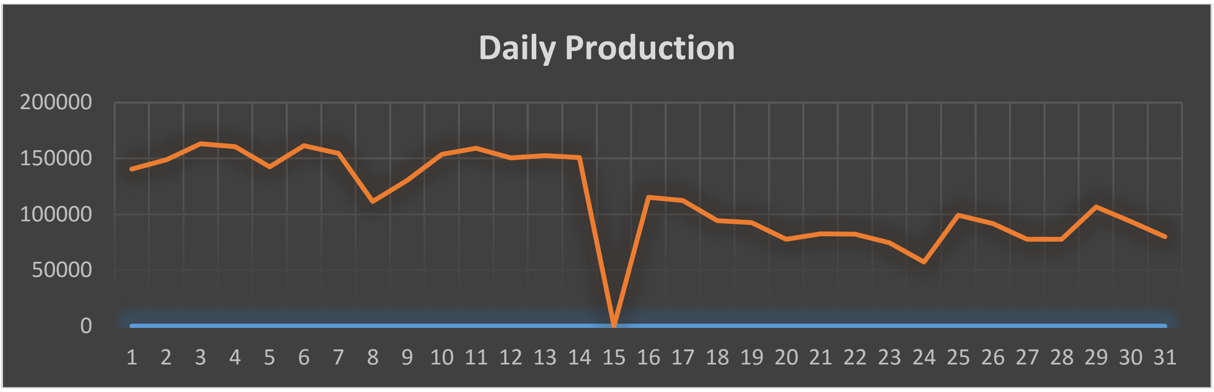

Figure A3: August'15 Daily Production Graph.

Table A4: August'15 Loss Time Calculation.

Shift Details			
	Shift	**Days**	**Total**
Total Shift	3	31	93

Considering 9 Machine & 480 minutes in each shift			
	Mc Hour/ Shift	**No of M/C**	**Total M/C Hour**
M/C Hour Available	44640	9	298080
Total Loss Time			142150
Machine Utilization			155930
Efficiency			52%

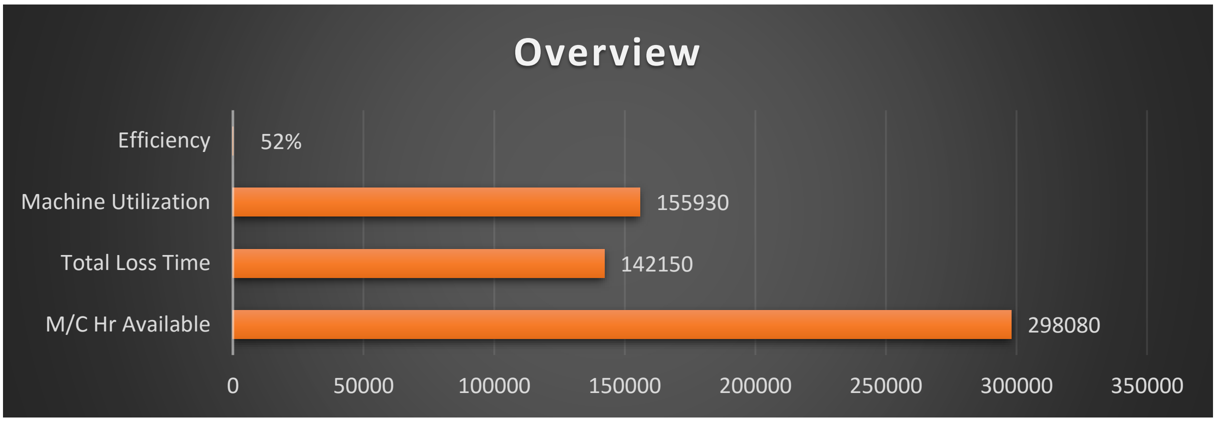

Figure A4: August'15 Monthly Overview.

Table A5: August'15 Shift Wise Loss Time & Percentage.

	Loss Time Code		
Shift	**PF**	**MCR**	**MBD**
M	1020	25250	12535
E	890	17120	13230
N	60	18920	8220
Total	1970	61290	33985
Loss Time Code	**H**	**MCC**	**OTR**
M	4900	2540	8970
E	4430	800	10695
N	4070	460	8040
Total	13400	3800	27705

Shift wise Total Loss Time

Shift	Total	Percentage	Average/Shift
M	55215	39%	**33%**
E	47165	33%	
N	39770	28%	

Machine wise Loss time & percentage			
Loss Time Code	**Loss time**	**LT/P%**	**Over all LT**
PF	1970	1%	48%
MCR	61290	43%	
MBD	33985	24%	
H	13400	9%	
MCC	3800	3%	
OTR	27705	19%	
Total	142150		

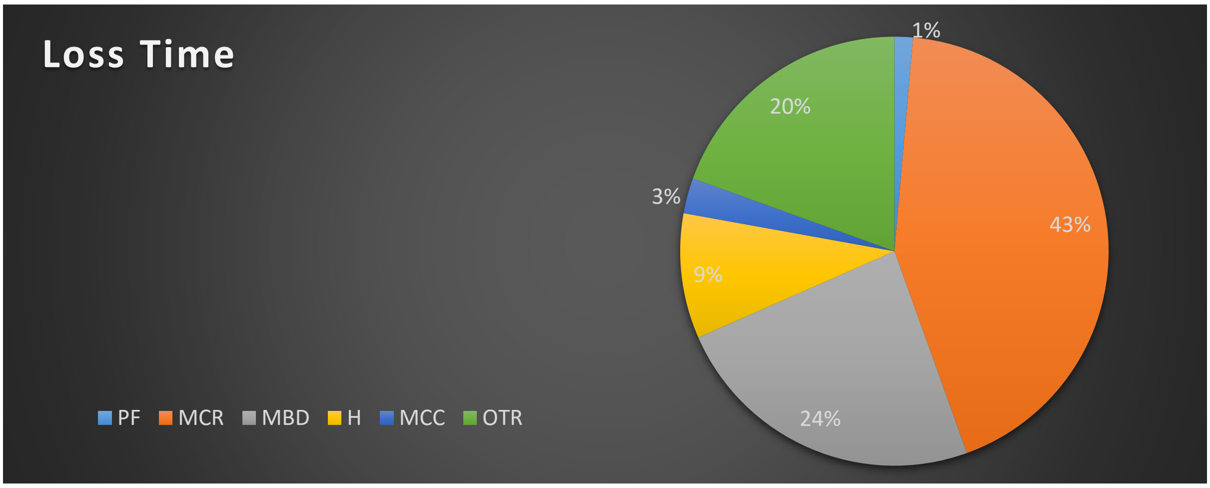

Figure A5: August'15 Total Loss time.

Table A6: August'15 Machine Wise Utilization & Efficiency.

Machine	M/C Utilization	Efficiency	Loss time
W1	22405	50%	22235
W2	24525	55%	20115
W3	28780	64%	15860
W4	35760	80%	8880
W5	29615	66%	15025
W6	23880	53%	20760
W7	31190	70%	13450
YUSA	30690	69%	13950
DIAM	32765	73%	11875
Average		65%	

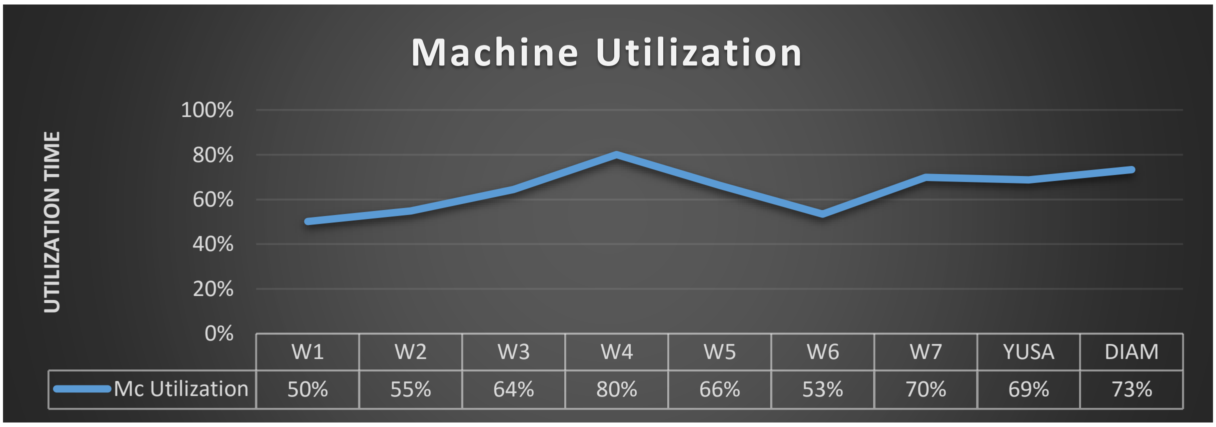

Figure A6: August'15 Total Machine Utilization.

Table A7: September'15 Production Scenario

Machine	6	Shift	3	Days	21
Production Data Analysis					**Total Quantity**
Expected Total Production Considering 13 Grid/ Min					4717440
Total Production Based on Mc Utilization					2146792
Actual Total Production based on current Condition					1738300
Based on Average Prod/Hour Total Month					4359661

Table A7: September'15 Shift wise Production

	Production	Productivity	Average
M	578028	33%	33%
E	530080	30%	
N	630430	36%	

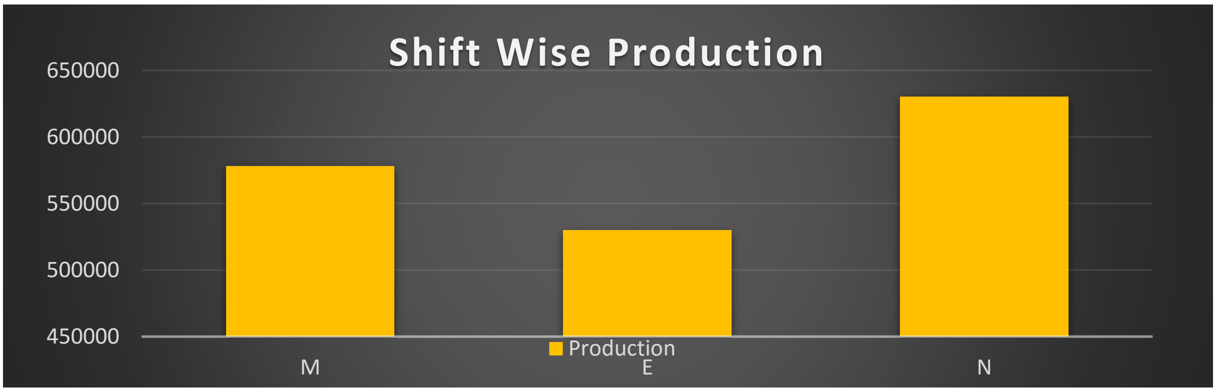

Figure A7: September'15 Shift wise Production.

