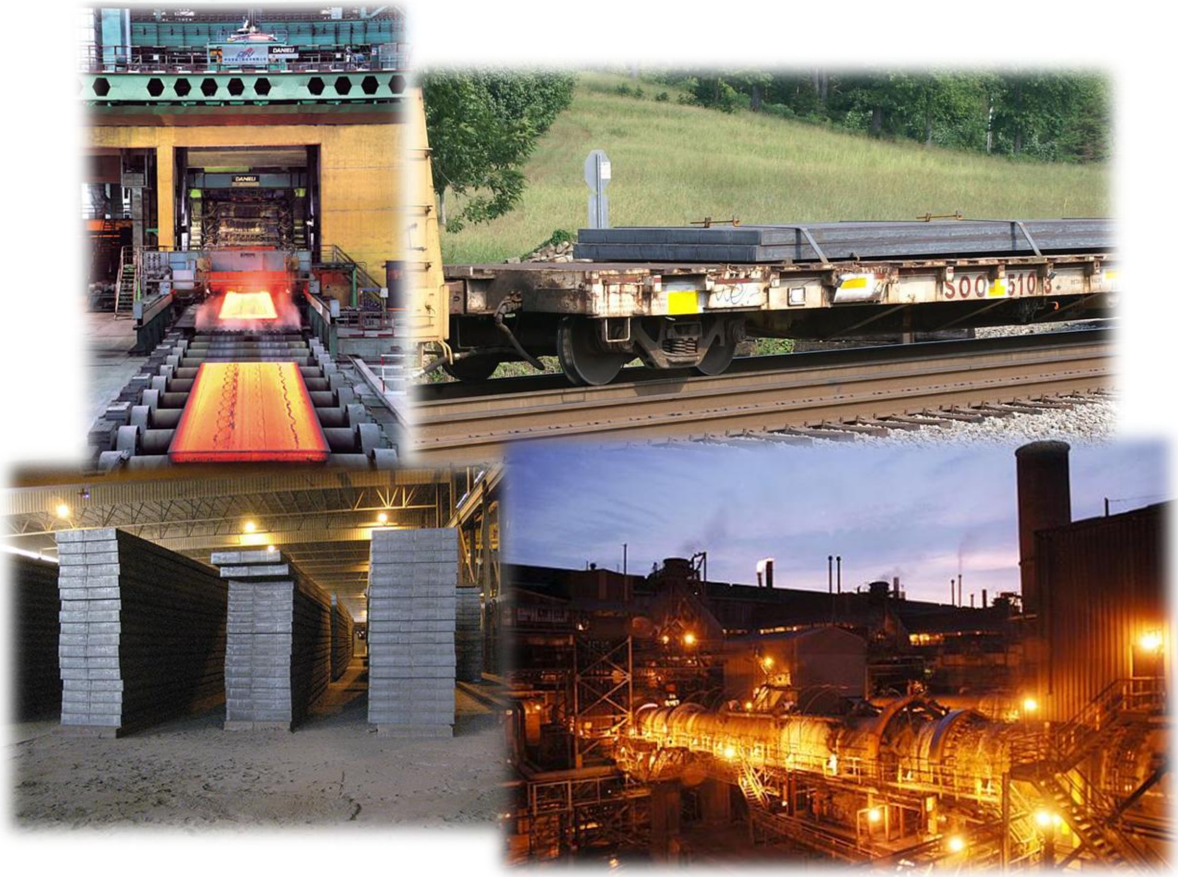
Improving the operations of a Slab Yard through the implementation of best practices



Project 421

11/10/2011

Geani Kasselman

EVRAZ
EVRAZ HIGHVELD STEEL AND VANADIUM

Executive Summary

EHSV is a steel producing company experiencing difficulties with operations in their slab yard such as excessive obsolete stock and poor control over inventory. Through analysis, the causes of the problems are identified and processes are improved. A complete stock count was done to achieve accurate data on inventory and all operations were analyzed- from work instructions to data systems. A practice to record slabs that could not be found as obsolete created surplus stock in the slab yard, congesting production. The obsolete stock is dealt with and better practices for inventory control, as well as a Material-Requirements-Plan for sufficient levels of inventory to satisfy production, but not overcrowd the slab yard, was developed. A new layout for the slab yard was implemented, improving methods for locating and accessing a slab. Lean Manufacturing was used to identify and illuminate waste within operations and operations were improved. The newly developed processes were implemented, operating staff trained and problems experienced during operations were dealt with and improved.

Contents

List of figures and tables

Chapter 1:

1.1. Introduction

Background

In 1957 the company Mineral Engineering of Colorado, through which Highveld was established built a plant in eMalahleni (old Witbank) to produce vanadium pent oxide. In 1960 the Highveld Development Company Limited was established to investigate the viability of processing titaniferous magnetite ore for the production of liquid iron and vanadium bearing slag and after just four years the process to build an integrated iron- and steelworks commenced.

In 1965 the name of the Highveld Development Company was changed to Highveld Steel and Vanadium Corporation Limited and by 1966 Highveld was the global leader in Vanadium production.

In 2006 Anglo American's share in the Highveld group was sold to Evraz Group S.A. registered in Luxembourg, becoming Evraz Highveld Steel and Vanadium (EHSV). Previous management neglected maintenance and left the plant in a terrible condition. Currently the plant is running on low production rates compared to other steel producing facilities because of the condition of the machines and equipment.

Highveld currently employs 2390 people who contribute to an annual production of 687 990 tons of steel and 46 614 tons of vanadium-bearing slag. Iron ore is melted and casted into steel-slabs, which is either exported or rolled into steel coils or plates according to orders placed by customers. The vanadium-bearing slag is sold to a neighboring company, Vanchem.

Highveld comprises of twelve divisions, including different Plant- and Admin-departments. Raw-material consisting of coal and iron ore is mixed according to specifications, preheated and then melted in a furnace. Additives are then added into the molten metal and steel slabs are cast according to a specific grade and size which is then rolled to form steel coils of different sizes according to orders placed.

The Slab yard was established in 1964 together with most of the apparatus that is still operating the facility today and is the buffer between the casting and rolling of the steel-slabs. The current inventory of EHSV stands on 43 607 tons of steel waiting to be allocated by an information system to be rolled into coils according to external orders. The slabs weigh ± 30 tons, being handled by an old overhead crane. About 26 Master-slabs enter the slab yard every 12 hour shift and the slabs are dispatched at a rate of approximately 20 to 30 slabs per 12 hour shift depending on the production of coil or plate. Slabs are received via Slab-trucks from the Steel plant after casting. The slabs have to be inspected and then stored until scheduled for rolling. The Information-system, known as FOX, keeps record of inventory and schedules the slabs according to the grade and size of a slab that suits an order placed by a customer. The slab yard Operator has no control over the schedule of the slabs and cannot predict a possible future schedule.

Figure 1: EHSV Slab yard

Existing problems of the slab yard:

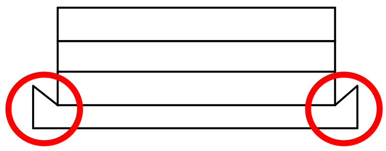
Excessive obsolete stock

The slab yard stores all slabs that are cast because of limiting factors regarding the material handling constraints and unavailability of alternative space. Obsolete Stock is seen as stock that is insufficient for allocating to a schedule by FOX for reasons involving the grade, size or some sort of defect from casting or cutting. Slabs that do not comply with a specific grade and size or entitles some sort of defect that will rarely be allocated for rolling is kept in the slab yard regardless of its age or usability. Currently the majority of stock, 73% is obsolete and congesting the storage facility, leaving insufficient space to effectively manage valuable stock. The problem is escalating as best practice obsolete stock policies and procedures are not formulated and formal obsolete stock management principles are not applied.

Control over inventory.

Proper receiving, inspection and storage processes are not being utilized and managed. Sufficient inspection methods are not in order and therefore no feedback can be given to the Steel plant on the quality of a cast. Piles exceeding three times the smallest base cause deformation to the slabs at the bottom because of the weight they are supporting. This is also seen as a safety concern. Slabs that are stacked incorrectly will be considered useless after deformation and will be of no value. The figure below illustrates the deformation of stacked slabs.

Figure 2: Slab Deformation



After slabs were inspected and cooled, slabs are marked and stored randomly wherever available space is identified, resulting in poor control over the location of slabs and specific inventory levels of valuable stock. The marking process is also not up to standard with the result of mistakes occurring in the numbering and becoming illegible after a while.

Accessibility of stock

Slabs are not piled properly making it difficult to locate and access slabs that are scheduled to be dispatched. When a slab is scheduled for rolling the slab yard operators have to find the slab in the facility, hollow out the slab and then dispatch it to rolling. A lack of control over the stock in the slab yard leads to difficulties in locating a slab and then accessing it. If a slab at the bottom of a pile is required all the others on top have to be relocated to available open space to access the bottom one, creating even more chaos. When a slab is not found, the slab yard informs the planner to re-order a slab from the casting process of the specific grade and size, generating double stock. The slab that is not found is made a “NO-CHARGE” slab on Fox and is not scheduled until it is found and the system is updated.

Figure 3: Piled slabs in the Slab yard

Constrained capacity due to aging equipment

Due to all the above mentioned factors the stock turnover is extremely slow. Together with this the only crane operating the facility is old and cannot operate on full capacity anymore making it even more time-consuming to allocate stock within the slab yard, having to work harder because of the current congestion in the slab yard.

1.1. Aim of Project

The main objective of this project is to improve the slab yard operations by developing and implementing appropriate obsolete stock and inventory management principles together with best practices, improving the layout and the flow of materials and exploiting the full capacity of the facility.

Objectives acting as basis for this aim:

- A complete analysis of the current stock in the slab yard.
- The identification of obsolete stock from the slab yard facility.
- Significant reduction of current obsolete stock and release space for effective stock management.
- Formulate obsolete stock management policies and procedures to avoid reoccurrence of high obsolete stock levels.
- Maintaining the correct levels of stock needed in the slab yard for optimal production.
- An innovative slab yard process for the receiving, storing and locating of the slabs.
- Ensure slabs are identifiable and accessible at all times and can be retrieved with minimum effort.
- Optimized layout, material flow and handling.

1.2. Project Scope

The project will focus mainly on slab yard operation, specifically the receiving, storing and allocation of stock. Stock will be analyzed from the moment it is received in the slab yard until it is dispatched to flat-products for rolling or disposed as scrap. Any stock that is stored or processed in another location is irrelevant to this project, as well as the stock still on the way to the slab yard. The information system (FOX) that administrates the orders and keeps record of stock will be used as a guideline to help establish the sequence of which slabs will be allocated, together with the value of each slab.

1.3. Key deliverables

- Complete inventory list. Stating what inventory is valuable and what inventory has a negligible chance to be used.
- Possible outcomes for the use/removal of stock that is useless to production, with advantages and disadvantages of each.
- A proper corrective action to ensure that the overstock of obsolete slabs does not re-occur.
- Written work-instructions for proper operating of the slab yard.
- Improved process, including the receiving and storing of inventory, resulting in less defects after receiving and better space allocations for storing of slabs within the slab yard to make them more accessible in the future.
- A better layout for the Slab yard.

1.4. Project Approach

1.4.1. Activities:

Step 1: The analysis of present inventory levels of the slab yard facility.

Determining what stock is of merit to the Company and what can be distinguished as obsolete stock, what the value of the obsolete stock is to the company lying in inventory and the probability of being used in the future, considering aspects such as the grade, age and defects of each slab. Using FOX as a guideline to examine the trend of orders and the different slabs allocated will help give a better understanding of the market trends and therefore give an idea for the type of customers for which to cater. Approaching the finance department would also be beneficial in determining the value of the slabs and what the cost is to keep the slabs in inventory.

A physical reconciliation of the stock within the slab yard is also part of step one, quantifying and separating the stock into groups of meaning to management and ensuring that the stock listed is correct according to grade and size specified.

Step 2: Possible solutions for obsolete stock.

Determining different solutions to remove or use obsolete stock, through analyzing what would bring the most value to the company. Questioning what the different possibilities will contribute to the company and what outcome will resolve in the best possible solution, not only at present but in the future as well. In conclusion with the solution a prevention method will be obtained as well, to ensure that the problem does not re-occur.

Possible outcomes will be determined by studying other similar facilities, research in the field of waste (in the form of obsolete stock) disposal and the different methods of material handling of steel slabs.

Step 3: Investigate current processes.

The receiving, storing, allocation and disposal of a slab will be closely monitored determining the time it takes and process implications. Time and motion studies will be used throughout this task. Another approach will be questioning and understanding the process through the people working in the slab yard on a day to day basis gaining firsthand experience.

The data gathered through this will be analyzed into core and non-core functions and useful data will be used in the steps to follow.

Step 4: Improved process development.

