RAW MATERIALS INVENTORY MANAGEMENT FOR A COKE PLANT

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by

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ABSTRACT

Analysis of inventory management and logistics for a metallurgical coke plant at Mittal Steel, Vanderbijlpark Works, Gauteng, South Africa.

Inventory management and logistics is a concept, which has shown considerable development in the post-World War II era. The concept of applying inventory and logistics as a business function initially emerged during the price wars era and evolved during the quest for quality era. Thereafter, business inventory and logistics had a promotion/marketing focus, which evolved to the point where it is now. Today, inventory management and logistics can provide time and place utility, thus adding value to a business. The major focus in this respect is on increasing customer service.

In this dissertation the concept of inventory and logistics is examined by means of both a literature and empirical study. This study focuses mainly on the development of inventory management, logistics, inbound logistics and outbound logistics. The main focus of the different chapters is effective inventory management.

The main reason for this study was to determine whether inventory management and control comply with the proposed manufacturing standards. This was also investigated empirically, by determining the inventory control systems and manufacturing factors as perceived from a manufacturer's point of view. From the many interesting findings of this study it was concluded that many inventory control systems did not comply with the proposed standards. Future fields of study and recommendations are provided in an effort to contribute to the study field of inventory management and logistics and its practitioners.

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Abbreviations

PU for CHE:	Potchefstroom University for Christian Higher Education
JIT:	Just-in-time
RMH:	Raw Materials Handling Plant
MRP:	Material Requirements Planning
PIC:	Production and Inventory Control
MPTA:	Million Tons per Annum
ISG:	International Steel Group
SAP R/3:	Information technology system
MPS:	Master production schedule
EOQ:	Economic order quantity
CLM:	Council of Logistics Management
GGL:	Grootegeluk Coal (Ellisras)
PLC:	Programmable Logic Controller
MIS:	Management Information System
TSH:	Tshikondeni Coal (Musina)
BUR:	Burton Coal (Australia)
WCP:	West Coast Premium Coal (New Zealand)
BUL:	Bulli Coal (Australia)
RGB:	Riverside Goonyela Blend Coal (Australia)

LIST OF KEY TERMS

MITTAL STEEL: Global steel company of which Vanderbijlpark steel is situated in Gauteng.

COKE PLANT: Production unit which heats up coking coal in the absence of air to produce metallurgical coke.

RAW MATERIALS: Coking coal components to make up blend for coke production.

COMPETITIVE ADVANTAGE: The relative efficiency in a particular economic activity of an individual or group of individuals over another economic activity, compared to another individual or group.

CUSTOMER: A customer is an individual or group of individuals to whom you provide one or more products or services are provided. A business can also be seen as a customer when the business pays to receive a service, or purchases goods.

CUSTOMER SERVICE: Customer service refers to the service a business offers to its customers, especially of industrial goods and expensive consumer goods, such as computers or cars. Customer service also includes after-sales service, such as a repair and replacement service, extended guarantees, regular mailing of information and free-phone telephone calls in case of complaints. The appeal of business products is substantially influenced by the customer service offered.

INVENTORY MANAGEMENT: The management of several raw materials systems to ensure that production units can produce continuously.

INBOUND LOGISTICS: Inbound logistics refer to all those activities related to the procurement of requirement for the business up to the point where these requirements are delivered to the production function. It also includes the coordination of the flow of materials during the production process until the final products are made available for storage and distribution.

LOGISTICS MANAGEMENT: Logistics management refers to the control of the movement of physical materials inside a plant. It is usually subdivided into materials management, which is the control of the movement of materials in the factory, from the arrival of raw materials to the packaging of the product; which includes the storage of goods and the distribution to other distribution and consumers.

OUTBOUND LOGISTICS: Outbound logistics is responsible for distributing the goods to customers.

PROCUREMENT/PURCHASING: Purchasing refers to all of the activities associated with the buying process.

VENDORS/SUPPLIERS: A vendor/supplier refers to a person who sells goods or services.

SWEEPINGS: Wasted coal which is recovered which spilled from the conveying systems.

COAL BLEND: Mixture of several coal components, each with its own quality parameters.

SYSTEM 500-08: Logistics information system. (internally)

SFIN: Is coal that is in transit (coal is still on the ship/ in the harbour).

SFCS: As soon as the truckload of coal is received at the Works.

CHAPTER 1

PROBLEM STATEMENT AND REASON FOR RESEARCH

1.1 INTRODUCTION

Production and inventory control (PIC), in its broadest definition, encompasses functions common to all manufacturing businesses, whether heavy industry or light industry. Variations in the functions being carried out, from business to business, partly reflect the planning horizon used. But the extent to which these functions are recognized and utilized relates to the level in the organisation at which the planning and scheduling are performed.