Table A8: September'15 Machine wise Production

	Production	**Productivity**	**Average**
W1	24657	1%	12%
W2	16258	1%	
W3	292700	17%	
W4	204423	12%	
W5	56051	3%	
W6	374903	22%	
W7	376202	22%	
YUSA	261505	15%	
DIAM	131839	8%	

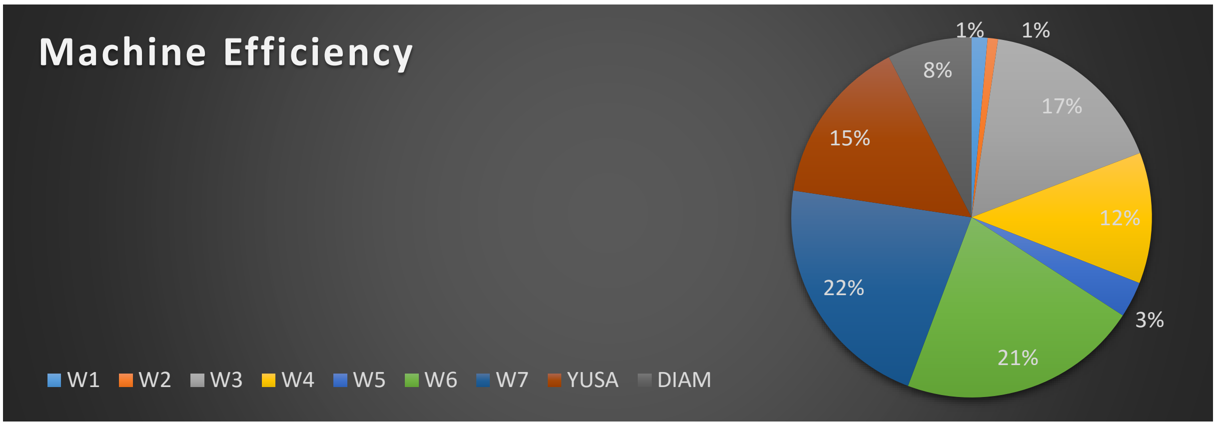

Figure A8: September'15 Machine Efficiency

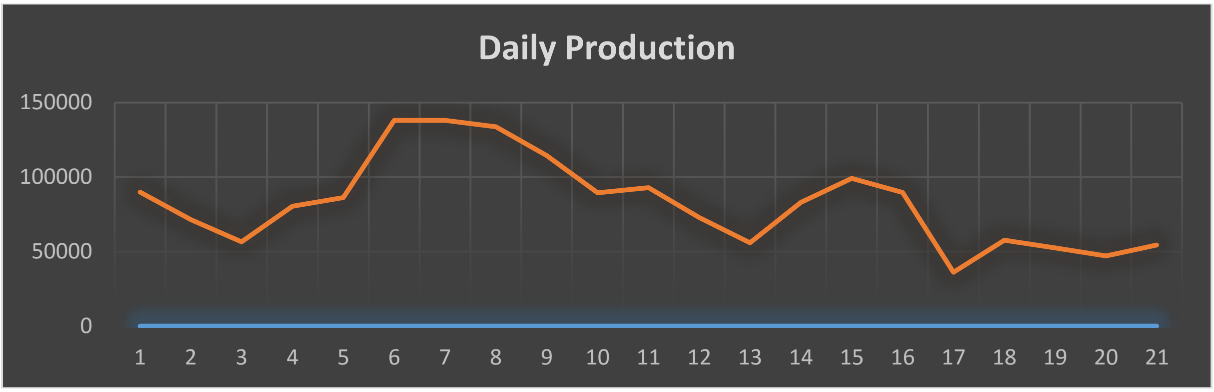

Figure A9: September'15 Daily Production Graph

Table A9: September'15 Loss Time Calculation

Shift Details			
	Shift	**Days**	**Total**
Total Shift	3	21	63

Considering 9 Machine & 480 minutes in each shift			
	Mc Hour/ Shift	**No of M/C**	**Total M/C Hour**
M/C Hour Available	30240	9	157920
Total Loss Time			68575
Machine Utilization			89345
Efficiency			57%

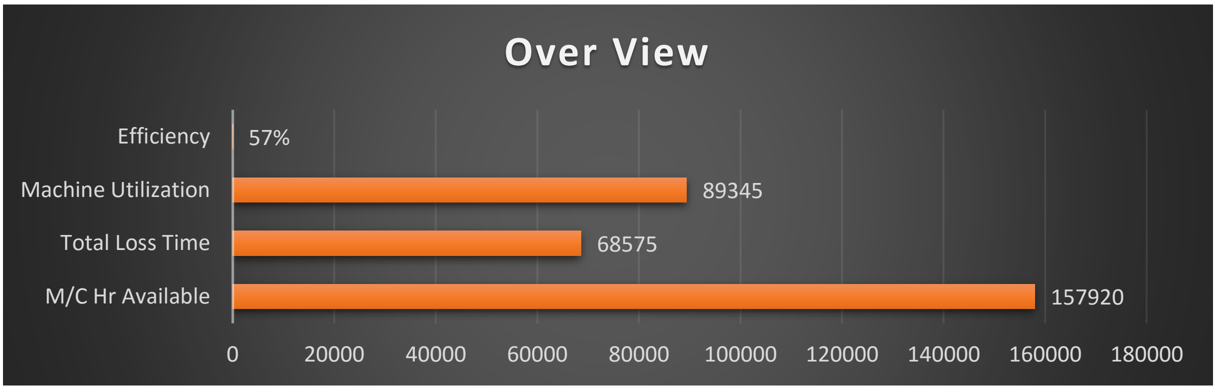

Figure A10: September'15 Monthly Overview.

Table A10: September'15 Shift Wise Loss Time & Percentage.

	Loss Time Code		
Shift	**PF**	**MCR**	**MBD**
M	1560	6900	8720
E	2230	6670	6495
N	50	7830	9080
Total	3840	21400	24295
Loss Time Code	**H**	**MCC**	**OTR**
M	1650	1950	2930
E	1500	1100	5550
N	2060	240	2060
Total	5210	3290	10540

		Shift wise Loss Time	
Shift	**Total**	**Percentage**	**Average/Shift**
M	23710	35%	**33%**
E	23545	34%	
N	21320	31%	

Machine wise Loss time & percentage			
Loss Time Code	**Loss time**	**LT/P%**	**Over all LT**
PF	3840	6%	43%
MCR	21400	31%	
MBD	24295	35%	
H	5210	8%	
MCC	3290	5%	
OTR	10540	15%	
Total	68575		

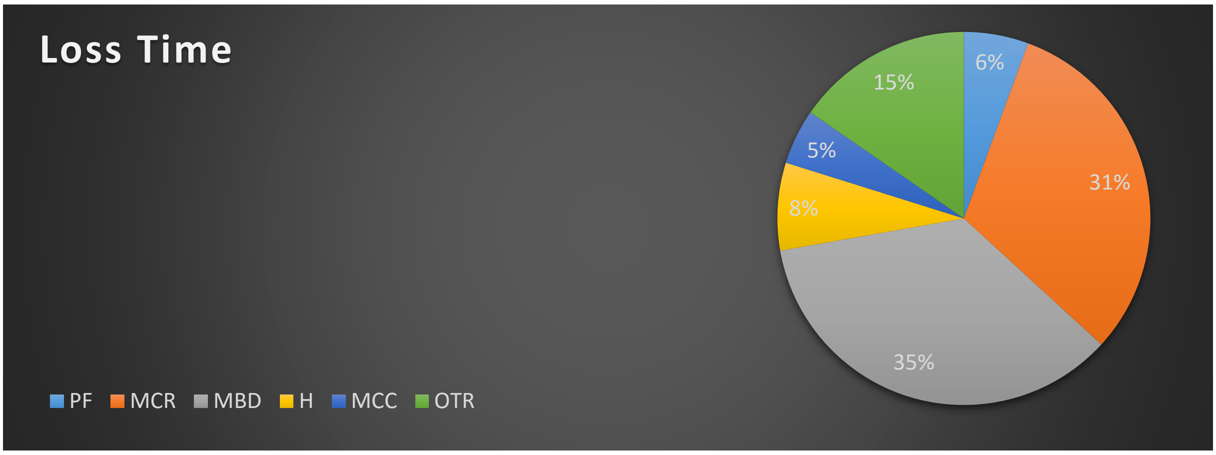

Figure A11: September'15 Monthly Loss time.

Table A11: September'15 Machine Wise Utilization & Efficiency

Machine	M/C Utilization	Efficiency	Loss time
W1	28870	95%	1370
W2	28960	96%	1280
W3	18305	61%	11935
W4	23910	79%	6330
W5	26780	89%	3460
W6	14510	48%	15730
W7	19310	64%	10930
YUSA	18840	62%	11400
DIAM	24100	80%	6140
Average		75%	

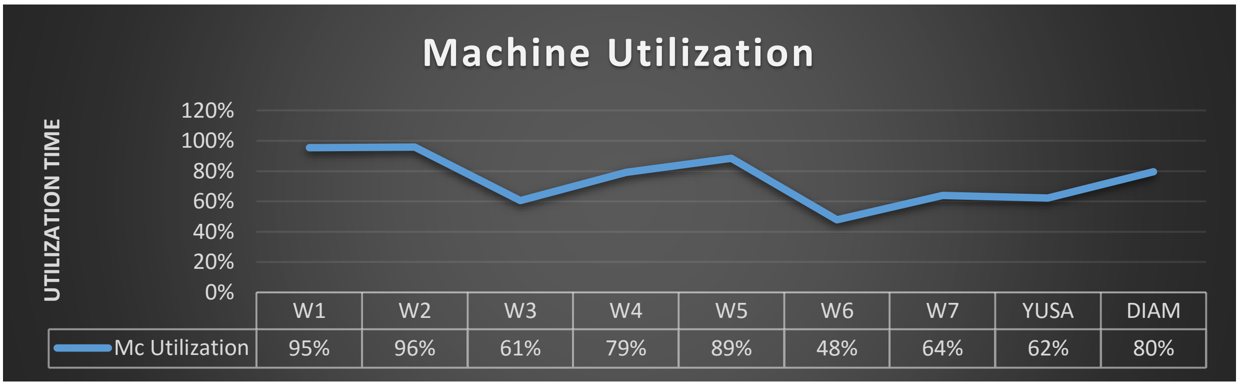

Figure A12: September'15 Machine Utilization.

Table A12: October'15 Production Scenario.

Machine	6	Shift	3	Days	31
Production Data Analysis					**Total Quantity**
Expected Total Production Considering 13 Grid/ Min					6963840
Total Production Based on Mc Utilization					1895530
Actual Total Production based on current Condition					2841700
Based on Average Prod/Hour Total Month					6435690

Table A13: October'15 Shift wise Production.