Improved processes will be developed for the slab yard, using information gathered in previous steps, facility planning processes and material handling techniques. Determine potential processes for better receiving and storing of slabs in the facility that will ensure better control over inventory. The integration of different processes within the organization to maintain and develop the agreed services, which will support and improve the effectiveness of the company's primary activities, is also of importance to a well functioning system. FOX will be used to achieve and maintain a level of significant synchronization with orders placed and allocating storage space for the slabs.

This step must ensure easy allocation of slabs and storing slabs in such a way to ensure no defects occur during storage. Analysis of each possible process and what process will suite the slab yard of Evraz Highveld Steel and Vanadium the best. Company policies would be integrated to ensure it is in accordance with company policy.

Step 5: Development of an improved facility layout.

After understanding each process the layout must be developed in accordance with the chosen processes to ensure sufficient flow of material through the slab yard. Using facilities planning techniques and studies of other facilities with similar inventory, size and weight, different layouts will be determined and the best possible solution should be obtained.

The correct inventory levels would be established using best practice methods to ensure sufficient and smooth flow of material through the slab yard.

Step 6: Approval and discussion.

The possible solutions to the problem will be presented to the management of Evraz Highveld Steel and Vanadium for discussion and approval and where necessary changes will be formulated to accommodate their policies.

Step 7: Implementation.

Implementing the desired methods for receiving, storing, locating and disposal of a slab within the obtained layout, ensuring synchronization and embracing chances where needed ensuring control over stock and better management.

This will be a “hands on approach”, ensuring the needed training is provided for management and the operational team to fully comprehend and feel comfortable with the changes made.

1.5. Resources

FOX Information System

Evraz Highveld Steel and Vanadium Slab yard Work instructions and Company Policies

Facilities Planning 4th Edition Tompkins

Portable Computer

Stationery

Internet Access

Resources determined on to improve facility.

1.6. Budget

The full budget will only be available after a full analysis of stock and the improved processes is determined.

Employment of Engineering student .... R 2000.00

Research .... R 500.00

Transport .... R 1200.00

Total .... **R 3700.00**

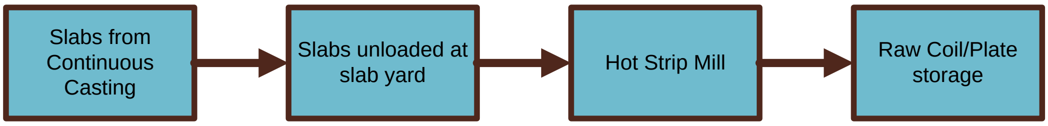
Chapter 2: Literature Study

This chapter provides an overview of the field of study and best practices.

2.1. Process Classification

The hot slabs are shipped via a railroad and rack cars from the continuous casting process to the finishing mill which involves the rolling of slabs into plates or coils. The slabs are then offloaded and stored within the slab yard where they are stacked before being processed by the hot mill.

Figure 4: Movement of Slabs



To analyze and improve a process a wide variety of alternative practices has to be explored and considered, even combining some of these different processes. Inventory can be classified as raw-material, work-in-progress (WIP) or finished goods with different methods of consumption- First-in-First-out, Last-in-First-out or as per order placed by a customer.

Inventory is a buffer used to adapt the process to occurring variation in the system and is kept for different reasons, the most common one being the predictability factor- engaging in capacity planning and production scheduling, you need to have some sort of control about raw-material or WIP that is available. A process with fluctuations in the demand keeps inventory on hand for protection against out of stock incidents due to demand fluctuations, where unreliable suppliers force companies to keep inventory of input materials to ensure operations are not affected by the behaviour of the supplier. Purchasing items in bulk saves money when quantity discounts are given and less ordering or shipping costs are paid, but buying in bulk means you have to store the items as inventory.

Just-in-time is when no inventory is kept and as an item arrives it is either processed or sold, depending on the operations. This eliminates cost of carrying inventory, less control and space is needed for operations. More advanced operations use the just-in-time method because any of the following aspects affects the process negatively:

- Poor cash flow.
- Lack of strong control.
- Poor communication between departments, processes or suppliers.
- Lead time.
- Quality of materials received varies.

To determine the cost associated with an item in inventory different aspects need to be considered such as the worth of an item, the space occupied, labour for handling, deterioration and theft.

2.2. Concepts Used for Improvement

2.2.1. Best Practices for Inventory Management

Lindley (2001) provides the following best practices for inventory control:

1. **Classification of inventory**
   Using classification methods such as ABC-analysis (explained later in this chapter) items must be classified into different categories to identify the necessary measures for controlling and storing of inventory.

2. **Implementing and sustaining maintenance for items kept in storage**
   It is important to maintain items in inventory during storage to prevent defects from occurring, like cleaning or turning items to prevent staining or fading of colour. Proper methods and processes should be implemented towards the nature of the items kept in inventory to prolong the shelf life of an item.

3. **Cycle-counting as a daily routine**
   Dividing the stock take into specific amounts to be checked each day improves the inventory records throughout the year and familiarizes the operators with the type and location of inventory within the facility.

4. **Identification and removal of obsolete items**

   Obsolete stock must be identified and removed from the facility on a regular basis. This adds capacity and availability to the facility, reduces congestion and the chance of obsolete items chosen for processing and recognizes processes to continual monitoring of stock. Processes must be defined to first identify stock, then the means of disposal.

5. **Layout of the storing facility needs to stress efficiency and effectiveness**

   The layout must support the strategic intend of the business and processes. A good layout optimizes the use of resources while satisfying other criteria's such as control and quality.

6. **Manning levels should be optimized and inventory levels controlled**

   The goal is to stock the minimum level of inventory but still have the parts readily available when they are required. A control mechanism must be in place to ensure levels of inventory don't exceed the maximum or surpass the minimum.

7. **A defined receiving and disposal process in place**

   Inventory that is received must be properly inspected and then placed in a predetermined location in accordance with operations and strategy as well as the later disposal of items. If proper receiving and disposal processes are not in place, with accurate records, it will result in poor control over inventory.

8. **Proper Housekeeping Practices**

   This involves daily activities in the facility from primary activities to supporting activities, keeping the working environment clean and neat, free from obstacles in pathways and all items accessible. Appropriate methods must be implemented for waste disposal and maintenance of the facilities and equipment, for example replacing broken windows and repainting of walls.

9. **There is a defined locator system for inventory and tools**

   Inventory and tools must be easily locatable within the storing facility with the correct type of locator system for the inventory stored. Proper management of inventory cannot occur without control over inventory and their locations.

10. The workflow process is mapped and put in place for all planned work

The process and work instructions must be clearly defined and available, together with the responsible persons for each activity. Control is only applied if all operating staff are familiar with the process and aware of their duties within the storing facility. Step definitions, training plans and job descriptions are required for sufficient inventory management.

The expected outcomes after implementation of best practices:

- Reduced inventory levels
- Increased inventory accuracy
- Obsolete inventory identifier
- Overstock inventory identifier
- Accurate minimum/maximum inventory levels
- Work processes identified
- Reduced emergency buying/ordering
- Reduced inventory stock out occurrence
- Increased operational efficiency of equipment
- Reduction in production downtime

2.2.2. Lean Manufacturing

Critical to achieving success when improving or implementing processes within a company is to base the processes on the company policies and vision-and-mission. Lean manufacturing (LM) is one of EHSV company policies and should therefore be the baseline of any process developed and implemented. LM started by Toyota in Japan during the 1970's and is still one of the most referred to concepts of all time. Lean Manufacturing is to manufacture only what is needed by the customer, when it is needed and the exact quantities ordered (Abdullah, 2003). For companies to survive in the competitive market they often have to move from mass production to LM, using fewer resources and reducing excessive workloads improving the quality and save on overall expenses.

Figure 5: Lean Principles

Lean-Manufacturing is a set of tools and methodologies that seek continuous elimination of waste in the production process; waste is anything that does not add value to the end product from the perspective of the end user. The core benefits of this method are lower production cost; increased output and shorter production lead times. This eliminates the unnecessary paperwork and double handling in a process that can be considered as wasteful. LM strives for production smoothing (continuous flow), easier maintenance and standardization of work. Eliminating the seven wastes of LM creates value at a lower cost and improves production rate. In figure 6 the seven different wastes identified by LM can be distinguished.

Figure 6: The Seven Wastes of Lean Manufacturing

2.2.3. ABC Inventory Analysis for

ABC-analysis is partly based on Pareto's 80/20-law. ABC classifies inventory into three classes A, B and C. The classes are ordered in decreasing order of value to the company or operation; this can be turnover, scarceness, demand or the priority of stock. ABC-analysis is applicable to many different things, but for the scope of this project we will only focus on the inventory perspective of ABC.

Category A inventory, normally represents a small amount of the inventor, but is of the most value to the company and the level of Category A stock requires tight control and detailed stock-keeping.

Category B and C inventory are usually more than category A, but their value is not worth as much to the company. B and C category inventory should still be managed, but not as stringent as category A.

There are 4 basic steps for ABC-analysis:

1. List all inventory, their quantities and applicable information for calculating their worth to the Company.
2. Determine their worth according to company preferences and organize them in descending order.
3. Prioritize inventory- classifying them into a category A, B or C.
4. Establish monitoring systems and controls for each category appropriate to the industry.

Chapter 3: Stock Count and Analysis of Current Inventory

During the June/July period of 2011 EHSV was down for two weeks due to maintenance to production equipment and facilities, providing the opportunity for the annual stock take and a complete analysis of existing slab yard operations.

3.1. Data collection and analysis of current inventory

Assisting in the stock-take with the personnel of the slab yard and temporary personnel, provided a better understanding towards the type of inventory kept as well as daily operations performed in the slab yard. EHSV has a predetermined approach to stock taking, used as a company policy. Before the official stock-take was started the slabs were all piled neatly by the crane drivers for easy access. All operations are stopped and no slab is moved until the stock take is completed. All the existing data of inventory on the system was removed from the stock list and archived. Dividing the team for the stock take into groups of two people, the slab yard was divided into sections and each group had to record the stock in the section given to the group. The persons responsible for the stock take in a specific area put their names on top of each sheet for later references. Each slabs ID, gauge, length and width was recorded where clear and visible with the necessary remarks on each slab.

Table 1: Example of Stock-take sheet

ID	Gauge(mm)	Width(mm)	Length(mm)	Remarks
A37812C	180	1440	8000	Deformation occurred
A2784F	250	2025	9000	Incomplete Slab-ID
No-id	250	1440	6400	No ID visible-to be sampled Renamed: A14

A Stock-keeping-unit (SKU) is given to the slabs at the steel plant, known as the cast number, for example A12345B. Where;

A	12345	B
Cast Quality	Specific Cast Number	The block number from the specific cast

This SKU is the primary key that is used as the identifier in FOX, the scheduling programme. Slabs are marked by slab yard operators and consequently human-error is unavoidable, such as incomplete cast-numbers with only four digits instead of five or two different cast numbers on the same slab with no indication on which one to use. Some numbers were unclear and it was difficult to distinguish between the numbers 6, 8, 5 and 3. Older slab number's had visibility problems, due to the elements the visibility of the cast-number were unclear and no identification could be recorded, these slabs were then measured and made no-ID (no-identification) on the stock-sheet. Each group then renamed the slab to a letter and subsequent numbers, for example group A would name the first no-ID slab A01 and the next one A02, called the Q-cast number. A remark was added to slabs that had visible defects, such as skew cuts or deformation.

Figure 7: Examples of named slabs with SKU's

On completion of the stock count, the newly recorded information on inventory was added to the stock list from which FOX will generate the new schedules for production. Samples were taken from the slabs that could not be identified and sent to the lab for possible identification via comparison of their composition and quality against records of missing slabs. If a slab was identified-measurements were used to confirm that it is the correct identity and slabs were then renamed to their old cast-number cancelling the Q-cast number. A slab that could not be traced to a missing slab by quality, composition and measurements, was then given a new identity consisting of a SKU of the same quality and composition, only a new block number was added at the end, for instance if a specific cast had 4 slabs-the last block letter would have been, D, then the "no ID" slab receives the block letter E. This is for simplifying the process, meaning you have more slabs in one cast with the same properties which in return makes it simpler to satisfy customer orders and reduces the workload of adding another cast.

The “no-ID” slabs were all named and their information recorded before a meeting was held to discuss the data collected from the stock take and compare it to the previous data that was archived. The archived data’s inventory is at 24 078 tons (±2000 slabs) of steel of which only 8 460 tons would be usable for Customer orders, verifying 14 200 tons of steel that is unusable or out of specification for customer orders. The stock-take only recorded ±1100 tons of steel to be out of specifications or that had some sort of defect. These slabs are either too short and will not return a proper yield after rolling or slabs with larger defects that will lead to holes in the plate if it were rolled. The difference between the total tons of slabs counted in the stock take were 642 tons more than the archive data and management declared it as insignificantly small. The difference could therefore be ignored and the new data was kept in the system for the generation of future schedules.