At the highest level within a company, the executives are primarily concerned with profitability and growth. Both concerns influence both the direction that the company takes in the various markets, which it serves or desires to serve and the requirements for capital needed for equipment, facilities, and current assets (cash, accounts receivable, and inventory). For a corporate strategic plan to be meaningful, normally it is consolidated from forecasts and plans built by various divisions within the company. This section is about planning carried on in various divisions of the business units.

Strategic planning for a business unit involves the study of future expectations and scenarios, including various course of action that management can take to help mould the business unit as it moves toward the objectives set by executive management. The business unit is one whose planning and managing are generally the responsibility of one manager. Business-unit strategic planning begins with a forecast of the future. Raw Material forecasts for strategic planning are based on a variety of analyses, including a history of actual experience and predictions of the economic and competitive environment expected in the future.

Grouping product forecasts by manufacturing unit and production process enables the development of the production plan for a specific manufacturing unit. The product grouping must be an identifiable product. This enables major production process capacities to be analyzed. A rough-cut material-requirements plan can be supplied to purchasing for analysis of supplier's capacity, and will enable the development of purchasing strategies and selection of suppliers. Make-or-buy analysis can be carried out as the material-requirements planning (MRP) process deepens.

A tactical production plan is sometimes called an aggregate plan, a resource requirement plan, or a rough-cut resource plan. This tactical plan is used to determine the impact of planned production on key resource considerations such as the raw materials stock levels, availability of raw materials, stock space availability and other key resources.

Inventories, like receivables, represent a significant portion of most firm's assets, and, accordingly require substantial investments. In order that this investment do not become unnecessary large, inventories must be managed accordingly to be efficient (Greene, 1987:2.1 – 2.3).

1.2 PROBLEM STATEMENT

If we consider the assets of the company, Mittal Steel, Vanderbijlpark Works, it is necessary to underline the importance of the management of raw materials, which amounts to 70% of the total cost of the company. Of all the raw materials handled by this works 80% of the costs are included in the Iron Making Business Unit's Coke making production facility (Coke Plant). The Coke Plant's raw materials input exceeds 1.8 million tons of metallurgical coal with a rand value of R1,53 billion per annum. Average losses due to inefficient inventory control systems amounts to 8% per annum. These systems include mass-measuring control, quality deviations, write-offs, to name a few. The inventory control management system needs to be investigated due to major losses experienced.

Inventory control is a common, but costly exercise in any business; the losses incurred due to inventory write-offs can make up to 8% of losses incurred on a business's bottom line. Vanderbijlpark currently produces 3,5 million tons per annum (mtpa) of liquid steel and supplies 84% of South Africa's flat steel requirements. To produce 3,5 million tons of liquid steel per annum the Blast Furnaces need to produce 2,6 million tons of liquid iron per annum. To produce one ton of liquid iron, you need to produce 410 kilograms of metallurgical coke. To meet the budgeted liquid iron production of 2,6 million tons per annum the required coke production = 1.43 million tons per annum. The required coal budget for producing 1,43 million tons of coke per annum = 1.80 million tons of coking coal per annum.

The write-offs in the previous financial year amounted to 8% of the coal budget, which is R76,5m. It is therefore clear that the problem statement is to minimise write-offs by optimizing the current raw materials inventory control systems (Mittal Steel, Iron Making Business Unit, year end results, 2004).

1.3 THE TARGET ORGANISATION

Previously known as Iscor Ltd, but it is now known as Mittal Steel, South Africa. Over the past eight to ten years Mittal Steel, SA, has undergone a remarkable journey from being a state owned enterprise, to become part of an efficient world class conglomerate. Mittal Steel SA is now part of one of the most global steel companies in the world.

After the merger with International Steel Group (ISG) Mittal Steel will become the world's leading steel producer, with business units and customers in every corner of the world and an annual production capacity of 64 million tons per annum. The enlarged Mittal Steel will span the globe with around 30% of its assets in North America, 30% in Europe and the remaining 40% split between Asia and Africa. Mittal Steel is the largest steel maker in the world with:

- Steel-making facilities in 14 countries (USA, Canada, Mexico, Trinidad, France, Germany, Czech Republic, Poland, Romania, Bosnia, Macedonia, Kazakhstan, Algeria and South Africa) and sales and marketing offices in a further 11.
- Shipments of 42,1 million tons and revenues of over $22 billion in 2004.
- 164 000 employees spanning 45 different nationalities.
- Share listings on the New York and Amsterdam stock exchanges.
- A 5000 strong customer base, spanning 120 countries.