	Production	Productivity	Average
M	894994	31%	33%
E	941695	33%	
N	1005011	35%	

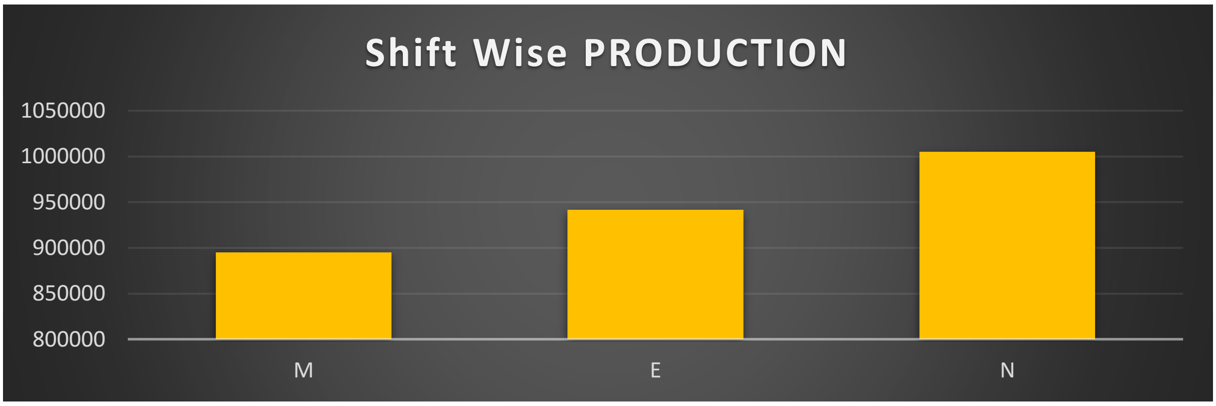

Figure A13: October'15 Shift wise Production.

Table A14: October'15 Machine wise Production.

	Production	Productivity	Average
W1	0	0%	14%
W2	93	0%	
W3	93	0%	
W4	460003	16%	
W5	455854	16%	
W6	447106	16%	
W7	62261	2%	
YUSA	583203	21%	
DIAM	333585	12%	

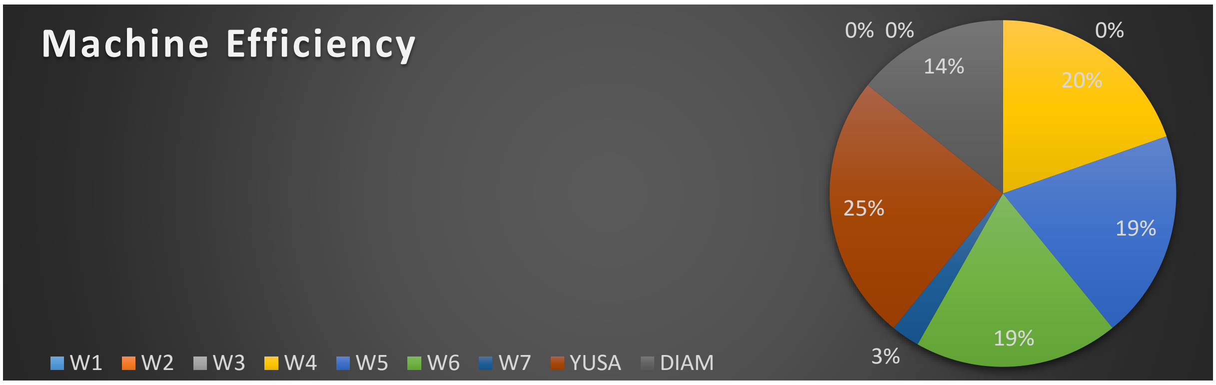

Figure A14: October’15 Machine Efficiency.

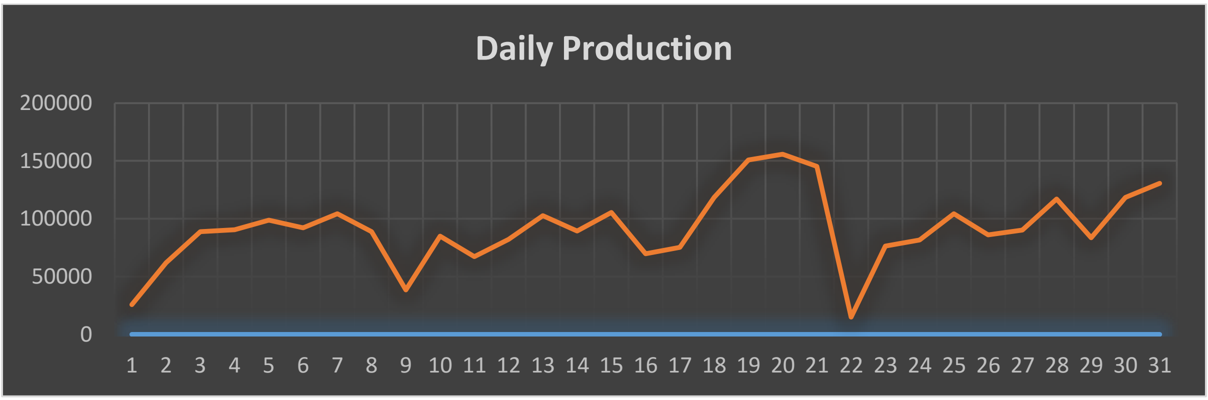

Figure A15: October’15 Daily Production Graph.

Table A15: October’15 Loss Time Calculation.

Shift Details			
	Shift	**Days**	**Total**
Total Shift	3	31	93

Considering 6 Machine & 480 minutes in each shift			
	Mc Hour/ Shift	**No of M/C**	**Total M/C Hour**
M/C Hour Available	44640	9	261600
Total Loss Time			121555
Machine Utilization			140045
Efficiency			54%

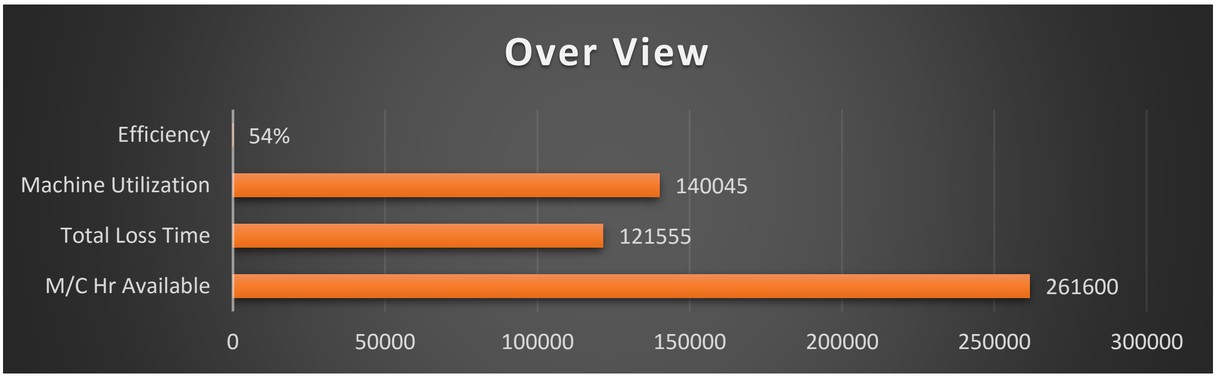

Figure A16: October'15 Monthly Overview.

Table A16: October'15 Shift Wise Loss Time & Percentage

	Loss Time Code		
Shift	**PF**	**MCR**	**MBD**
M	2905	11060	12551
E	1833	11840	12941
N	390	13290	10330
Total	5128	36190	35822
Loss Time Code	**H**	**MCC**	**OTR**
M	3700	2170	12510
E	2795	1950	8670
N	3590	1320	7710
Total	10085	5440	28890

Shift Wise Loss Time

Shift	Total	Percentage	Average/Shift
M	44896	37%	**33%**
E	40029	33%	
N	36630	30%	

Machine wise Loss time & percentage			
Loss Time Code	**Loss time**	**LT/P%**	**Over all LT**
PF	5128	4%	46%
MCR	36190	30%	
MBD	35822	29%	
H	10085	8%	
MCC	5440	4%	
OTR	28890	24%	
Total	121555		

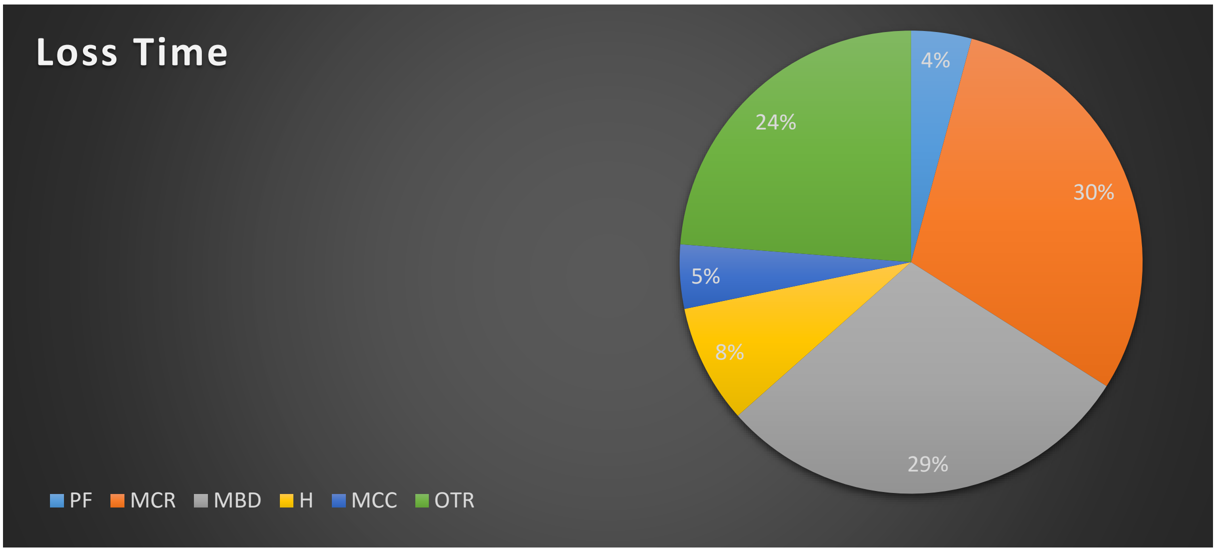

Figure A17: October'15 Monthly Total Loss Time.

Table A17: October'15 Machine Wise Utilization & Efficiency

Machine	M/C Utilization	Efficiency	Loss time
W1	44640	100%	0
W2	44640	100%	0
W3	26360	59%	18280
W4	22929	51%	21711
W5	25252	57%	19388
W6	38160	85%	6480
W7	26575	60%	18065
YUSA	28459	64%	16181
DIAM	23190	52%	21450
Average		70%	

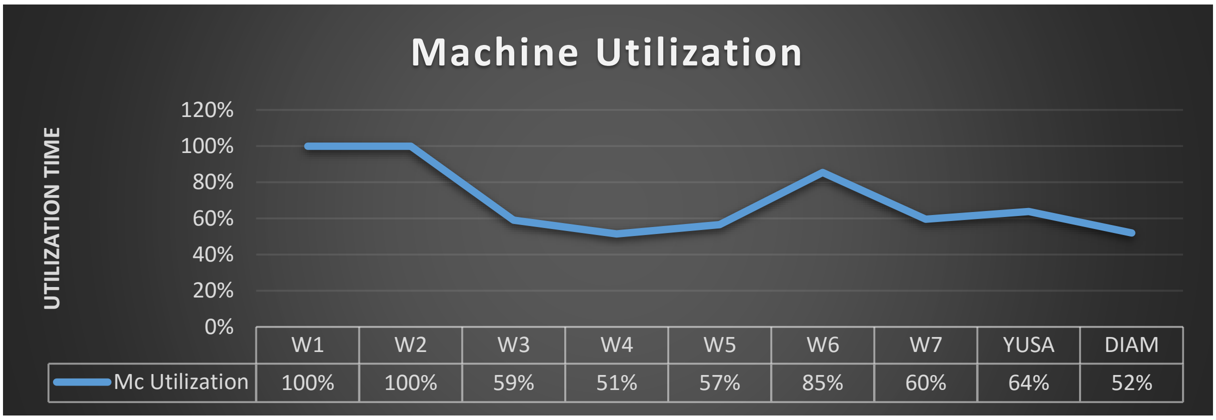

Figure A18: October'15 Machine Utilization.