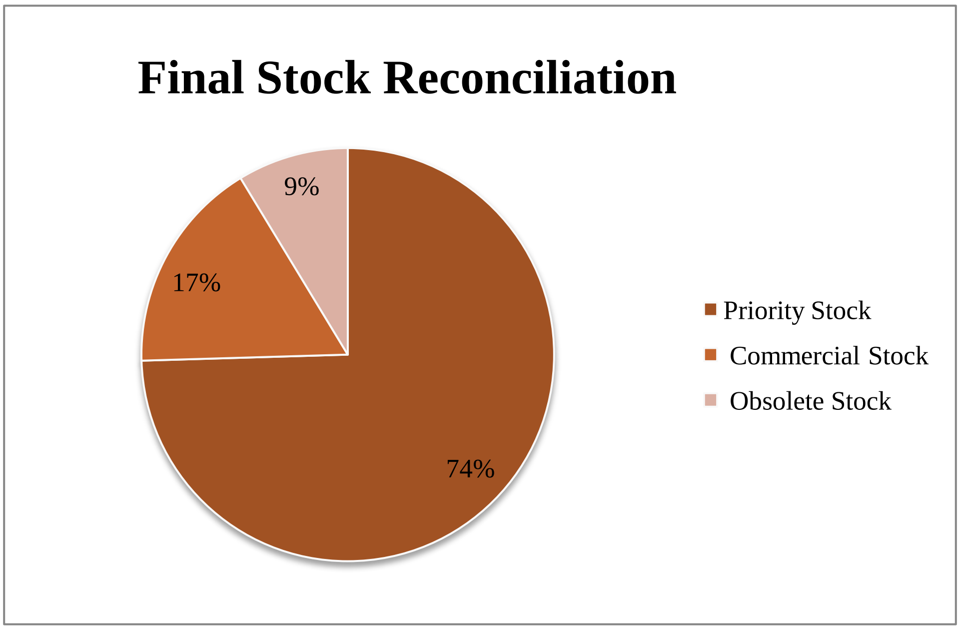
Figure 8: Named slabs after stock take

This noteworthy difference in slabs that are obsolete according to previous data and the stock-take required investigation. FOX does not automatically record skew cuts on slabs, this has to be done manually and therefore it would be possible for the stock-take to show a larger number of obsolete slabs than FOX does. After some investigation it was found that when a slab was placed on a schedule to be rolled by the scheduling department and the slab yard operators did not find the slab it was recorded as a “NO-CHARGE” within the system, meaning the slab was not available for cutting or piled for rolling. The slab had no defects, but because they could not determine its location, the only way to inform the system to add a new slab to that schedule was to record the slab as a "NO-CHARGE". To satisfy customers the schedules had to be rolled without any delays and there was no time to waste looking for a missing slab in a slab yard with ±2000 slabs. Improper management and system constraints lead to a significant amount of slabs recorded as unsuitable for processing, without any indication to what was preventing these slab from being processed. This created dead-stock in the Slab yard, meaning slabs that will never be allocated to a customer order although the slabs are sufficient regarding quality and size. Ordering a new slab in the place of the missing one also creates a problem as a cast consists of minimum six slabs and if slab is ordered all six are cast and the five left are kept as inventory in the slab yard creating additional excess stock.

The final data according to the stock-take and updated on the system were as follows;

- 24 150 tons of total stock.
- 18 000 tons of stock that is sufficient for allocations to customer orders, called priority stock.
- 4 050 tons of steel that could be sold as commercial-steel, steel with composition grade 5.
- 2 100 tons of steel that is obsolete.

Table 2: Final Stock Reconciliation



3.2. Inventory Categorization

Classifying the inventory into an ABC-analysis;

A: Items that require tight inventory control

B: Items that require less stringent inventory control than A but more than C

C: Items that require the least amount of inventory control, but still need to be managed.

Inventory within the slab yard falls into three categories (predetermined by EHSV):

Priority stock- This is steel that is in accordance with the specification of customers and will be used to satisfy the most valued orders. Priority stock represents the larger percentage of monetary value to the company and requires accurate demand forecast together with detailed stock-keeping. Within the priority class different qualities and sizes are present. The quality depends on the composition for a specific order.

Commercial Steel- This is known as grade 5 steel. Grade 5 steel is of a good enough quality to be processed, but certain defects prevent it from being of a good enough quality to satisfy customer orders of a specific grade of steel. Defects such as the composition of a slab or the size of the slab will not yield a proper plate or coil, but can still be rolled into flat-products to be sold on the commercial market. Commercial steel still brings monetary value to the company to cover losses but the revenue on a slab is not as high as that of priority stock. Commercial steel also consists of slabs with different composition and sizes.

Obsolete Stock- Slabs that obtain some sort of defect from the cast or cutting, or are cut pieces from slabs used and are too small to be rolled. Obsolete slabs are of no value to the slab yard but form part of inventory.

The different categories already determined make it easier to then classify them according to the ABC-analysis:

- → A: Priority Stock
- → B: Commercial Steel
- → C: Obsolete Stock

Conclusion on Stock take

Operations started after the stock take and a lot of errors occurred regarding the data that was captured during the stock take, especially the measurements of slabs. The values of the stock take were compared to the archived records of inventory, but only the total tons recorded and not specific slabs. Management never compared any other values and assumed that because the difference was so small it can be ignored and the new values can be accepted as correct. A slab was now allocated to an order and put on a schedule only to find that the slab's measurements were recorded incorrectly. Scrutinizing this it can be seen that detail attention is needed to update the stock take procedures of the slab yard. Inventory checking plays an essential part in improving record accuracy, keeping records updated as well as analyzing the causes behind inaccuracy when found during a stock check.

3.3. Analysis of slab yard operations

Processes within the slab yard and work instruction is revised and it is evident that adequate processes for operating the slab yard are in place but not firmly managed and are not fully aligned with Lean Manufacturing.

Manufacturing Strategy: (the underlying philosophy of a manufacturing system)

Proper control over operations is inadequate with each shift operating the slab yard in a different way according to the team leader of that shift, the completion of paperwork is different for each shift and some operations are unnecessarily repeated during shifts. Lean Manufacturing is only incorporated in parts of the process and management decisions are not always in line with this policy.

A proper support system for operating staff is not in place together with inadequate training and job descriptions given to employees, the employee morale is very low and employee's attitude towards the company is awfully negative. The communication between operations and management is in serious need of attention, most of the time management only communicates verbally and nothing is recorded for future references, verbal communication also occurs only between management and the shift on duty, without other shifts being informed.

Infrastructure Analysis:

The equipment in the slab yard working directly on the slabs to add value is old but still in fairly good working condition but cannot work at full capacity anymore. Therefore proper maintenance and operating procedures regarding capacity of equipment must be in place which is absent within the slab yard. The human resources in the slab yard is sufficient in numbers if they are properly managed and people are aware of what must be done, where and by whom but currently the resources are not applied properly. Human resources can be improved by proper training of employees because no proper training procedures are in place within the slab yard. An information system, FOX, is in place, but is still new to operations with a lot of modifications needed to fully cooperate with the production process.

Figure 9 : Operating equipment in the slab yard

Cutting-bed

Operating crane

The following work-instructions are available:

1. **The receipt of slabs.**

   These are instructions on how to receive a slab, what paper work should be completed and what data should be recorded.

2. **Dispatch of slabs.**

   Similar to the receiving a slab you have documentation for when a slab is dispatched as well as specific work instructions.

3. **Inspection, rectification and identification of slabs.**

   After a slab is received from the steel plant it has to be inspected to ensure it has no defects and that the quality of the slab is similar to the specifications of the cast and defects should be rectified where possible. Each slab should then be named according to the specifications in conclusion with the inspection.

4. **Stacking of Slabs and Crane operating.**
   All the slabs are moved and stored by crane operators, this document gives the standards on how to pile slabs in accordance with the Occupational Health and Safety act.
5. **Not Charge slabs and not located slabs.**
   Standing instructions for what to do when a slab cannot be found or for some or other reason is not suitable to be rolled.
6. **Cutting of Master slabs.**
   This involves the procedures for cutting a slab into pieces; a piece will either then be piled for rolling or stored for future use.
7. **Piling cut-slabs and loading the platform.**
   Piling is done according to a schedule and specific procedures should be followed to ensure that the correct schedule is piled as well as the correct order.
8. **Scrap Handling.**
   This is an instruction on where to store and how to remove scrap from the slab yard.
9. **Housekeeping.**
   In general all process should have good housekeeping rules, regarding the disposal of general waste, toilets and equipment within the working environment.

On paper the processes are clear and properly defined but none of these were properly implemented or managed. Changes such as better stacking and locating procedures as well as a better inventory count system are possibilities for further improvement to incorporate best practices. The obsolete stock management is also an area open for improvement to improve slab yard operations. The slab information is not updated regularly, creating errors in operation and complicating the process of fulfilling customer orders. Although proper work instructions are available, they are not connected to a responsible person with appropriate job-specifications. One of a company's most valuable assets is the people working within the company and worker morale should be kept high with proper training and a comfortable working environment. No process is of value if it is not implemented or managed. Chaos is the lowest form of resistance and if a process is not properly managed chaos will always return (Van Schoor, 2011) and management sets the standard to which workers have to oblige.

Chapter 4: Proposed solutions to reduce obsolete and surplus stock

One of management's biggest concerns was the significant amount of obsolete stock recorded in FOX, bearing in mind that FOX was implemented less than a year ago and that this was the first annual stock-take after the implementation of this scheduling programme. The stock take indicated that the amount of obsolete stock is not as significant as recorded in FOX. The apparent exaggeration was the result of practice to record slabs that could not be found as obsolete.

Three improvement proposals, which can be used in combination, are considered as a solution to improve obsolete stock management:

1. Adjustment to the Information System
2. Sufficient inventory levels for production
3. Management of obsolete stock for improved capacity

4.1. Improving the Information System

The Information System, FOX, is still adapting to the processes of the plant because it is still new to the operating procedures and was developed by an outside firm. The stock take made it clear that this system needs to be adjusted regarding the recording of slabs that are on schedule but cannot be rolled to different categories. FOX only allows the user to record a slab that cannot be rolled as obsolete. The first category of obsolete slabs has some existing defect preventing them from fulfilling customer orders. The second category is slabs that cannot be not found and therefore not rolled. The latter do not have any defects and when eventually found the slab will be suitable for customer orders.

FOX must be adjusted to accept two inputs for slabs not rolled that are on schedule, including a category "item not found", triggering a process to search for the item and reverse the temporarily "unavailable" status. In conclusion with this the system must have some sort of preventative measure regarding the recording of too many slabs in the "item not found" field, enforcing the slab yard to locate the slabs and update the system to prevent too much dead stock from lying in inventory.

4.2. Inventory Control

The lack of control over inventory is the reason for slabs disappearing from the slab yard. To improve control manageable inventory levels and obsolete stock management processes must be developed. Lower inventory levels will be easier to manage, leading to control over inventory especially in terms of locating and accessing slabs.

The goal is to stock the least amount of inventory possible but still have the inventory readily available when it is needed. This is in line with the Lean Manufacturing processes for facilities to run lean through holding inventory at a bare minimum to eliminate waste. The facility still operates at full capacity, minimizing down time and maximizing production output.

A Material Requirement Plan (MRP) works well in manufacturing environments where production schedules are developed to meet customer demand and will be used to calculate the exact requirements for production in the slab yard.

4.2.1. Material Requirements Plan (MRP)

The slab yard can be considered as a very essential inventory buffer point, allowing the decoupling of the steel plant and the rolling mills. The important question to answer is the optimum amount of stock that ideally needs to be stocked in the slab yard in order to function as an effective buffer. The key factors to consider are the variability in supply from the steel plant and variability in demand from the rolling mills or customer orders. MRP, if properly guided by higher level planning processes and accurate and updated planning parameters, will ensure that the correct materials are available for production by maintaining the lowest possible level of inventory.

Three primary inputs of a MRP:

1. **Master Production Schedule (MPS)**
   The MPS drives the calculations that determine the materials required. The Scheduling department within EHSV develops the MPS that drives the production of the slab yard. An example of a schedule can be seen in Appendix B. A schedule consists of approximately 50 slabs (1500 tons) and takes four shifts (one and a half days) to complete. The scheduling process first assigns slabs in inventory and if no suitable slab is available an automatic order is generated for a slab from the steel plant. Schedules are developed one week in advance for effective production planning.

2. **Bill of Material (BOM)**

   A BOM defines the product assembly structure required to produce an item. In the case of a slab yard producing coils or plates only a slab is needed and no other subassembly part. The parent-child diagram only consists of coil or plate as the parent and then the slab as child entity.

3. **Inventory Status Data (ISD)**

   The ISD informs the system of the quantities available to meet requirements in each period. The net requirement is calculated by subtracting the current inventory available from the total gross requirement including safety stock.

The scheduling department generates and monitors the MPS, BOM and ISD for production, but the ISD can be improved by only storing slabs on schedule and the required safety stock. This means that all slabs needed for production are ordered from the steel plant and the only inventory kept in the slab yard are the scheduled slabs and safety stock.

The following aspects indicate why the slab yard has to keep some level of inventory and cannot receive inventory on time without some sort of buffer:

- The slab yard lacks strict control.
- The variability in supply from the steel plant, both in quantity and quality of slabs supplied.
- The ovens must be supplied with slabs continuously as a delay will cause the ovens to overheat.

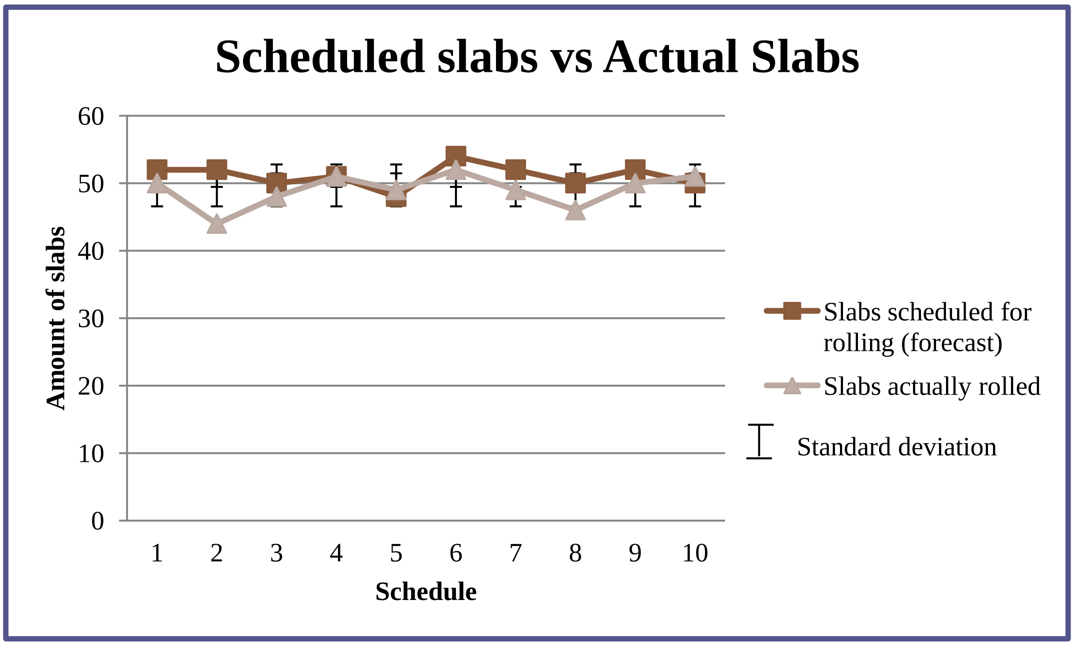
These requirements, combined with specific customer orders, dictate that a minimum quantity of most items (safety stock) needs to be available and kept in stock in the slab yard. The safety stock is determined using the forecasting error. The forecasting error is the standard error between the slabs that were supposed to be rolled according to the schedule (forecast) and the actual amount of slabs rolled. This error occur when something prevent a slab from being rolled, such as;

1. The slab was not found
2. The slab was defective
3. The slab size was incorrect

Table 3: Forecasting error

Forecasting error for slab yard production					
DAY	Slabs scheduled for rolling (forecast)	Slabs actually rolled	Forecast Error	Forecast Error %	(forecast error) ^{2}
1	52	50	2	4%	4
2	52	44	8	15%	64
3	50	48	2	4%	4
4	51	51	0	0%	0
5	48	49	-1	-2%	1
6	54	52	2	4%	4
7	52	49	3	6%	9
8	50	46	4	8%	16
9	52	50	2	4%	4
10	50	51	-1	-2%	1
Total (forecast error)^2					107
Average (forecast error)^2					10.7
Square root of average (standard deviation of forecast error)					3.3

Figure 10: Graph illustrating the standard deviation between the scheduled slabs and the slabs actually rolled



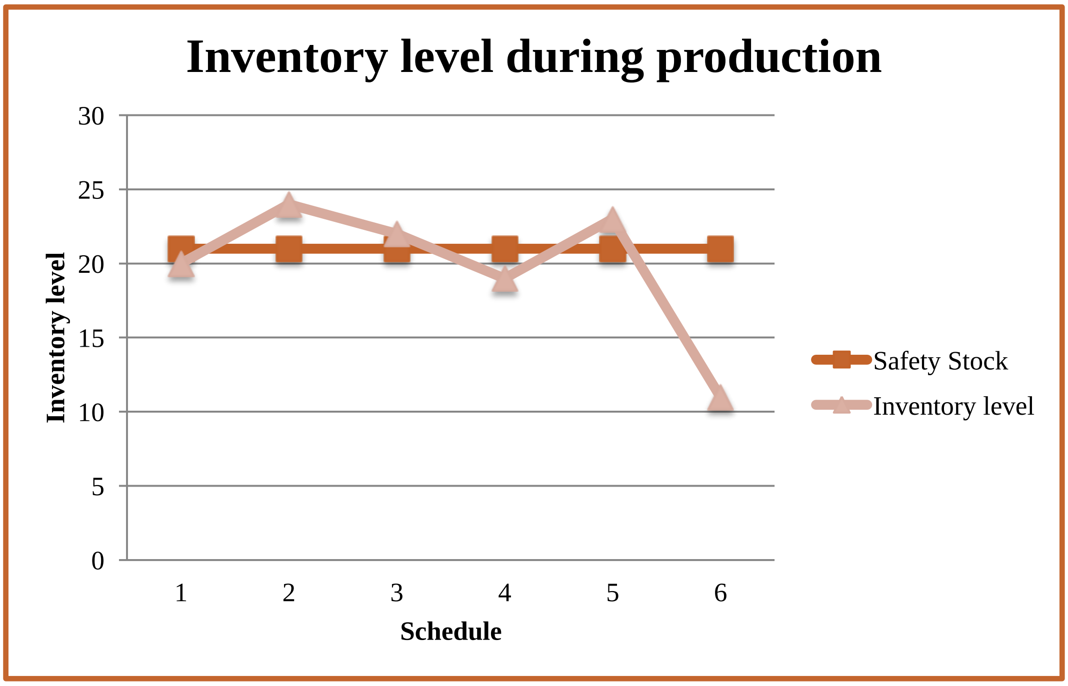
The forecasting error determines that 3.3 slabs must be kept in inventory as safety stock to prevent down time, rounding to four slabs per schedule. The more accurate the actual amount rolled to the schedule slabs are, the smaller the forecast error is and less inventory is necessary. Additionally the safety stock also has to cater for the variability in supply from the steel plant. Proper inspection when slabs are received will eliminate later changes to schedules when found that the quality of a cast was insufficient.

According to records the average amount of slabs to be found defective after inspection is 2.7 slabs per schedule. To ensure enough safety stock exists within the slab yard an additional three slabs have to be added to the safety stock to cater for the variability in supply from the steel plant. For a slab to arrive at the slab yard after an order has been placed takes approximately four days, meaning that three schedules will be completed before a replacement slab arrives.

In conclusion a safety stock of 21 slabs must be kept in inventory, this allows for the variability in production and supply, as well as the lead time for replacing slabs.

The schedules for production developed by the Scheduling department can serve as a MRP. The slab yard will only serve as a buffer between the steel plant and the rolling mills and not as a storage facility out of which items are scheduled. The slab yard only receive slabs on schedule for future production and store them until previous schedules are processed, with an extra 21 slabs serving as safety stock.

Figure 11: Illustration of Inventory Levels during Production



4.2.2. Proposed solutions to reduce obsolete stock

The amount of obsolete stock reduced significantly after the stock take identified the limitation in FOX, however true obsolete stock exists and should be properly managed.

Benefits of obsolete stock management:

- Adds capacity and availability to the facility
- Reduces congestion
- Reduces the possibility that obsolete stock is used during production instead of priority stock

Process for identifying and handling obsolete stock:

1. **Identify obsolete stock**

Obsolete stock first has to be identified then procedures can be determined regarding the disposal. The operators in the slab yard are trained to identify obsolete slabs. Examples are slabs with a guage of 180 mm and a length shorter than 800mm, which is automatically scrapped and any slab with visible defects shown during inspection such as pinholes from casting. Slabs that are deformed through piling or handling to such an extent that the slab will be unsuitable to roll are also classified as scrap or obsolete. Obsolete slabs are marked with red or white spray paint with the word SCRAP for later identification.

Figure 12: Marked Obsolete Slabs

2. Move to designated area

A designated area within the slab yard must be assigned to obsolete slabs and after a slab is identified as obsolete it must be moved to that area. The designated area for obsolete inventory prevents obsolete inventory from obstructing production and obsolete stock can be easily handled from there. An area dedicated to obsolete slabs is developed during Chapter Five.

3. Determine action

A slab that is identified as obsolete and then moved to the designated area cannot stay there and an action towards managing obsolete stock must be developed and implemented to manage obsolete stock in the facility, preventing it from becoming surplus after identification. The inventory in the Slab yard is classified as WIP (work-in-progress) with a WIP value. The WIP value consists of the cost of producing or purchasing an item classified as WIP.

Table 4: Proposed solutions for obsolete stock handling- Recovery vs. Loss:

Disposition	Recovery	Loss
Use as is	100%	0
Rework/Return to vendor	75%	25%
Sell/Disposal	25-75%	50-75%
Scrap/Write-off	10%	90%

The proposed solutions give an indication of the value that can be recovered or the value that will be lost to a company when handling obsolete stock. The following solution is more applicable to slab yard operations;

- Return obsolete slabs to the vendor/manufacturer

The purchased materials or goods received are unacceptable after inspection or during the production process due to inadequate quality and designated for return to the supplier/manufacturer for credit or replacement. In the case of EHSV returning the goods would not solely depend on the condition of the goods when received from the manufacturer, but also because of defects caused in the slab yard. The goods (obsolete slabs) would be returned to be reprocessed (re-melt and then cast) and refunded by replacing the slab with another useful item. The obsolete slab will be received as raw-material by the steel plant.

Improved handling for obsolete stock

The overhead cranes used to move the 30 ton slabs are currently utilized at full capacity to access the slabs that are on schedule. Moving obsolete slabs to a different location is a constraint to keep in mind and might need to be scheduled at regular intervals when the steel plant is not producing slabs. Alternatively, additional equipment can be obtained or another possibility would be to cut the obsolete slabs for easier handling.

- **Additional equipment to assist in handling obsolete slabs.**

Hiring or purchasing will have its own advantages and disadvantages when considered separately, but for the purpose of the project both will be seen just as an expense made by the company to facilitate in their need. Obtaining an extra crane to off-load slabs at a facility catering for obsolete stock after they have been written-off would assist in making space available in the slab yard. Obsolete slabs would then be loaded on to the slab-trucks by the existing cranes in the slab yard and be moved via the railway to the new destination set out for obsolete slabs, where they will then be handled by the hired or purchased crane. The reliability of the supplier and the the maintenance of the new equipment are aspects to consider when additional equipment is obtained. The new equipment will improve the production process which in turn will increase the revenue, but the production increase should justify the expense.

- **Cutting slabs for easy handling.**

This means machining an item or parts of it to make it more manageable. If slabs were cut into smaller pieces in the slab yard they would then be easier to remove via trucks that could be parked under the cranes in the slab yard to load the obsolete stock and then take them to the set out location. Smaller pieces will not have to be off-loaded with a crane, where a normal tipping-truck would be sufficient. The equipment needed is already available, although cutting would influence productivity and energy usage.

Removing obsolete slabs will affect the amount of stock stored in inventory and the slab yard recaptures space for better control over inventory in terms of accessibility and management of less slabs. A slab carried in inventory occupies between 1.2 and 1.7 square meters and 0.216 and 0.425 of cubic space. The resources, such as the equipment for handling slabs will be more efficient because all slabs moved are of value and no scrap is occupying the capacity of the equipment to be able to access valuable stock. There will also be a reduction in carrying costs as less labour is required to allocate and move slabs, as well as less deterioration and damage to stock.

Table 5: Cost/Effectiveness Analysis regarding material handling of slabs:

Area of Concern	Cost and Electiveness	
	Additional Equipment	**Cutting**
Personnel Cost	• Additional operating team for new facility	• Additional person for operating the cutting bed
Material Cost	• Hire or Purchase of crane • Production cost for operating the equipment and facility	• No additional equipment • Production cost for operating the cutting beds
Delivery Cost	• Training of new operating team	• Training of additional cutting-bed operator
Effectiveness of disposal	• Slabs will be moved from facility A to B	• Slabs are removed from the facility to be re-used.