Table A18: November'15 Production Scenario

Machine	6	Shift	3	Days	30
Production Data Analysis					**Total Quantity**
Expected Total Production Considering 13 Grid/ Min					6739200
Total Production Based on Mc Utilization					1928030
Actual Total Production based on current Condition					2863670
Based on Average Prod/Hour Total Month					5854800

Table A19: November'15 Shift wise Production

Shift	Production	Productivity	Average
M	967900	34%	33%
E	945550	33%	
N	950220	33%	

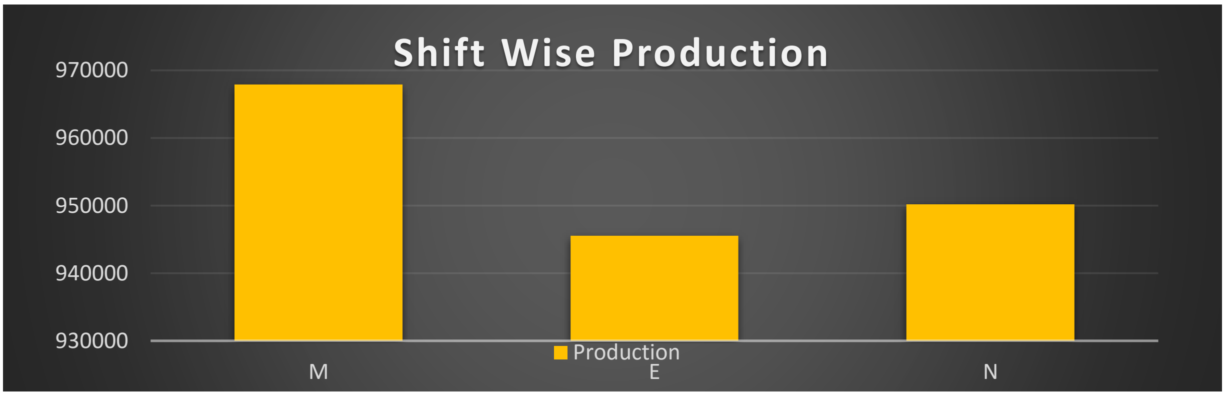

Figure A19: November'15 Shift wise Production.

Table A20: Machine wise Production.

Machine	Production	Productivity	Average
W1	430200	22%	25%
W2	337120	17%	
W3	0	0%	
W4	0	0%	
W5	0	0%	
W6	340450	18%	
W7	706400	37%	
YUSA	443900	23%	
DIAM	605600	31%	

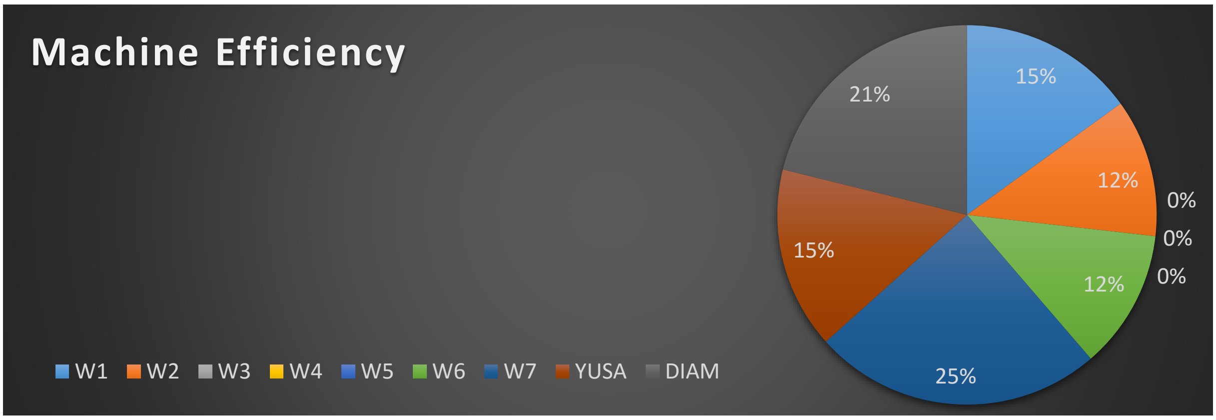

Figure A20: November’15 Machine Efficiency.

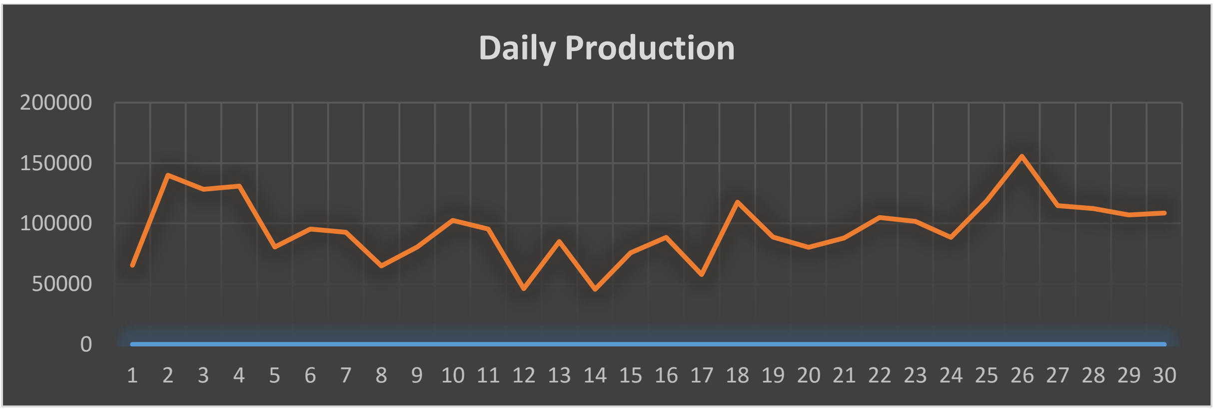

Figure A21: November’15 Daily Production Graph.

Table A21: November’15 Loss Time Calculation.

Shift Details			
	Shift	**Days**	**Total**
Total Shift	3	30	90

Considering 6 Machine & 480 minutes in each shift			
	Mc Hour/ Shift	**No of M/C**	**Total M/C Hour**
M/C Hour Available	43200	6	259200
Total Loss Time			110890
Machine Utilization			148310
Efficiency			57%

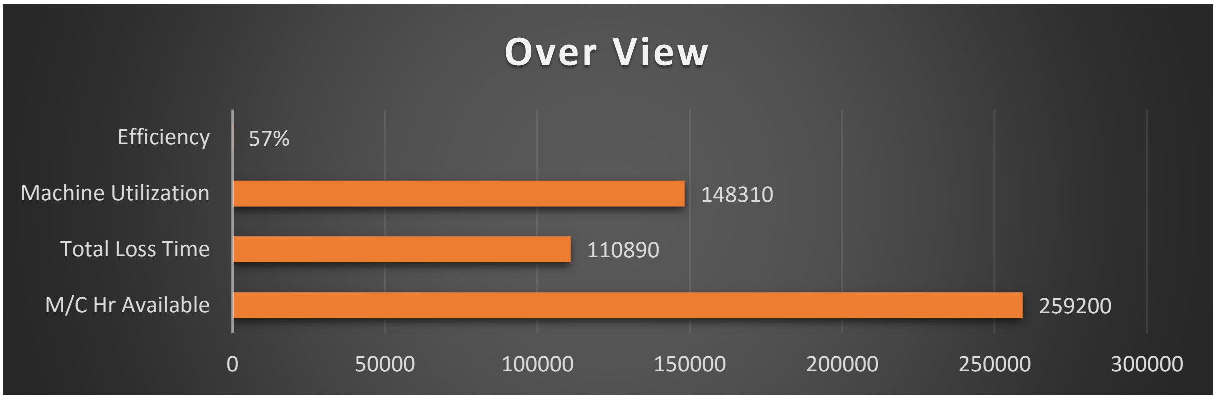

Figure A22: November'15 Monthly Overview.

Table A22: November'15 Shift Wise Loss Time & Percentage.

	Loss Time Code		
Shift	**PF**	**MCR**	**MBD**
M	5000	13220	11420
E	6420	14020	9750
N	500	15700	11070
Total	11920	42940	32240
Loss Time Code	**H**	**MCC**	**OTR**
M	2920	1580	4680
E	3020	1350	2990
N	3740	410	3100
Total	9680	3340	10770

Shift Wise Loss Time

Shift	**Total**	**Percentage**	**Average/Shift**
M	38820	35%	**33%**
E	37550	34%	
N	34520	31%	

Machine wise Loss time & percentage			
Loss Time Code	**Loss time**	**LT/P%**	**Over all LT**
PF	11920	11%	43%
MCR	42940	39%	
MBD	32240	29%	
H	9680	9%	
MCC	3340	3%	
OTR	10770	10%	
Total	110890		

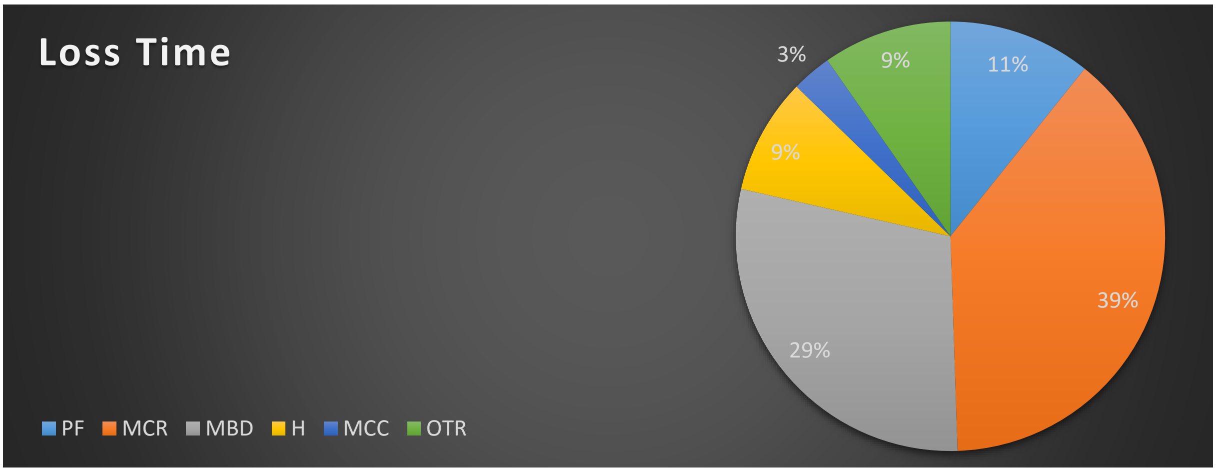

Figure A23: November'15 Monthly Total Loss Time.