In conclusion to these two solutions, it is clear that cutting slabs is the better material handling technique for the slab yard. No initial investment is needed to purchase or rent equipment as well as maintaining them. The slab yard already has equipment available to cut slabs and the only impact would be on the utilization of the machine and some additional labour. The cutting beds have the available capacity to cut the obsolete slabs for better handling.

Figure 13 : Illustration of a Cutting Process

4. **Make financial provision**

The financial provision ensures that all monetary value regarding the production or purchase of the obsolete item is dealt with. The value of the slab that is returned must be refunded to the steel plant and replaced with the value of a new slab.

5. **Take action**

Concluding the above mentioned suggestions, the best possible solution to reduce/manage obsolete stock within the slab yard would be to use existing equipment to cut them into smaller pieces that could be returned to the steel plant (vendor/manufacturer) to melt and cast new slabs that could be of use for customer orders. Using the inventory model and FOX as a defensive action to prevent the slab yard from being over stocked again. Continuous monitoring of inventory levels and scrap is a necessity.

Figure 14: Inventory in the slab yard

Chapter 5: Improved Slab Yard layout

The analysis of the slab yard revealed that the facility is congested with slabs piled randomly and no proper storage system is in place. The slab yard has very little control over slabs making it difficult to locate and retrieve slabs during production. A proper layout and locator system will improve the management of stock, which in turn will improve production.

The aspects that need to be considered to develop a proper layout for the storage of slabs are:

1. Space availability
2. Location system
3. Dimensions of the product or raw-material stored
4. Shape of an item
5. Weight of an item
6. Product Characteristics such as stackable, toxic, liquid and crushable
7. Storage method- Floor stacked, racks, carousel or shelving
8. Labour availability
9. Equipment and resources- including special attachments available
10. Support from an information system

In Chapter Four it was proposed that the slab yard would only store slabs already on schedule, six schedules in advance with safety stock. This gives a total of approximately 300 (9000 tons) slabs. The slab yard surface area is 1200m^2, making it able to accommodate 75 (16m^2 per slab) slabs placed on the surface. Slabs can still be piled on top of each other, indicating that sufficient space is available to accommodate slabs and walkways. The weight of slabs limits the possibilities for storing a slab and therefore the most feasible method is to pile slabs in stacks directly on the floor. It is, however, important to ensure that appropriate piling discipline is maintained. ISO states that any object can be stacked at a height of three times the smallest base, with the smallest base of a slab equal to 1440mm and the height between 180mm and 250mm. A pile can consist of 17 slabs. Furthermore, to ensure slab accessibility at all levels in a stack, practical considerations indicate that it is best is to keep slabs at a maximum of 12 per stack. This will also prevent deformation to slabs at the bottom of the pile carrying the weight of all the slabs on top. Slabs are currently stored randomly where there is available space and slabs are located manually through operators searching the facility.

5.1. Possible Layout and Locator systems:

There are five layout and storage options that can be considered:

5.1.1. Memory System

Memory systems are exclusively dependent on human recall. The foundation of this locator system is simplicity, some freedom from paperwork or data entry, and maximum utilization of all available space. Memory systems depend directly on people to recall the location of an item which limits the amount of items kept in inventory as well as the detail recalled of each item.

Impact on Physical Space

The most complete space utilization is available through the Memory system, because no item has a dedicated location that would prevent other Stock-keeping-unit's (SKU) from occupying that same location if it were empty.

Pros:

- ✓ Simple to understand
- ✓ Little to no ongoing paper-based or computer-based tracking required
- ✓ Full utilization of space
- ✓ No requirement for tying a particular stocking location to an SKU.

Cons:

- × The organization's ability to function must strongly rely on the memory, health, availability, and attitude of a human.
- × Significant and immediate decreases in accuracy resulting from changes
- × Once an item is lost to recall, it is lost to the system
- × Additional and longer training required for new personal

5.1.2. Fixed Location System

Fixed locator systems are at the other extreme of a Memory system; with this system each SKU has a fixed location. In fixed location systems, every item has a home and nothing else can live there. A number of fixed systems allow two or more items to be assigned to the same location, but only those items can be stored there.

Impact on Physical Space

If a number of any given SKU are large, then its fixed location may consist of two or more storage positions. However, collectively all of these positions are the only places where this item may exist within the facility, and no other items may be kept there. Fixed location systems require more space.

Pros:

- ✓ Immediate knowledge of where all items are located.
- ✓ Training time for new hires and temporary workers is reduced.
- ✓ Simplifies receiving and stock replenishment because fixed put-away instructions can be generated.
- ✓ Allows for controlled routing of order completion.
- ✓ Allows products to be aligned sequentially.
- ✓ The dedicated location concept.
- ✓ Allows product to be positioned close to its point-of-use.
- ✓ Allows product to be placed in a location most suitable to its size, weight, toxic nature, flammability, or other similar characteristics.

Cons:

- × Space planning must allow for the total cubic volume of all products likely to be in a facility within a defined period of time.
- × Dedicated systems are somewhat inflexible.
- × Basically, fixed or dedicated location systems allow for strong control over items without the need to constantly update location records. That control must be counterbalanced by the amount of physical space required by this system.
- × Items are fixed and cannot be moved around.

5.1.3. Zoning Location System

Zoning focuses on an item's features, only items with certain features can live in a particular area. An SKU's characteristics would cause the item to be placed within a certain area of the stockroom or at a particular level within a section of shelving. Irregular-shaped SKUs might be placed in lower levels to ease handling, or all items requiring the use of a forklift for put away or retrieval might be located in a specific area and on pallets. Basically zoning allows for control of item placement based on whatever characteristics the stock keeper feels are important. Items can be moved within the area, giving a little more freedom in moving items to access others or to create space where necessary because an item is not fixed to a location but fixed to an area.

Impact on Physical Space

As with dedicated systems the more tightly you control where a particular item will be stored, the more you will contribute to your available space or to the need to plan around maximum quantities.

Pros:

- ✓ Allows for the isolation of SKU's according to characteristics as size, variety, flammability, toxicity, weight, private labeling, and so on.
- ✓ Allows for flexibility moving items within a zone.
- ✓ Allows for the addition of SKUs within a zone (unlike a fixed system)
- ✓ Allows for flexibility in planning.

Cons:

- × Zoning is not always required for efficient product handling. You may be adding needless administrative complexity by utilizing zoning
- × Zoning requires updating of stock movement information.

5.1.4. Random Locator System

In a random system nothing has a home, but you know where everything is and the location is captured. Pure random locator systems allow for the maximization of space since no item has a fixed home and may be placed wherever there is space. This allows SKUs to be placed above or in front of one another and for multiple items to occupy a single bin/slot/position/rack. The primary characteristic of a random locator system that makes it different from a memory system is that each SKU identifier is tied to whatever location address it is in while it is there. In other words, memory systems tie nothing together, except in the mind of the stock keeper. Random systems have the flexibility of a memory system coupled with the control of a fixed or zone system. Essentially an item can be placed anywhere as long as its location is accurately recorded, being on paper or within an information system. When the item moves, it is deleted from the previous location and added to the current location. Therefore, an SKU's address is the location it is at present.

Impact on Physical Space

Because items may be placed wherever there is space for them, random locator systems provide us with the best use of space together with maximum flexibility while still allowing control over where an item can be found.

Pros

- ✓ Maximization of space.
- ✓ Control of where all items are at any given time.

Cons

- × Constant updating of information is necessary to track where each item is at any given time with proper control.
- × May be unnecessarily complicated with a small number of SKUs.
- × Basically, random locator systems force a tradeoff between maximization of space and minimization of administration.

5.1.5. Combination System

Combination systems enable you to assign specific locations to items requiring special consideration, while the rest of the products will be randomly located. Very few systems are purely fixed or purely random.

Conceptually you are enjoying the best features of the fixed and random systems. You achieve this by assigning only selected items to fixed homes—but not all items. The fixed system is used for the selected items and the random system for everything else.

5.2. Proposed Layout and Locator system

The stock take procedure divided the slab yard into areas and each group had to record the information within their area; if information on a slab or the slab itself were required, the operators searched the area in which the slab was recorded. Each area store approximately 100 slabs, where the entire slab yard has capacity for almost 2000 slabs. A slab was found effortlessly if the area was known, but the time and labour to find a slab of which the area was unknown more than doubled. The stock take procedure is similar to the zoning system, with the SKU of a slab linked to an area.

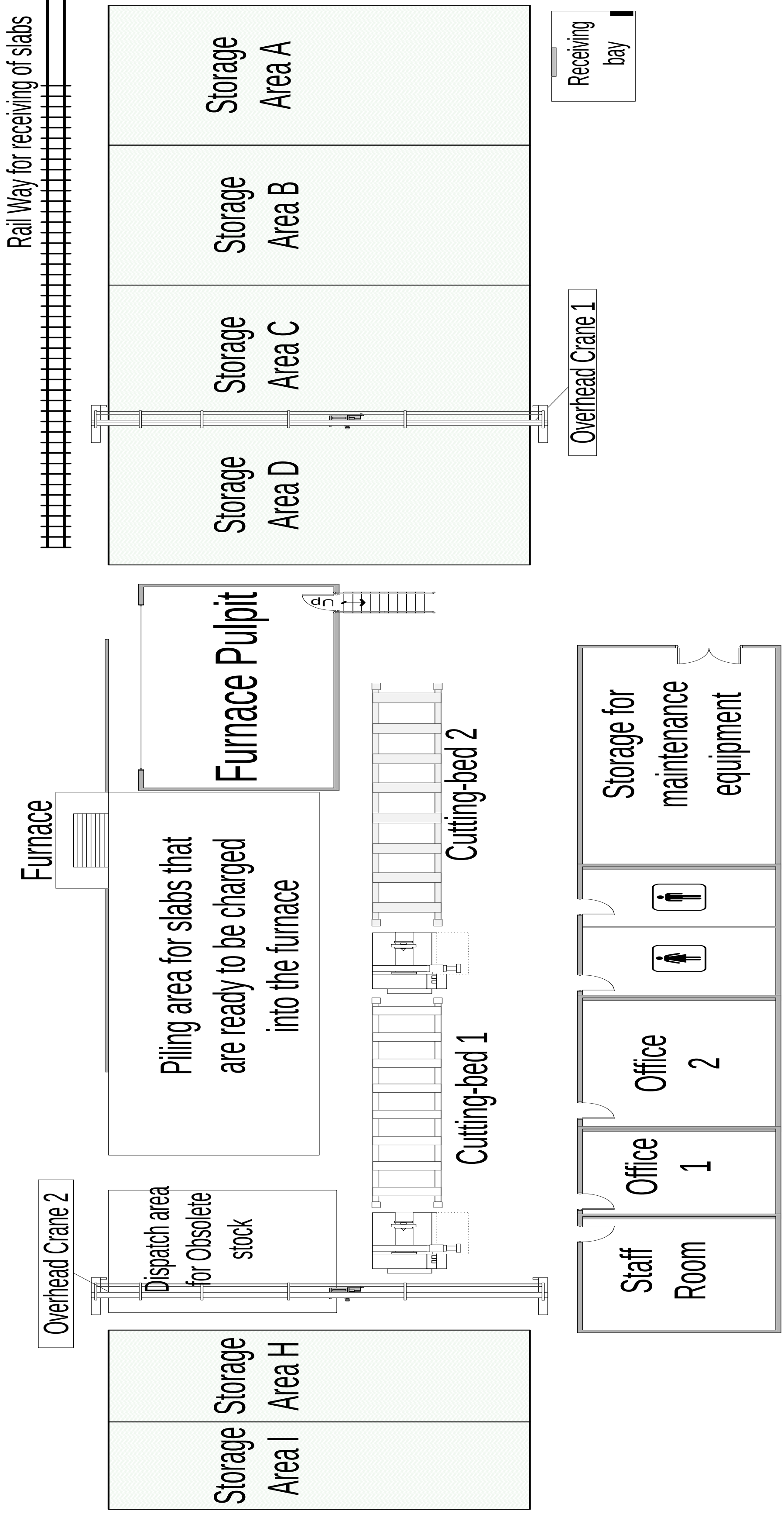
It is apparent that the zoning system will be the most appropriate system for the slab yard considering the stock take and the benefits of a zoning location system. If the location of a slab is not fixed, the slab can be moved within an area and less space is required. Slabs can be piled and if a slab at the bottom of the pile needs to be accessed the slabs on top can just be moved to another location within the current area and no additional effort is needed to update the location of a slab each time it is moved. The schedule and grade of a slab can be used to determine the area in which to store a slab, in return the overhead crane only has to operate in a specific area to access slabs for rolling and not across the slab yard. Additional slabs can be added to an area when needed or moved from one area to another making the system more flexible to a change in schedule to satisfy an urgent customer order.

The improved layout:

The layout consists of four larger (named A, B, C and D) open area storage facilities and two smaller ones (H and I). The layout can be seen in Figure 16. The overhead crane support structure (I-beams) is used to divide the facility into areas. Overhead crane one will manage the larger areas and overhead crane two will manage the cutting, charging and smaller storage facilities. Both cranes have a 30 ton capacity.