Table A23: Machine Wise Utilization & Efficiency.

Machine	M/C Utilization	Efficiency	Loss time
W1	24730	57%	18470
W2	25220	58%	17980
W3	43200	100%	0
W4	43200	100%	0
W5	43200	100%	0
W6	20560	48%	22640
W7	26080	60%	17120
YUSA	27770	64%	15430
DIAM	23950	55%	19250
Average		57%	18482

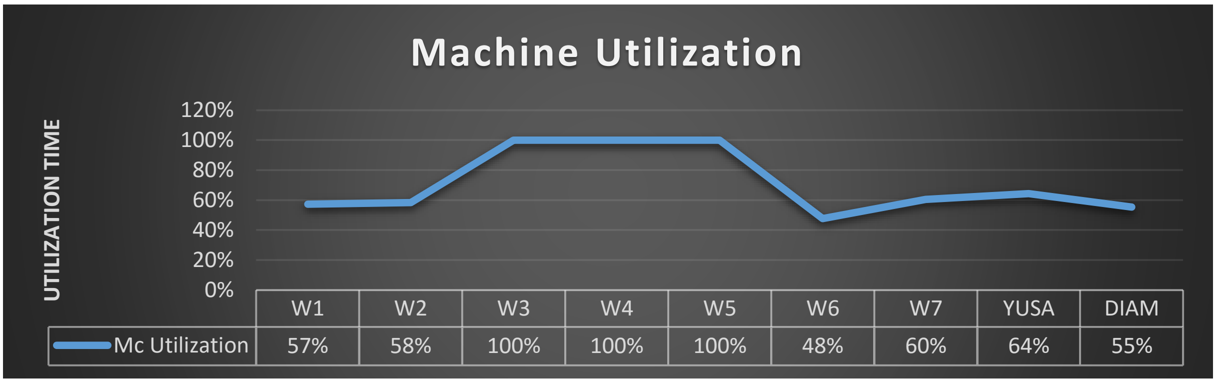

Figure A24: November'15 Machine Utilization.

Table A24: December'15 Production Scenario.

Machine	7	Shift	3	Days	21
Production Data Analysis					**Total Quantity**
Expected Total Production Considering 13 Grid/ Min					5503680
Total Production Based on Mc Utilization					1751770
Actual Total Production based on current Condition					1859650
Based on Average Prod/Hour Total Month					5086271

Table A25: December'15 Shift wise Production.

	Production	Productivity	Average
M	582493	31%	33%
E	630843	34%	
N	646441	35%	

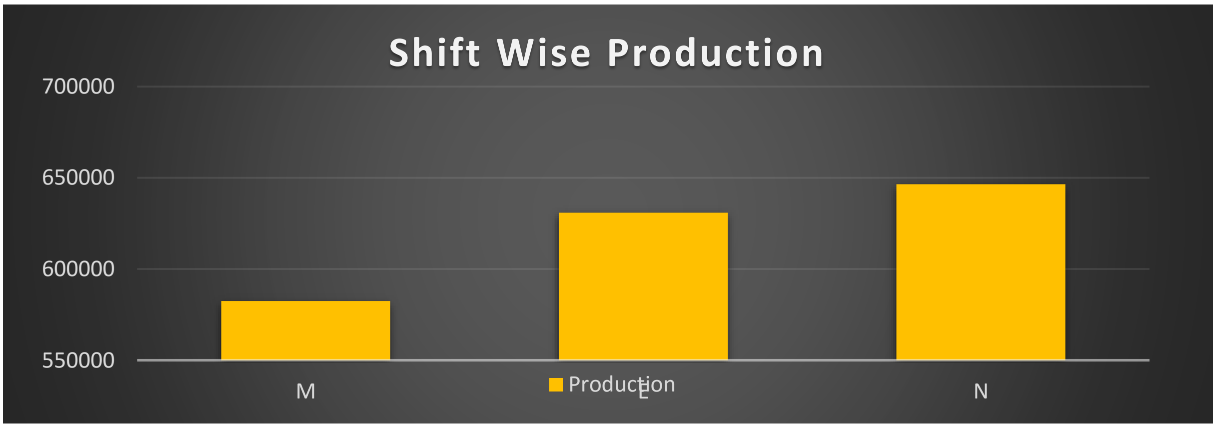

Figure A25: December'15 Shift wise Production.

Table A26: December'15 Machine wise Production.

	Production	**Productivity**	**Average**
W1	0	0%	9%
W2	414550	22%	
W3	401500	22%	
W4	219400	12%	
W5	59	0%	
W6	59	0%	
W7	43100	2%	
YUSA	393200	21%	
DIAM	91900	5%	

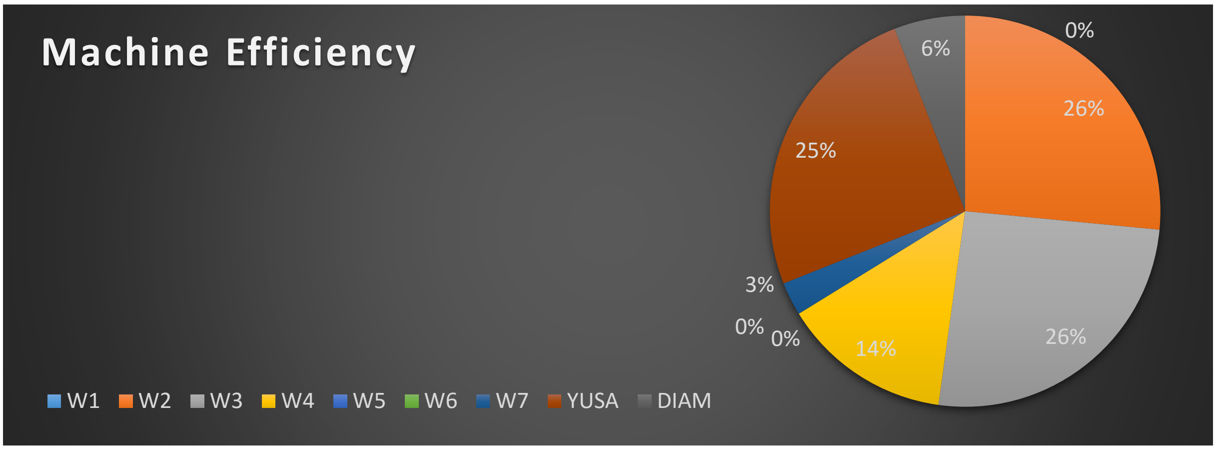

Figure A27: December'15 Monthly Machine Efficiency.

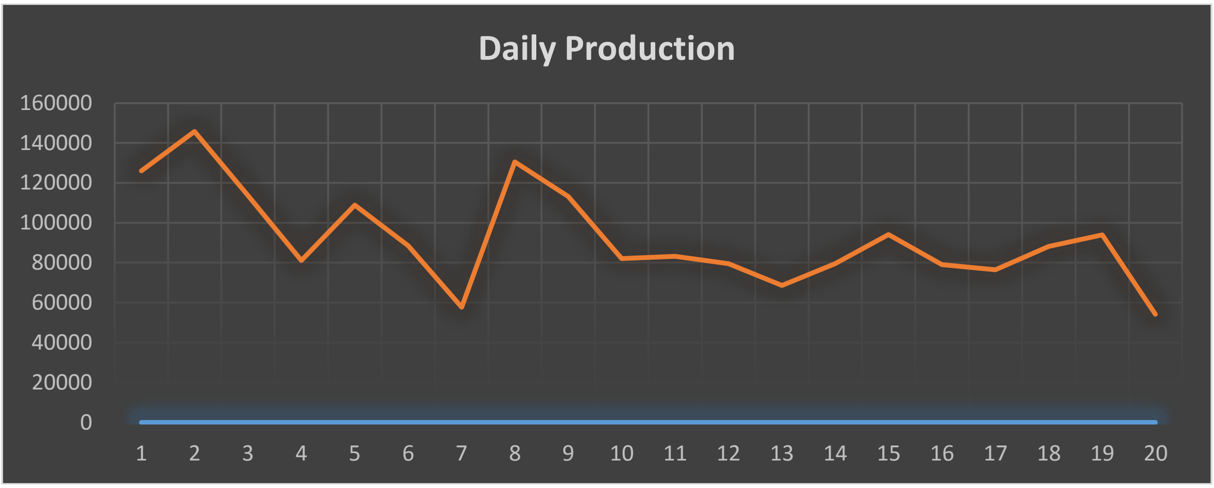

Figure A28: December'15 Daily production graph.

Table A27: December'15 Loss Time Calculation.

Shift Details			
	Shift	**Days**	**Total**
Total Shift	3	21	63

Considering 6 Machine & 480 minutes in each shift			
	Mc Hour/ Shift	**No of M/C**	**Total M/C Hr**
M/C Hour Available	30240	9	211200
Total Loss Time			85356
Machine Utilization			125844
Efficiency			60%

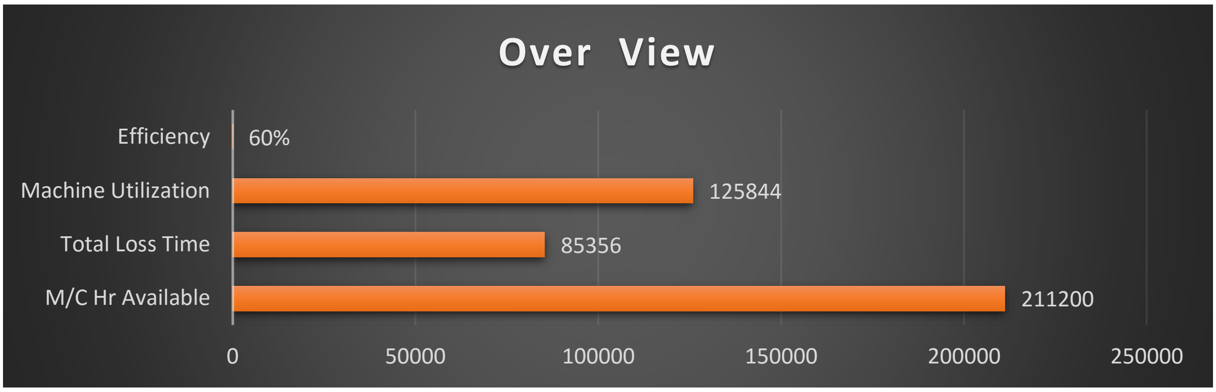

Figure A29: December'15 Monthly Overview.

Table A28: December'15 Loss Time Shift & Machine Wise.