Figure 15 : An illustration of the areas within the slab yard.

Figure 16: The new layout



A slab will receive an area code after it is inspected at the receiving end and will then be moved and placed in that area by the crane operator. The information system will be updated with the SKU of that slab, indicating the dimensions, grade and area/zone in which the slab is stored. A schedule will then be generated for slabs allocated to a customer order to be rolled; the schedule will be in accordance with an area, scheduling only slabs in one specific area at a time. The overhead crane will then access all the slabs on that schedule moving within the area and then placing them in the piling area allocated for slabs that are on schedule to be rolled.

Area A will be used for inspection purposes and slabs will be stored there until inspected and another location is established. Area B will then store all the commercial steel, leaving area C and D to store the priority stock. The smaller areas, H and I, will be used for the cut pieces from slabs in area H, these are pieces cut from a slab of which the bigger piece is rolled and the other piece will be used in future orders. All the obsolete stock will be stored in area I, from where it will be cut and dispatched.

Illustrations of the areas with dimensions are given in Figure 16 and 17, with the piles of slabs and walkways. The walkways are essential to ensure accessibility and therefore the slabs must be piled neatly not covering the walkways. The critical aspect of this layout is to ensure that slabs are only moved within the specific area and not across boundaries to other areas.

Figure 17: Layout of areas A to D with piles of master slabs

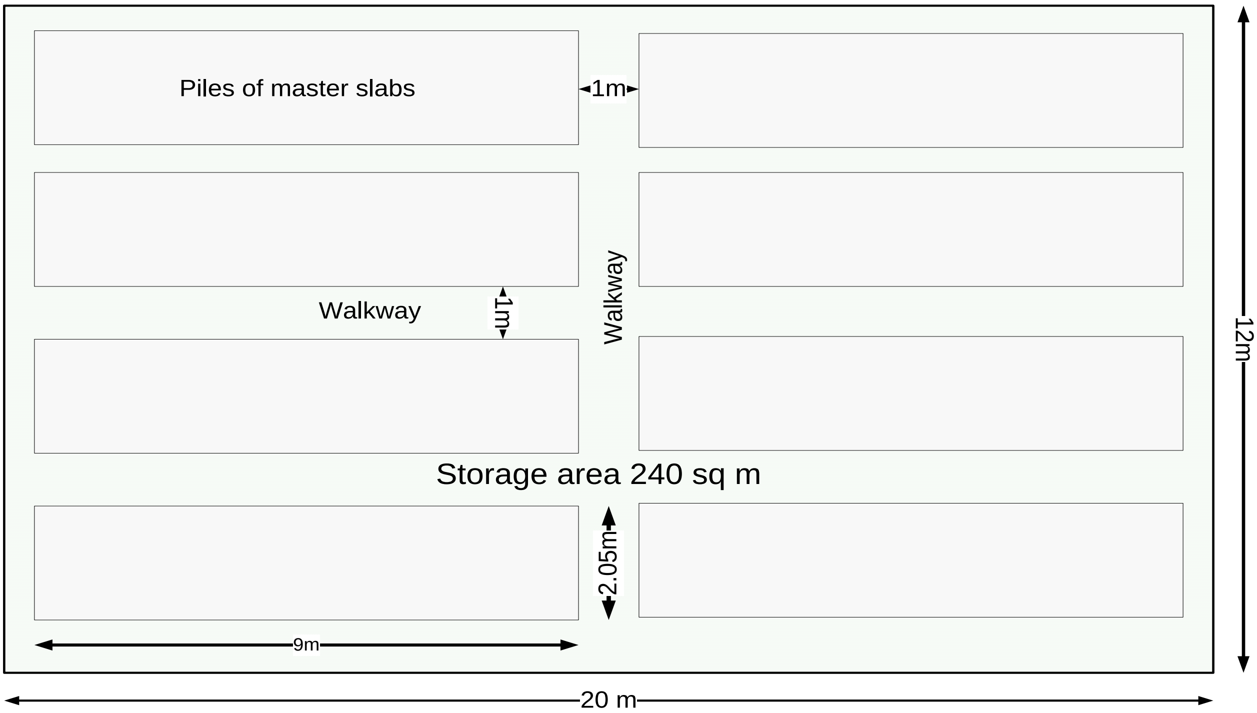
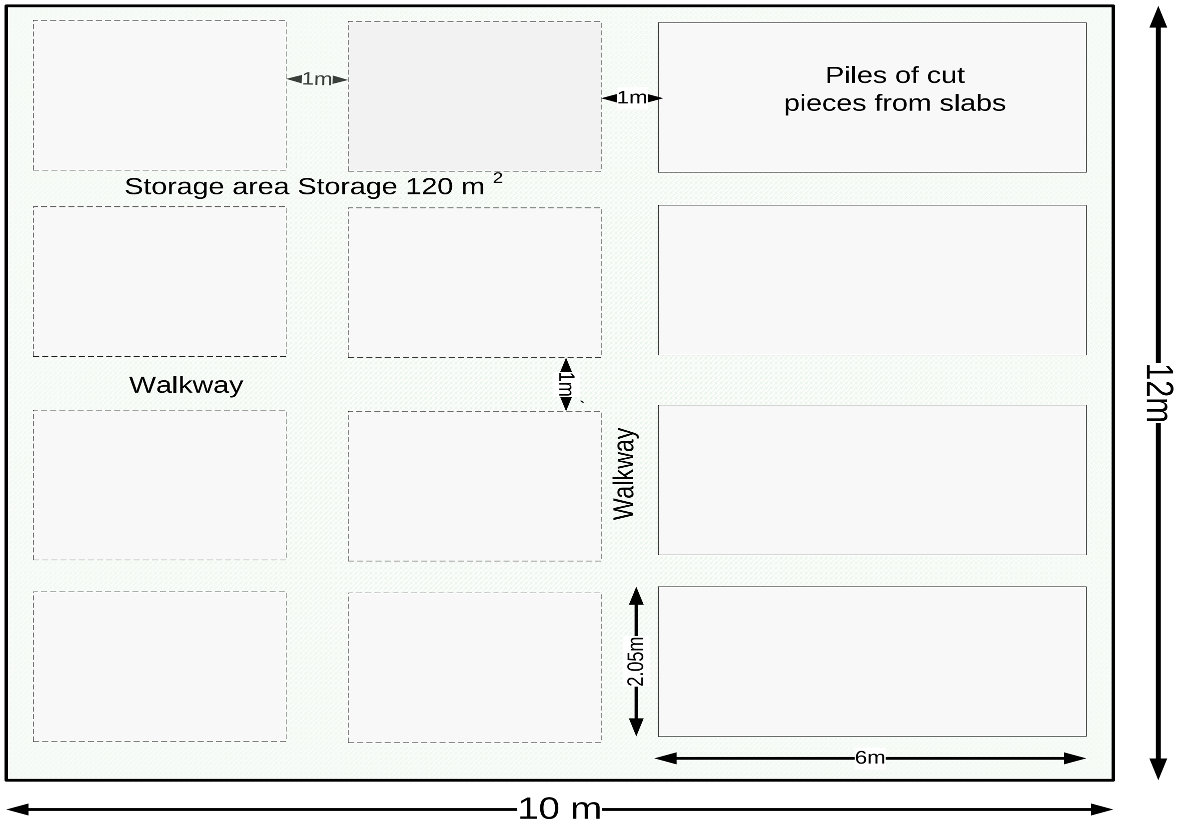


Figure 18 : Layout of smaller areas H and I, with cut pieces or obsolete slabs



Chapter 6: Improved Slab yard processes

Improved processes for operating the slab yard were developed to support the changes made to the layout and improved stock keeping and monitoring. The entire process is illustrated in Appendix C. The changes will also enhance communication and improve management within the slab yard. Lean Manufacturing was implemented throughout the processes to keep work standardized and production flowing. In Appendix D, a copy of the work instructions can be found, the inspection process. Each process and its tasks are explained in this chapter.

6.1. An improved stock-take procedure

A stock take should be kept as simple as possible by avoiding any large counts or long hours. One important principle is that a stock take should be organized carefully and in advance (Wild: 2009). Although the different methods of counting are common sense, it is sometimes good to revise the methods available to determine the most appropriate ones to use during inventory checking.

Methods available:

- A straight count of all the items
- Weight counting
- A quantity count using a device
- Batching in standard quantities.
- Arrays
- Consistent stacking

For the purpose of this project weight counting and straight counting is eliminated because of the weight of slabs making weight counting impossible and the number of slabs in the slab yard are too many for straight counting. Arrays would supply the best option for the slab yard because of the amount of detail needed of each slab as well as the significant amount of slabs that ought to be checked. As a rule the stock should be organized in such a way that a person doesn't have to check too many slabs at a time, to keep concentration at a maximum, and organizing the layout so that slabs can be checked instantaneously. The resources needed for the stock take must be arranged before hand and ensured that if the checking of stock is complex that adequate people are used or the people are properly trained. The paperwork ought to be simplified with less writing and more pre-printing.

In the slab yard the trend, Cycle stock-take, would be more appropriate and it provides better accuracy to records throughout the year. The inventory records cooperate in operations in the course of scheduling the slabs and therefore it is important to keep them updated.

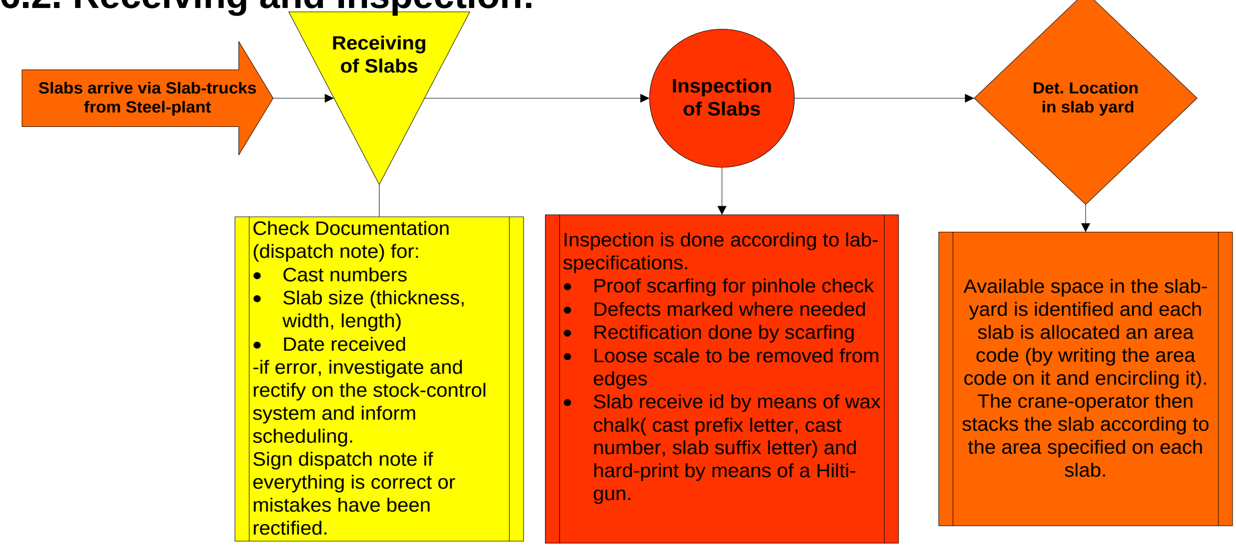
Cycle stock-take divides the stock into the amount of weeks worked by the company and checking that amount of stock per week, where EHSV can also divide them into the number of shifts worked. This will also assist in correcting the error FOX has with slabs that were not found, putting them back into stock regularly with the checking of a certain number of slabs each shift and not annually. Another benefit is that this also enhances the operator's familiarity with the slabs and their locations. The scheduled operation's within the slab yard enhances the effectiveness of this trend as all slabs have to be monitored throughout the process.

Advantages of a Cycle stock-take:

- Provides accurate stock levels throughout the year.
- Better quality of information is produced.
- Cost less-because it is carried out as a weekly routine and no shutdown is needed.
- Less disruption of work.
- Provides the opportunity to spend time to examine the causes of discrepancies.
- People trained and familiar to the process are used making data more reliable.

The major disadvantage of a cycle stock-take is that if it is not properly managed it could create even more disarray, therefore proper management systems should be in place before attempting a cycle stock-take.

6.2. Receiving and Inspection:



Receiving:

The important part of receiving slabs would be to confirm that the correct documents are completed by the steel plant and that these are correct. Confirming cast numbers, slab sizes and the amount of slabs received on the dispatch note reflects what is actually received. If an error is picked up, the correct investigation process should be undertaken and any mistakes should be rectified and the necessary people must be informed. The dispatch note is only signed after confirmation that all the information is correct or rectified.