	Loss Time Code		
Shift	**PF**	**MCR**	**MBD**
M	1420	7066	5750
E	1920	7475	7050
N	0	8190	5250
Total	3340	22731	18050
Loss Time Code	**H**	**MCC**	**OTR**
M	2890	3540	8730
E	1645	3510	8650
N	1810	2870	7590
Total	6345	9920	24970

Shift Wise Loss Time

Shift	**Total**	**Percentage**	**Average/Shift**
M	29396	34%	**33%**
E	30250	35%	
N	25710	30%	

Machine wise Loss time & percentage			
Loss Time Code	**Loss time**	**LT/P%**	**Over all LT**
PF	3340	4%	40%
MCR	22731	27%	
MBD	18050	21%	
H	6345	7%	
MCC	9920	12%	
OTR	24970	29%	
Total	85356		

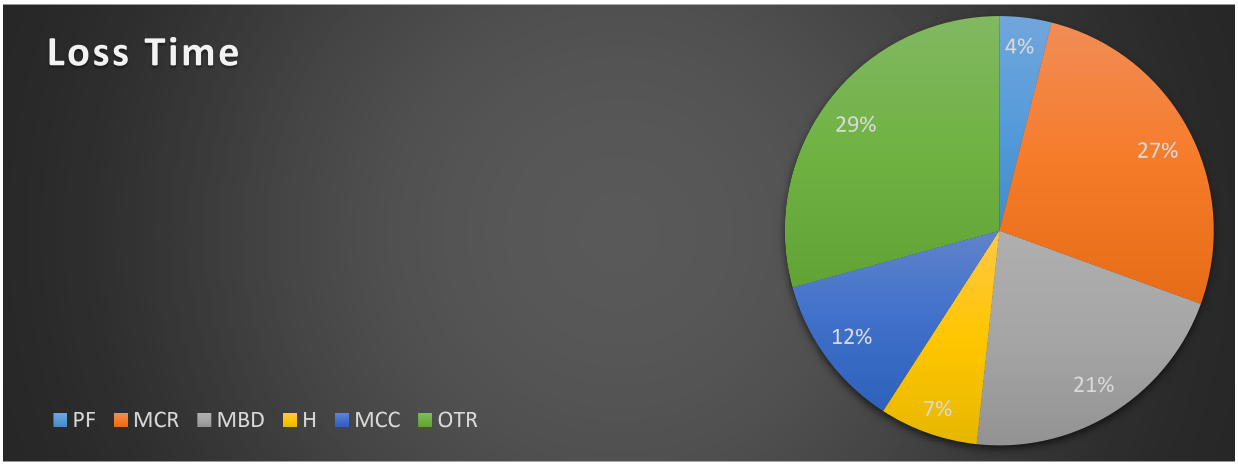

Figure A30.: December'15 Monthly Total Loss Time.

Table A29: Machine Wise Utilization & Efficiency.

Machine	M/C Utilization	Efficiency	Loss time
W1	21670	72%	8570
W2	20814	69%	9426
W3	21070	70%	9170
W4	30240	100%	0
W5	30240	100%	0
W6	13510	45%	16730
W7	20740	69%	9500
YUSA	14540	48%	15700
DIAM	13980	46%	16260
Average		69%	

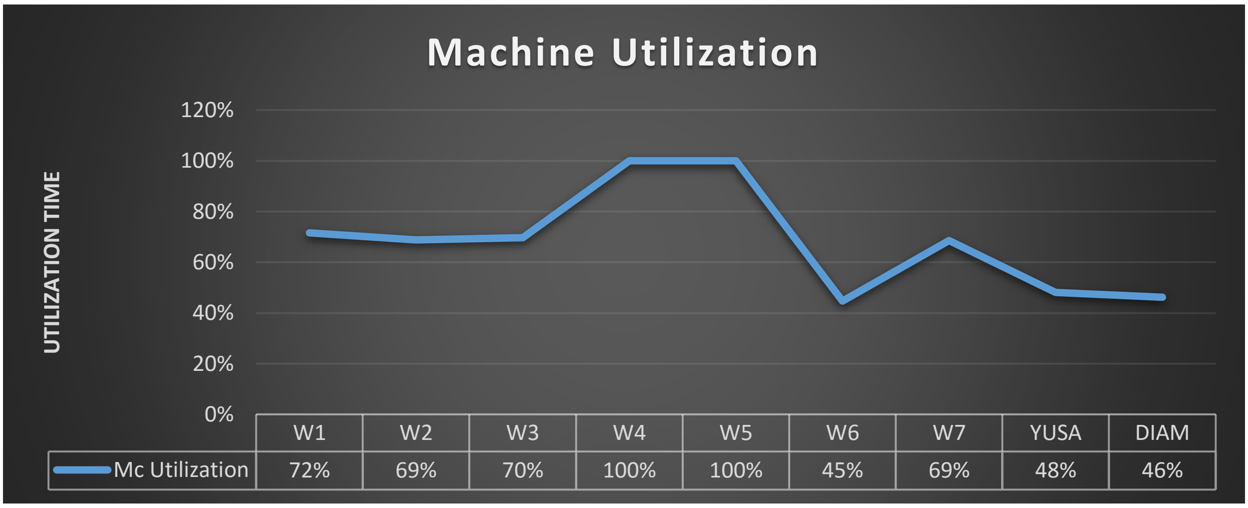

Figure A31: December'15 Monthly Machine Utilization.

Table A30: January'16 Production Scenario.

Machine	8	Shift	3	Days	31
Production Data Analysis					**Total Quantity**
Expected Total Production Considering 13 Grid/ Min					9285120
Total Production Based on Mc Utilization					1709831
Actual Total Production based on current Condition					3221300
Based on Average Prod/Hour Total Month					8375486

Table A31: January'16 Shift wise Production.

	Production	Productivity	Average
M	959466	30%	33%
E	1108166	34%	
N	1153866	36%	

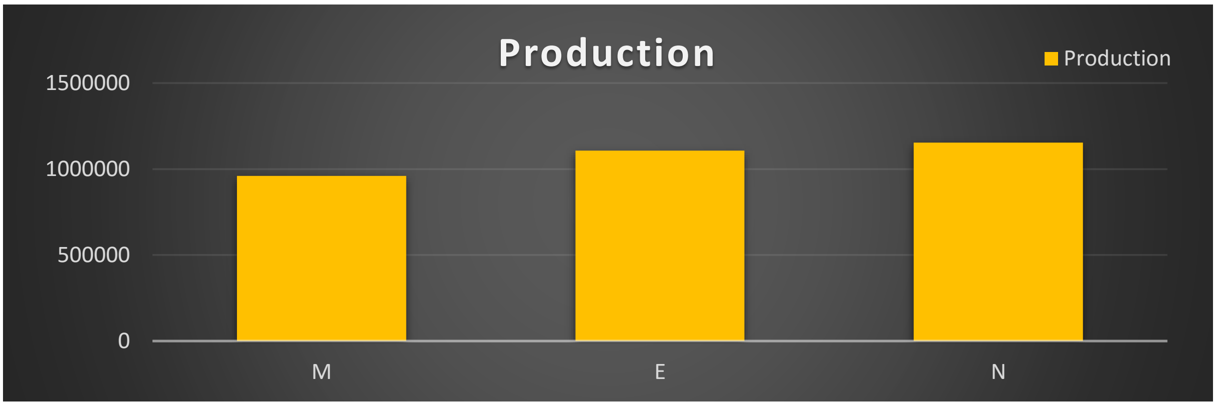

Figure A32: January'16 Shift wise Production.

Table A32: Machine wise Production.

	Production	**Productivity**	**Average**
W1	443400	14%	9%
W2	658300	20%	
W3	384406	12%	
W4	291059	9%	
W5	173762	5%	
W6	337703	10%	
W7	482500	15%	
YUSA	123458	4%	
DIAM	326910	10%	

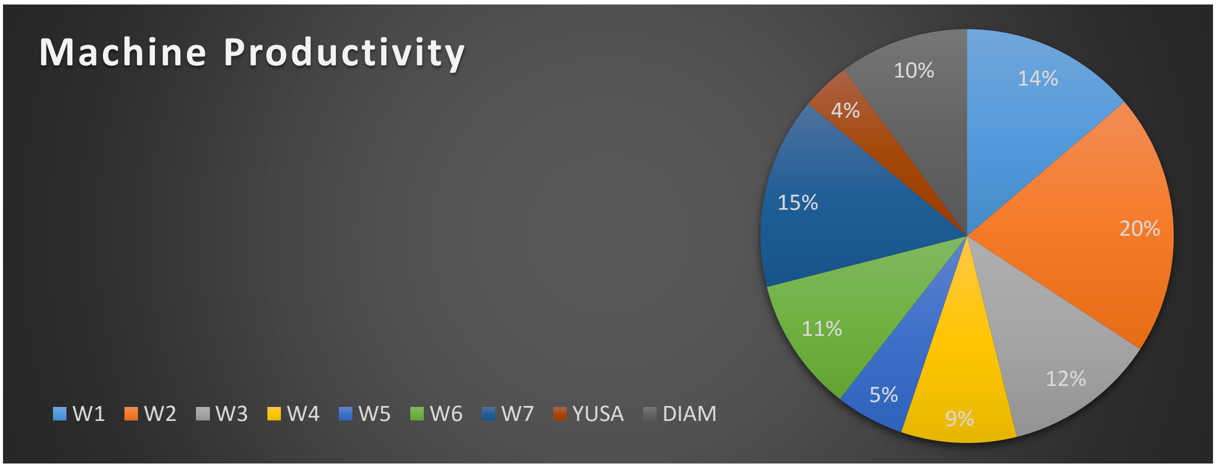

Figure A33: January’16 Monthly Machine Efficiency.

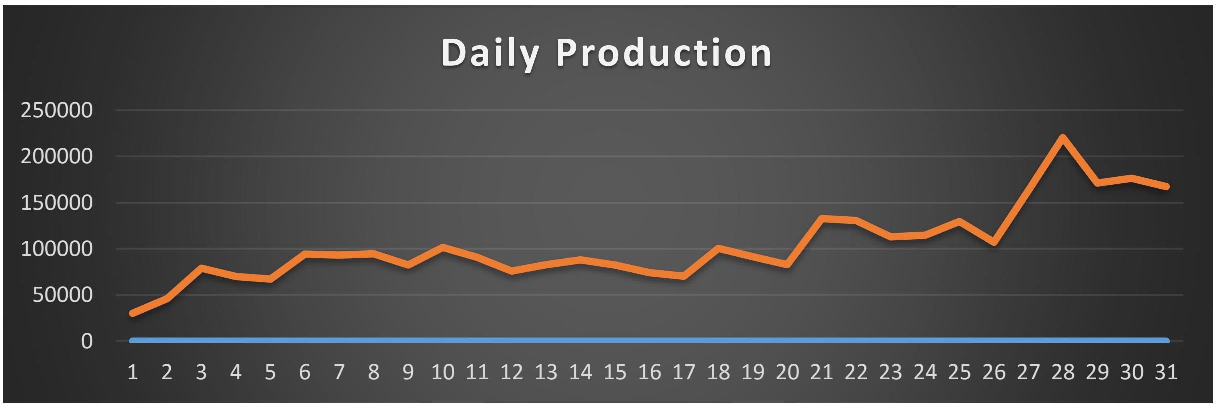

Figure A34: January’16 Daily Production Graph.

Table A33: January’16 Loss Time Calculation.