Inspection of slabs:

The purpose of inspection is to ensure the quality of the slabs received from the slab yard is sufficient and give feedback to the steel plant on the quality of their cast. If proper inspection isn't done the steel plant will not be aware of poor quality and areas for possible improvement. Inspection also determines into which category each slab falls.

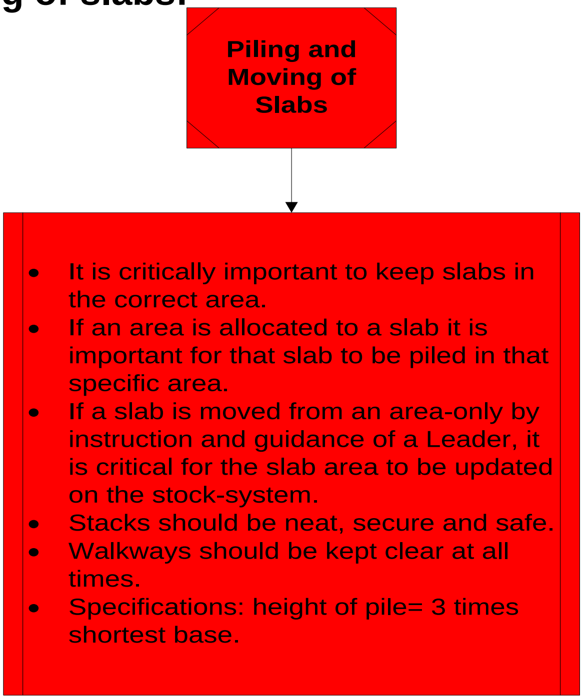
Inspection involves proof scarfing slabs to check for pinholes, slabs that are defective are marked and the defects are indicated. Slabs with defects that are rectifiable, are rectified by scarfing and all slab scale is removed from the edges. Each slab is marked additionally on both sides with wax chalk and then also hard-stamped for identification after heat treatment with a Hilti-gun.

Figure 19: Inspection of slabs

Storing slabs after inspection.

The slab yard operator determines the location for keeping the slab after inspection and the slab has been categorized. All category slabs have their designated locations to improve further production. The area code determined, where the slab must be placed is written on top of the slab and is encircled to prevent confusion with the cast number. The crane operator is then responsible for placing the slab in the area indicated and the area code is recorded into the FOX system.

6.3. Piling and Moving of slabs:



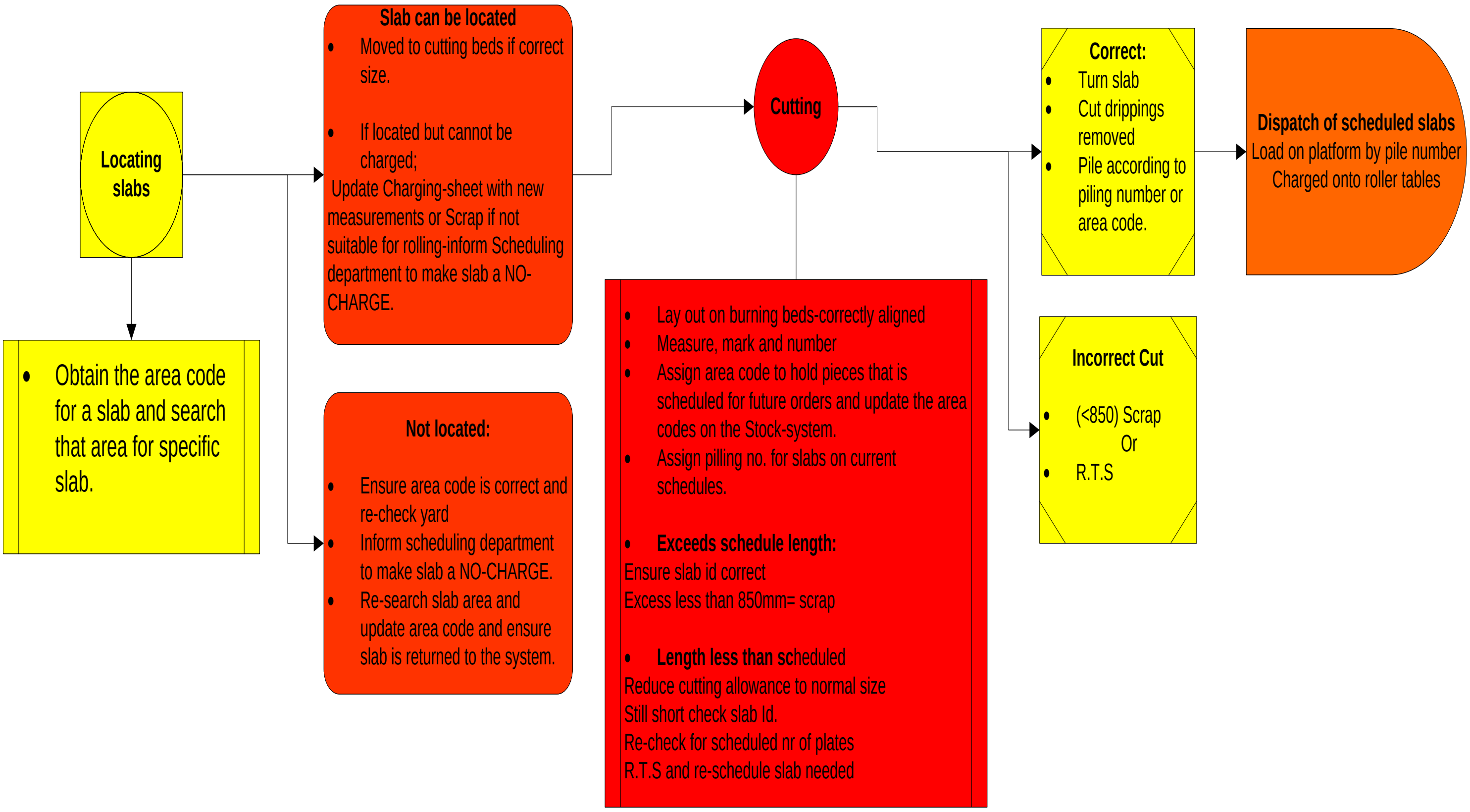
Piling and moving

The newly developed layout and FOX improvements, correct piling and moving of slabs is crucial to the success of operations. A slab is scheduled according to area and if the schedule is given out slabs are searched for in that area and all slabs on schedule come from an area for easy accessing and less movement of cranes. If a slab is moved to another area without updating the system , the improved process would be worthless, slabs will disappear again making it difficult to locate them and this would also effect the handling of slabs when slabs from all over the slab yard have to be loaded onto the platform.

According to ISO any pile's length must not exceed three times the smallest base of the pile and this is a new rule implemented in the slab yard. This prevents the possibility of defects occurring to piled slabs with the height of the pile not being able to damage the slab at the bottom. Neat piling and keeping the walkways clear would assist in making the slab yard a safe and uplifting working environment. Cleared walkways make it easier to move between slabs allocating slabs and convenient for cycle stock take.

Figure 20 : Slabs piled incorrectly

6.4. Locating and Cutting of slabs:



Locating and cutting slabs.

A schedule is compiled by the scheduling department indicating which slabs are next for cutting and then piling to be rolled. The schedule gives the area code and cast numbers then the operators in the slab yard have to locate the slab and mark it so that crane operators know which slabs should be accessed next. If a slab is not found, or if a slab is found but has some sort of defect preventing it from being rolled, the scheduling department should be informed so that they can schedule a new slab to that roll order. All slabs found and suitable for rolling are measured to confirm and correct measurements recorded and the slab can be rolled. All appropriate slabs are then loaded onto the cutting bed and cut into the correct sizes and then piled on the platform for rolling. If cutting the slab causes a defect the slab should also be rescheduled. After a slab is piled on the platform it is seen as dispatched from the lab-yard and is removed from the stock list.

Chapter 7: Implementation & Conclusion

7.1. The removal of obsolete stock

The first objective was to identify and remove true obsolete stock from the congested slab yard. The identified obsolete stock, as identified during the stock take, was moved to the designated area for scrap items. Thereafter obsolete items were cut into pieces while production was still down for maintenance, utilizing the full capacity of the cutting beds. The cut pieces were then loaded onto slab carts and returned to the steel plant. All 2100 tons of obsolete slabs were removed before production restarted, adding significant capacity to the slab yard for production.

7.2. Improved inventory control and reduced stock

The Scheduling department was responsible for placing all available slabs left in the slab yard on schedule to assist in prioritizing and clearing excess stock. The steel plant maintenance shut down took longer than expected, giving the opportunity to clear the slab yard. Eight schedules were created using only the slabs in inventory with two schedules of which some slabs were in inventory and the others had to be ordered. The slab yard was able to complete five rolling mill schedules before the steel plant restarted production, leaving the slab yard only with slabs already on schedule. A total of 24040 tons of priority stock and 3860 tons of commercial steel were scheduled and rolled. The scheduling department is now responsible for generating schedules through ordering slabs from the steel plant and keeping safety stock to ensure no downtime in production. Figure 19 indicates stock levels before and after.

Figure 21 : Improved inventory levels

7.3. Implementation of the new layout.

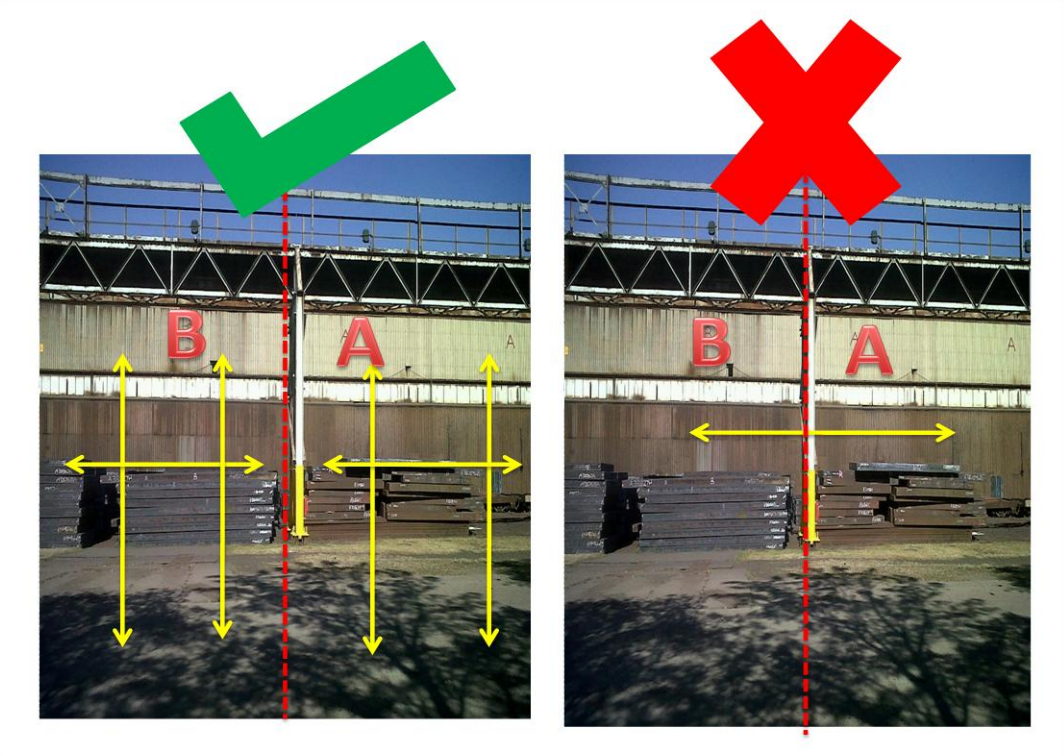
The pre-procedure for stock take involved the organizing of slabs neatly in piles with walkways in the slab yard. This procedure assisted the implementation of the new layout as slabs were already piled in areas and accessible through walkways. The areas were then named accordingly on the support structures of the facility, with temporary painting while proper sign boards were made. All slabs were then moved to their appropriate areas and slabs lying across the boundaries were moved neatly into the designated area. All supporting documents and information systems were updated adding an area code to the SKU detail of a slab.

Figure 22: Naming of areas

7.4. Training of employees.

The new process relies on the discipline of the operating staff within the slab yard and it is critical that they understand the process and are aware of their responsibilities. The most critical training aspect to understand is the designated areas and allocation of specific slabs to specific areas, especially for the crane operators who are directly responsible for the movement of the slabs. After discussion it was found that some employees were illiterate and the letter A to I had to be taught to them first before they could match the letter written on a slab to an area. Illustrations were used to explain the allowed movements of slabs in the slab yard. The possibility of coulour coding was considered, but this involved more complex marking of slabs. A slab will have to be sprayed in accordance with a colour to indicate the location of the slab. Better training of employees to establish between the letters A to I was therefore considered the most feasible solution.