Shift Details			
	Shift	**Days**	**Total**
Total Shift	3	31	93

Considering 6 Machine & 480 minutes in each shift			
	Mc Hour/ Shift	**No of M/C**	**Total M/C Hr**
M/C Hour Available	44640	9	306720
Total Loss Time			160910
Machine Utilization			145810
Efficiency			48%

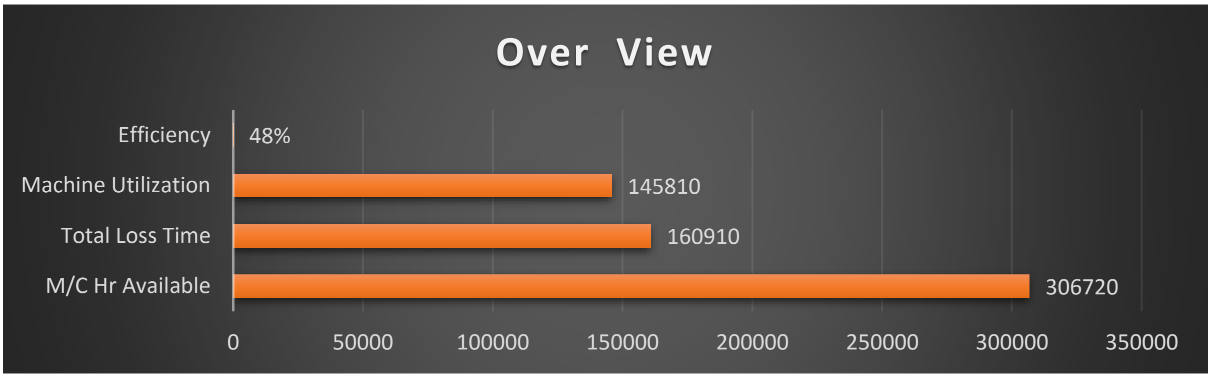

Figure A35: January’16 Monthly Overview.

Table A34: January’16 Shift Wise Loss Time & Percentage.

	Loss Time Code		
Shift	**PF**	**MCR**	**MBD**
M	920	17925	18560
E	2220	18370	19830
N	690	19040	17200
Total	3830	55335	55590
Loss Time Code	**H**	**MCC**	**OTR**
M	4170	4150	10440
E	4695	1880	5220
N	4160	650	10790
Total	13025	6680	26450

Shift Wise Loss Time

Shift	Total	Percentage	Average/Shift
M	56165	35%	**33%**
E	52215	32%	
N	52530	33%	

Machine wise Loss time & percentage			
Loss Time Code	**Loss time**	**LT/P%**	**Over all LT**
PF	3830	2%	52%
MCR	55335	34%	
MBD	55590	35%	
H	13025	8%	
MCC	6680	4%	
OTR	26450	16%	
Total	160910		

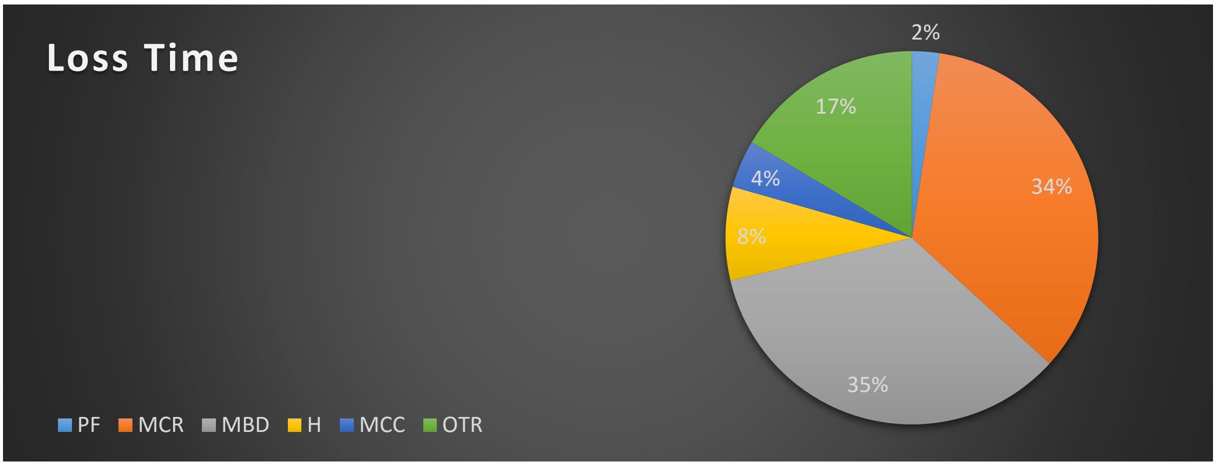

Figure A36: January'16 Monthly Total Loss time.

Table A35: January'16 Machine Wise Utilization & Efficiency.

Machine	M/C Utilization	Efficiency	Loss time
W1	19170	43%	25470
W2	27340	61%	17300
W3	24660	55%	19980
W4	36400	82%	8240
W5	38040	85%	6600
W6	19745	44%	24895
W7	21285	48%	23355
YUSA	32430	73%	12210
DIAM	21780	49%	22860
Average		60%	

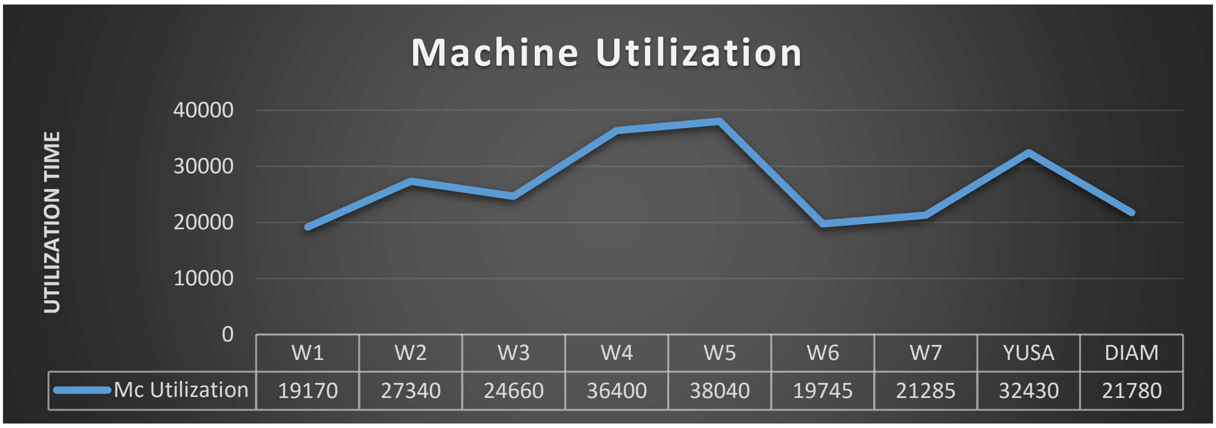

Figure A37: January'16 Monthly Machine Utilization.

Table A36: Hourly Monitoring Log Sheet.

X Batteries Limited — **Plate Preparation Hourly Production Log Sheet**

Casting M/C:	W6	Grid Type	Grid TX1.7 (1.7% Sb-Pb)	Shift	M	Target	11500	Date:	10/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty (in pcs)	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
6 am	1200	1200				20		15	35	6.00 am	6.20 am	35			
7 am	1400	2600							-			-			
8 am	1000	3600		25					25	8.35 am	9.00 am	25			
9 am	1400	5000							-			-			
10 am	600	5600			40				40	10.20 am	11.00 am	40			
11 am	1000	6600		35					35	11.15 am	11.50 am	35			
12 am	1400	8000							-			-			
1 pm	1400	9400							-			-			
Total		9400	-	60	40	20	-	15	135	Total		135	Target Daviation		2100

Casting M/C:	W6	Grid Type	Grid TX1.7 (1.7% Sb-Pb)	Shift	E	Target	11500	Date:	10/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
2 pm	1350	1350							-			-			
3 pm	900	2250		35					35	3.25 pm	4.00 pm	35			
4 pm	800	3050	35						35	4.15 pm	4.50 pm	35			
5 pm	1000	4050				30			30	5.00 pm	5.30 pm	30			
6 pm	1350	5400							-			-			
7 pm	1400	6800							-			-			
8 pm	1200	8000		20					20	8.17 pm	8.37 pm	20			
9 pm	1350	9350							-			-			
Total		9350	35	55	-	30	-	-	120	Total		120	Target Daviation		2150

Casting M/C:	W6	Grid Type	Grid TX1.7 (1.7% Sb-Pb)	Shift	N	Target	11500	Date:	10/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
10 pm	1200	1200				25			25	10.05 pm	10.30 pm	25			
11 pm	800	2000		35					35	11.00 pm	11.35 pm	35			
12 pm	0	2000			60				60	12.00 am	12.59 am	60			
1 am	1200	3200							-			-			
2 am	1350	4550							-			-			
3 am	1400	5950							-			-			
4 am	1300	7250		20					20	4.20 am	4.40 am	20			
5 am	1400	8650							-			-			
Total		8650	-	55	60	25	-	-	140	Total		140	Target Daviation		2850

X Batteries Limited — **Plate Preparation Hourly Production Log Sheet**

Casting M/C:	W6	Grid Type	Grid TX1.7 (1.7% Sb-Pb)	Shift	M	Target	11500	Date:	11/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty (in pcs)	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
6 am	300	300	35			20			55	6.00 am	6.55 am	55			
7 am	1000	1300						20	20	7.35 am	7.55 am	20			
8 am	1400	2700						5	5			5			
9 am	1050	3750		25					25	9.15 am	9.40 am	25			
10 am	0	3750					60		60	10.00 am	11.00 am	60			
11 am	0	3750					60		60	11.00 am	12.00 pm	60			
12 am	1250	5000						15	15			15			
1 pm	1350	6350							-			-			
Total		6350	35	25	-	20	120	40	240	Total		240	Target Daviation		5150

Casting M/C:	W6	Grid Type	Grid TX1.7 (1.7% Sb-Pb)	Shift	E	Target	11500	Date:	11/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
2 pm	0	0			55				55	2.00 pm	3.00 pm	55			
3 pm	900	900							-			-			
4 pm	1250	2150		15					15	4.38 pm	4.53 pm	15			
5 pm	1400	3550							-			-			
6 pm	1350	4900							-			-			
7 pm	1000	5900		20					20	7.31 pm	7.51 pm	20			
8 pm	1200	7100				20			20	8.27 pm	8.47 pm	20			
9 pm	1350	8450							-			-			
Total		8450	-	35	55	20	-	-	110	Total		110	Target Daviation		3050

Casting M/C:	W6	Grid Type	Grid TX1.7 (1.7% Sb-Pb)	Shift	N	Target	11500	Date:	11/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
10 pm	1350	1350							-			-			
11 pm	1350	2700							-			-			
12 pm	800	3500		35					35	12.00 am	12.59 am	35			
1 am	1300	4800							-			-			
2 am	1150	5950				15			15	2.13 am	2.28 am	15			
3 am	1400	7350							-			-			
4 am	1300	8650		10					10	4.20 am	4.30 am	10			
5 am	1350	10000							-			-			
Total		10000	-	45	-	15	-	-	60	Total		60	Target Daviation		1500

X Batteries Limited		Plate Preparation Hourly Production Log Sheet				
Casting M/C:	W6	Grid Type	Grid TX1.7 (1.7% Sb-Pb)	Shift	M	Target	11500	Date:	12/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty (in pcs)	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
6 am	1000	1000		20					20	6.15 am	6.35 am	20			
7 am	1050	2050						15	15	7.22 am	7.37 am	15			
8 am	1350	3400							-			-			
9 am	1050	4450			15				15	9.37 am	9.52 am	15			
10 am	1200	5650		15					15	10.15 am	10.30 am	15			
11 am	0	5650	40		20				60	11.00 am	11.59 am	60			
12 am	1250	6900				10			10	12.00 pm	12.10 pm	10			
1 pm	0	6900						60	60	1.00 pm	1.59 pm	60			
Total		6900	40	35	35	10	-	75	195	Total		195	Target Daviation		4600