Figure 23: Illustration on the moving of slabs



Conclusion

The slab yard has significant potential to improve and with the new best practices implemented it can only enhance production. It is important that the slab yard is properly managed otherwise chaos will just return. The employees of the slab yard have sufficient knowledge and experience in their operation, but lack motivation. The morale of the employees is low and production can improve significantly if more attention is given to the well being of employees. Most of my understanding in the field was received from the people working in the slab yard and not from management; I found that management is often oblivious to the operational problems.

The following future improvements can be considered to improve the slab yard operations:

- A globally positioning system (GPS)-locator for slabs.
- Automatic Cutting bed.

Reference List

Abdullah, F, 2003. Lean Manufacturing tools and techniques in the process industry with a focus on steel, University of Pittsburg.

Fled M. W, 2000. Lean Manufacturing: Tools, Techniques and how to use them. Baca Raton, London: The St Lucie Press.

Mobley, RK & Higgins, LR. 2001. Maintenance Engineering Handbook, seventh edition, McGaw-Hill.

Muller, M. 2011. Essentials of inventory management. [Online]. Available http://www.library.up.ac.za/e-sources/essentials+of+inventory+management[2011, August 4]

Flat-products Work Instructions, Slab yard, EHSV, viewed 6 August 2011, <http://www.evraz.com/portal/flat-products/workinstructions/slab yard />.

Wild T, 2009. Improving inventory record accuracy. viewed 14 July 2011.

Wrennal, W. 2007. Maynard's Industrial Engineering Handbook, fifth edition ,Maynard (eds), McGraww-Hill.

APPENDIX A

Glossary

Cast Number: Number given to a slab to identify specific cast

Commercial Steel: Stock that is not of sufficient grade to suit customer orders but can be sold on the commercial market

EHSV: Evraz Highveld Steel and Vanadium

FOX: The information system supporting operations in the slab yard. The programme keeps record of inventory and with the help of the Scheduling department creates schedules for production

Gauge: The thickness of a slab

LM: Lean Manufacturing, production process illuminating all waste

NO-CHARGE: The term used by the slab yard for a slab that is on schedule but cannot be rolled

NO-ID: Term used for slabs that are unidentifiable

Obsolete Stock: Stock with some sort of defect preventing it from being processed

Priority Stock: The most valued stock in the slab yard

Q-cast: Renaming ID of unidentifiable slabs

SKU: Stock-keeping-unit

Slab: Composition of iron ore and other substances casted into a block to be processed (rolled) into plates or coils

Steel Plant: The plant within EHSV where slabs are cast

APPENDIX B

Example of A Schedule

EVRAZ EVRAZ HIGHVELD STEEL AND VANADIUM

Document Source	FLAT PRODUCTS
Document Title	SCHEDULES
Document Number	FPMPR 001
Revision Number	1.0
Date	MAY 2011
Page	1 of 2
Prepared by	JLG
Approved by	CP

EVRAZ HIGHVELD STEEL AND VANADIUM CORPORATION
FLAT PRODUCTS DIVISION

PUSHER SCHEDULE

EVRAZ EVRAZ HIGHVELD STEEL AND VANADIUM

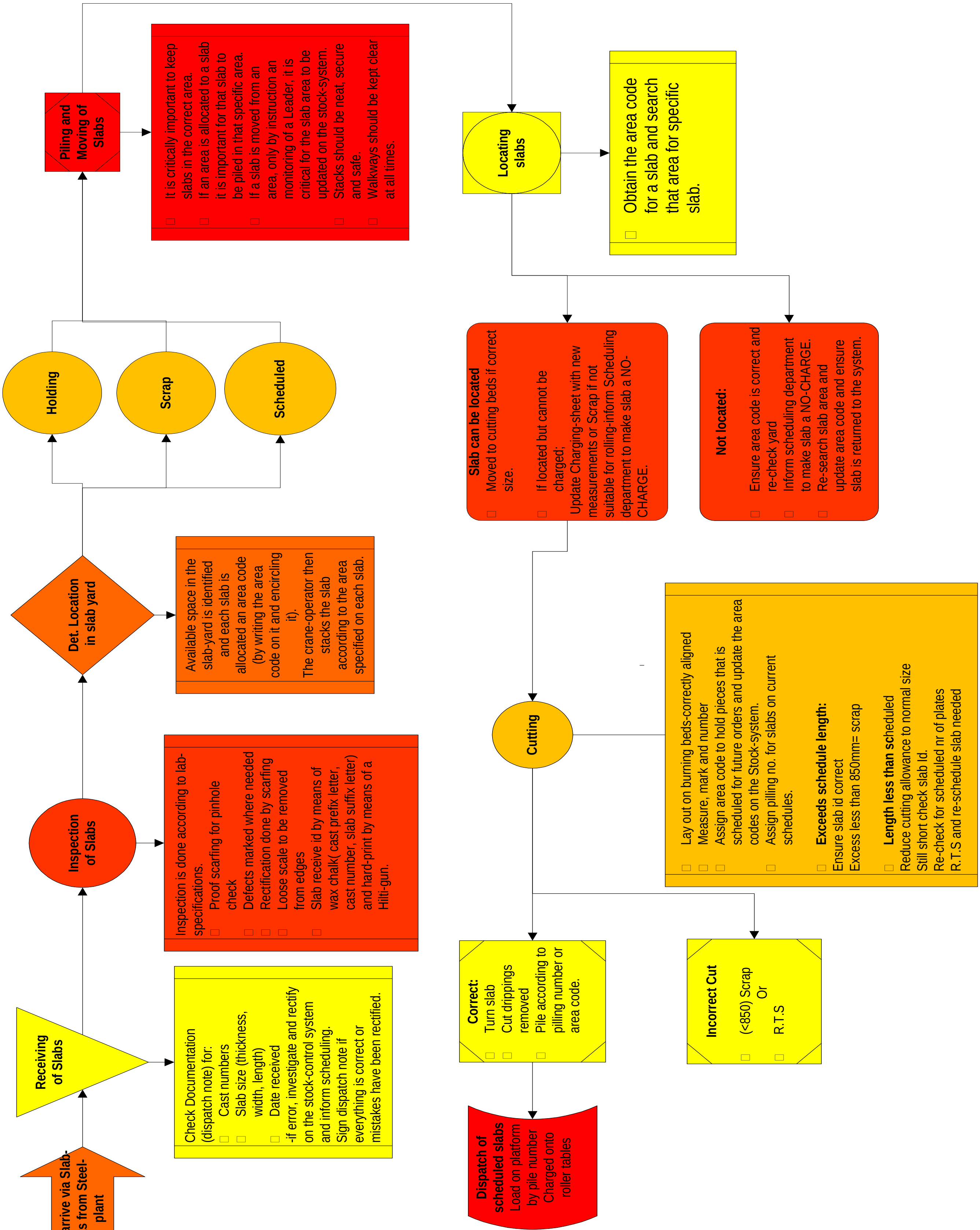
Schedule 765 printed on 2011-05-03 03:53 by petros

PAGE LIGHTS 0 t 0 MEDIUMS 0 t 0 HEAVIES 164 t 20 TOTAL 164 t 20
TOTAL LIGHTS 288t 122 MEDIUMS 772 t 146 HEAVIES 181 t 22 TOTAL 1241 t 290

Page 1 of 15

Order	R\O	Cast No	Slab	FN	CH Pos	Slab Size T	Slab Size W	Slab Size L	Quality	Roll Width	T-G	RM	Finished Product T	Finished Product W	Finished Product L	Pieces / Slab	ST	PT	Yield	Client	Delivery	Destination
534339-1	1	Q00460W SLOW COOLING	269763	PF		250	2025	2460	PM02	2040	248.2	182.2	180	2000	3000	1	9.7	8.4	86.7	KLAT	2011-07-30	
534339-1	2	Q00460W SLOW COOLING	269764	PF		250	2025	2460	PM02	2040	248.2	182.2	180	2000	3000	1	9.7	8.4	86.7	KLAT	2011-07-30	
534292-1	3	A37681W	269447	PF		250	2025	1060	PM01	2040	248.2	20.2	20	2000	4000	3	4.2	3.8	90.0	TATA	2011-06-30	SHEARLINE
534119-1	4	A37733W	265479	PF		250	2025	1900	UQ55	2490	203.3	18.2	18	2450	9850	2	7.5	6.8	90.9	BEKK	2011-06-30	SHEARLINE
534119-1	5	A37733W	265480	PF		250	2025	1900	UQ55	2490	203.3	18.2	18	2450	9850	2	7.5	6.8	90.9	BEKK	2011-06-30	SHEARLINE
534119-1	6	A37733W	265481	PF		250	2025	1900	UQ55	2490	203.3	18.2	18	2450	9850	2	7.5	6.8	90.9	BEKK	2011-06-30	SHEARLINE
534385-1	7	A37735W	271466	PF		250	2025	2620	UQ55	2440	207.5	25.3	25	2400	10000	2	10.3	9.4	91.1	BSI	2011-06-30	HOT SHEAR?
534171-1	8	A37735W	271026	PF		250	2025	2090	SN35	2440	207.5	20.2	20	2400	10000	2	8.3	7.5	91.3	BMQ	2011-05-31	SHEARLINE
533970-1	9	A37735W	264174	PF		250	2025	2090	UQ55	2440	207.5	20.2	20	2400	10000	2	8.3	7.5	91.3	BEKK	2011-05-31	SHEARLINE
533970-1	10	A37735W	264175	PF		250	2025	2090	UQ55	2440	207.5	20.2	20	2400	10000	2	8.3	7.5	91.3	BEKK	2011-05-31	SHEARLINE
534161-1	11	A37736A	266747	PF		250	2025	2110	UQ55	2440	207.5	20.2	20	2400	10000	2	8.3	7.5	90.4	NJR	2011-05-31	SHEARLINE
534161-1	12	A37736A	266748	PF		250	2025	2110	UQ55	2440	207.5	20.2	20	2400	10000	2	8.3	7.5	90.4	NJR	2011-05-31	SHEARLINE
534161-1	13	A37736A	266749	PF		250	2025	2110	UQ55	2440	207.5	20.2	20	2400	10000	2	8.3	7.5	90.4	NJR	2011-05-31	SHEARLINE
534161-1	14	A37736A	266750	PF		250	2025	2110	UQ55	2440	207.5	20.2	20	2400	10000	2	8.3	7.5	90.4	NJR	2011-05-31	SHEARLINE
533741-1	15	A37737A	258559	PF		250	2025	2100	UQ55	2440	207.5	20.2	20	2400	10000	2	8.3	7.5	90.9	TRAC	2011-06-30	SHEARLINE
533741-1	16	A37737A	258560	PF		250	2025	2100	UQ55	2440	207.5	20.2	20	2400	10000	2	8.3	7.5	90.9	TRAC	2011-06-30	SHEARLINE
533741-1	17	A37737A	258561	PF		250	2025	2100	UQ55	2440	207.5	20.2	20	2400	10000	2	8.3	7.5	90.9	TRAC	2011-06-30	SHEARLINE
534161-1	18	A37736W	266751	PF		250	2025	2100	UQ55	2440	207.5	20.2	20	2400	10000	2	8.3	7.5	90.9	NJR	2011-05-31	SHEARLINE
534161-1	19	A37736W	266752	PF		250	2025	2100	UQ55	2440	207.5	20.2	20	2400	10000	2	8.3	7.5	90.9	NJR	2011-05-31	SHEARLINE
534161-1	20	A37736W	266753	PF		250	2025	2100	UQ55	2440	207.5	20.2	20	2400	10000	2	8.3	7.5	90.9	NJR	2011-05-31	SHEARLINE

APPENDIX
C
Slab Yard Processes



Slab-Yard Process

APPENDIX
D
Work Instruction-Inspection

EVRAZ EVRAZ HIGHVELD STEEL AND VANADIUM

HIGHVELD STEEL AND VANADIUM CORPORATION LIMITED

FLAT PRODUCTS DIVISION

SLABYARD WORK INSTRUCTIONS

RESPONSIBLE PERSON	INSPECTION, RECTIFICATION AND IDENTIFICATION OF MASTER SLABS	REFERENCE DOCUMENTS
Team member Shift team leader	Slabs are laid out for inspection. Proof scarfing is carried out for pinhole checks (excluding SS 10/200, EN8D + S45C) Defects are marked out in chalk by the team member on the top and bottom surface when required. Rectification is done by scarfing. Slabs are identified in wax chalk on the two side edges with cast prefix letter, cast number and slab suffix letter by the team member. The cast prefix letter, cast number and slab suffix letter are hard stamped on one end of the slab by the team member. Loose scale to be removed on side edges with a scraping tool (25 mm flat bar) before identification takes place. Identity is checked by the team member on completion of identification.	Inspection Sheet

Safety Precautions

1 Wear safety shield and foil jacket and trouser when scarfing
2 Maintain a safe distance of more than 3m when in the vicinity of scarfing being done
3 Be your brother's keeper
4 Be aware of flying sparks (stand well clear of hot sparks)