Casting M/C:	W6	Grid Type	Grid TX1.7 (1.7% Sb-Pb)	Shift	E	Target	11500	Date:	12/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
2 pm	1250	1250						10	10	2.00 pm	2.10 pm	10			
3 pm	1300	2550							-			-			
4 pm	1250	3800		10					10	4.38 pm	4.53 pm	10			
5 pm	1150	4950		15					15	5.12 pm	5.27 pm	15			
6 pm	1100	6050				20			20	6.20 pm	6.40 pm	20			
7 pm	1250	7300		20					20	7.38 pm	7.58 pm	20			
8 pm	1100	8400				15			15	8.27 pm	8.47 pm	15			
9 pm	1250	9650							-			-			
Total		9650	-	45	-	35	-	10	90	Total		90	Target Daviation		1850

Casting M/C:	W6	Grid Type	Grid TX1.7 (1.7% Sb-Pb)	Shift	N	Target	11500	Date:	12/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
10 pm	1350	1350							-			-			
11 pm	1350	2700							-			-			
12 pm	1000	3700		25					25	12.12 am	12.37 am	25			
1 am	1300	5000							-			-			
2 am	1150	6150				15			15	2.13 am	2.28 am	15			
3 am	850	7000			25				25	3.35 am	4.00 am	25			
4 am	1250	8250		10					10	4.20 am	4.30 am	10			
5 am	1350	9600							-			-			
Total		9600	-	35	25	15	-	-	75	Total		75	Target Daviation		1900

X Batteries Limited		Plate Preparation Hourly Production Log Sheet				
Casting M/C:	W6	Grid Type	Grid TX1.7 (1.7% Sb-Pb)	Shift	M	Target	11500	Date:	13/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty (in pcs)	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
6 am	1000	1000			15				15	6.25 am	6.40 am	15			
7 am	1300	2300						15	15	7.02 am	7.17 am	15			
8 am	1250	3550		15					15	8.13 am	8.28 am	15			
9 am	0	3550	45		15				60	9.00 am	9.59 am	60			
10 am	850	4400				25			25	10.25 am	10.50 am	25			
11 am	0	4400	40		20				60	11.00 am	11.59 am	60			
12 am	650	5050		25		10			35	12.00 pm	12.35 pm	35			
1 pm	1350	6400							-			-			
Total		6400	85	40	50	35	-	15	225	Total		225	Target Daviation		5100

Casting M/C:	W6	Grid Type	Grid TX1.7 (1.7% Sb-Pb)	Shift	E	Target	11500	Date:	13/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
2 pm	450	450			45			10	55	2.15 pm	3.00 pm	55			
3 pm		450			60				60	3.00 pm	3.59 pm	60			
4 pm		450			60				60	4.00 pm	4.59 pm	60			
5 pm		450			60				60	5.00 pm	5.59 pm	60			
6 pm		450		25		20			45	6.00 pm	6.45 pm	45			
7 pm	1350	1800							-	7.00 pm	7.59 pm	-			
8 pm	1300	3100							-	8.00 pm	8.59 pm	-			
9 pm	650	3750						40	40	9.00 pm	9.40 pm	40			
Total		3750	-	25	225	20	-	50	320	Total		320	Target Daviation		7750

Casting M/C:	W6	Grid Type	Grid TX1.7 (1.7% Sb-Pb)	Shift	N	Target	11500	Date:	13/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
10 pm	1350	1350							-			-			
11 pm	1400	2750							-			-			
12 pm	800	3550		25					25	12.12 am	12.37 am	25			
1 am	1300	4850							-			-			
2 am	1000	5850				15			15	2.13 am	2.28 am	15			
3 am	950	6800			25				25	3.35 am	4.00 am	25			
4 am	1250	8050		10					10	4.20 am	4.30 am	10			
5 am	1350	9400							-			-			
Total		9400	-	35	25	15	-	-	75	Total		75	Target Daviation		2100

X Batteries Limited | Plate Preparation Hourly Production Log Sheet

Casting M/C: W6 | Grid Type: Grid TX1.7 (1.7% Sb-Pb) | Shift: M | Target: 11500 | Date: 14/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty (in pcs)	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
6 am	1150	1150				20			20	6.35 am	6.55 am	20			
7 am	1000	2150						20	20	7.35 am	7.55 am	20			
8 am	200	2350	45					5	50	8.05 am	8.55 am	50			
9 am	1050	3400		25					25	9.15 am	9.40 am	25			
10 am	0	3400			60				60	10.00 am	11.00 am	60			
11 am	0	3400					60		60	11.00 am	12.00 pm	60			
12 am	1250	4650						15	15	12.17 pm	12.32 pm	15			
1 pm	1350	6000		15					15	1.05 pm	1.20 pm	15			
Total		6000	45	40	60	20	60	40	265	Total		265	Target Daviation		5500

Casting M/C: W6 | Grid Type: Grid TX1.7 (1.7% Sb-Pb) | Shift: E | Target: 11500 | Date: 14/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
2 pm	1250	1250						10	10	2.00 pm	2.10 pm	10			
3 pm	1300	2550							-			-			
4 pm	1250	3800		10					10	4.38 pm	4.53 pm	10			
5 pm	1150	4950		15					15	5.12 pm	5.27 pm	15			
6 pm	1100	6050				20			20	6.20 pm	6.40 pm	20			
7 pm	1250	7300		20					20	7.38 pm	7.58 pm	20			
8 pm	1100	8400				15			15	8.27 pm	8.47 pm	15			
9 pm	1250	9650							-			-			
Total		9650	-	45	-	35	-	10	90	Total		90	Target Daviation		1850

Casting M/C: W6 | Grid Type: Grid TX1.7 (1.7% Sb-Pb) | Shift: N | Target: 11500 | Date: 14/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
10 pm	1350	1350							-			-			
11 pm	1350	2700							-			-			
12 pm	650	3350		35					35	12.00 am	12.59 am	35			
1 am	1300	4650							-			-			
2 am	1150	5800				15			15	2.13 am	2.28 am	15			
3 am	1350	7150							-			-			
4 am	1200	8350		10					10	4.20 am	4.30 am	10			
5 am	1350	9700							-			-			
Total		9700	-	45	-	15	-	-	60	Total		60	Target Daviation		1800

X Batteries Limited | Plate Preparation Hourly Production Log Sheet

Casting M/C: W6 | Grid Type: Grid TX1.7 (1.7% Sb-Pb) | Shift: M | Target: 11500 | Date: 15/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty (in pcs)	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
6 am	0	0			60				60	6.00 am	6.59 am	60			
7 am	950	950				25			25	7.15 am	7.40 am	25			
8 am	1200	2150		15					15	8.44 am	8.59 am	15			
9 am	1300	3450							-			-			
10 am	1350	4800							-			-			
11 am	1250	6050		10					10	11.00 am	11.10 am	10			
12 am	1300	7350							-			-			
1 pm	1300	8650							-			-			
Total		8650	-	25	60	25	-	-	110	Total		110	Target Daviation		2850

Casting M/C: W6 | Grid Type: Grid TX1.7 (1.7% Sb-Pb) | Shift: E | Target: 11500 | Date: 15/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
2 pm	1200	1200				20		15	35	6.00 am	6.20 am	35			
3 pm	1400	2600							-			-			
4 pm	1000	3600		25					25	8.35 am	9.00 am	25			
5 pm	1400	5000							-			-			
6 pm	600	5600			40				40	10.20 am	11.00 am	40			
7 pm	1000	6600		35					35	11.15 am	11.50 am	35			
8 pm	1400	8000							-			-			
9 pm	1400	9400							-			-			
Total		9400	-	60	40	20	-	15	135	Total		135	Target Daviation		2100

Casting M/C: W6 | Grid Type: Grid TX1.7 (1.7% Sb-Pb) | Shift: N | Target: 11500 | Date: 15/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
10 pm	1300	1300							-			-			
11 pm	1250	2550							-			-			
12 pm	950	3500		25					25	12.35 am	12.59 am	25			
1 am	1300	4800							-			-			
2 am	1150	5950				15			15	2.33 am	2.48 am	15			
3 am	850	6800			25				25	3.35 am	4.00 am	25			
4 am	1250	8050		10					10	4.35 am	4.40 am	10			
5 am	1300	9350							-			-			
Total		9350	-	35	25	15	-	-	75	Total		75	Target Daviation		2150

X Batteries Limited — **Plate Preparation Hourly Production Log Sheet**

Casting M/C:	W6	Grid Type	Grid TX1.7 (1.7% Sb-Pb)	Shift	M	Target	11500	Date:	16/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty (in pcs)	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
6 am	1350	1350							-			-			
7 am	1400	2750							-			-			
8 am	1250	4000		15					15	8.27 am	8.42 am	15			
9 am	1150	5150			20				20	9.33 am	9.53 am	20			
10 am	1350	6500							-			-			
11 am	1000	7500		10				15	25	11.15 am	11.40 am	25			
12 am	600	8100	20			15			35	12.20 pm	12.55 pm	35			
1 pm	750	8850		15	10			10	35	1.10 pm	1.40 pm	35			
Total		8850	20	40	30	15	-	25	130	Total		130	Target Daviation		2650

Casting M/C:	W6	Grid Type	Grid TX1.7 (1.7% Sb-Pb)	Shift	E	Target	11500	Date:	16/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
2 pm	1350	1350							-			-			
3 pm	1400	2750							-			-			
4 pm	800	3550		25					25	4.12 pm	4.37 pm	25			
5 pm	1300	4850							-			-			
6 pm	1000	5850				15			15	6.13 am	6.28 am	15			
7 pm	900	6750			25				25	7.35 am	8.00 am	25			
8 pm	1250	8000		10					10	8.20 am	8.30 am	10			
9 pm	1350	9350							-			-			
Total		9350	-	35	25	15	-	-	75	Total		75	Target Daviation		2150

Casting M/C:	W6	Grid Type	Grid TX1.7 (1.7% Sb-Pb)	Shift	N	Target	11500	Date:	16/2/2016

Production			Loss Time							MBD Description					
Time	Production Qty	Qumilitive	PF	MCR	MBD	H	MCC	OTR	Total	Start Time	End Time	Total	Sign Prd	Sign Mtn	Remarks
10 pm	1300	1300							-			-			
11 pm	1250	2550						10	10	11.35 pm	11.45 pm	10			
12 pm	950	3500		25					25	12.35 am	12.59 am	25			
1 am	1300	4800							-			-			
2 am	1150	5950			15				15	2.45 am	2.58 am	15			
3 am	0	5950			60				60	3.00 am	4.00 am	60			
4 am	0	5950			60				60	4.00 am	5.00 am	60			
5 am	0	5950			60				60	5.00 am	6.00 am	60			
Total		5950	-	25	195	-	-	10	230	Total		230	Target Daviation		5550