Mittal Steel's aim is to be the best quality, lowest cost and most profitable steel producer in the world, serving its customers wherever they are. Mittal Steel has four iron, steel and mill works situated in; Vanderbijlpark, Vereeniging, Newcastle and Saldanha. The Vanderbijlpark and Saldanha plants are under the flat steel route, being slab to coil/plate route and Newcastle and Vereeniging are the long steel route being billet to formed product route. Furthermore, each works in the group is run by Business Unit Managers with the aid of divisional managers and plant managers reporting accordingly. Line management is assisted by the central services' business unit. At Vanderbijlpark Works the flat steel products division is managed as a strategic business unit, comprising of:-

- IRON MAKING BUSINESS UNIT, consists out of various raw materials handling plants, coke production plant, a sintering plant and two blast furnaces.
- STEEL MAKING BUSINESS UNIT, consists of a direct reduction iron plant, an electric steel making plant and an oxygen steel making plant.
- ROLLING BUSINESS UNIT, includes the hot strip mills, cold strip mills, plate mill and finishing lines.
- CENTRAL SERVICES BUSINESS UNIT, includes finance, human resources, information management, marketing and sales and other divisions.

These business units are managed independently, but integration is being done by high-level management, in order to capture the maximum synergy benefits in management, marketing, product range, procurement and information technology.

Mittal Steel have, over the past number of years, embarked on an extensive re-engineering programme at the Vanderbijlpark Works, leading to improved operation efficiencies and the modernisation of technologies and steel making processes, making it one of the most cost-effective producers of quality products globally (LNM GROUP, FORGING AHEAD, The quarterly bulletin of LNM, issue 3 autumn 2004).

1.4 AIM OF RESEARCH

1.4.1 GOAL AND OBJECTIVES

To examine the current raw material inventory control system at the Coke Plant at Mittal Steel, Vanderbijlpark Works. The primary objective will include the following:

- To analyze and develop a raw materials inventory management system that will minimize inventory write-offs and improve profit margins.
- To improve planning systems surrounding raw materials management. This system needs to consider JIT (Just-in-Time) and iron making techniques. These techniques will lead to optimal stock levels of raw materials which will stabilize the iron making process.

- To analyze and improve current processes by utilizing the SAP R/3 information system

1.5 METHODOLOGY

1.5.1 LITERATURE

Theories from text books and plant operations were studied. Plant operations includes Vanderbijlpark and Newcastle Works. Mittal Steels' Metallurgical Coke Plant currently uses coal from around the world;

- Six international coal components are being shipped in from Australia, Nieu-Zealand and America to Richards bay, South Africa. From Richards bay it is transported by rail to Vanderbijlpark and Newcastle Works.
- There are two national coal suppliers; Grootegeluk and Tshikondeni mines. This is also transported by rail.

1.5.2 EMPIRICAL

The empirical part of the study consisted of a complete structured internal audit on the current raw materials inventory control systems at the Coke Plant. This audit was conveyed by Mittal Steel's internal auditing team, including myself as team leader. The main purpose of this audit was to analyse the current situation and to make recommendations.

1.6 CHAPTER STRUCTURE OF THIS STUDY

This study is structured by the following chapters:-

CHAPTER 1: PROBLEM STATEMENT AND REASON FOR RESEARCH

CHAPTER 2: PRODUCTION, INVENTORY CONTROL AND LOGISTICS OF BULK RAW MATERIALS – THE KEY COMPONENTS

CHAPTER 3: THE COKE PLANT PRODUCTION PROCESS AND RESEARCH RESULTS

CHAPTER 4: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 2

PRODUCTION, INVENTORY CONTROL AND LOGISTICS OF BULK RAW MATERIALS – THE KEY COMPONENTS

2.1 PRODUCTION AND INVENTORY CONTROL AS A UNIT

The purpose of this study is to investigate and to propose new methods to control the inventory of bulk materials, which in this case will be Metallurgical coal for the coke production process.

To do this effectively it is necessary to discuss production planning and inventory management as a combined unit, because in most production environments it cannot be separated, due to it's close interface. It is also necessary to discuss the logistics surrounding the handling of bulk materials because of its economical value, which is included in the total raw material price.

One of the major responsibilities of the production planning group, is the determination of the timing and volume requirements for materials used in the manufacturing operation. At the Coke plant, which is under discussion, these functions are managed by the management team itself, thus production planning, inventory management and the production process are managed by one team. The only function which exists outside this team's responsibility is the purchasing function.

The purchasing team needs to understand the production process because it is the production team's responsibility to indicate to them which coals need to be contracted and purchased. (Timing and volume requirements of each coal component.)

2.2 FUNDAMENTALS OF PRODUCTION PLANNING

The objective of production planning is to coordinate the use of a department's resources and to synchronise the work of all individuals concerned with production in order to meet required completion dates, at the lowest total cost, consistent with desired quality.

Historically, all firms conducted their production planning and control activities manually, with the use of a variety of Gantt charts and specialised visual scheduling and other control mechanisms. Today, most companies utilise some type of computer-based system to perform essentially the same type of activities in a more comprehensive, semiautomatic manner. Regardless of the specific operating system used, an effective production planning operation must accomplish five general activities.

2.2.1 PRE-LIMINARY PLANNING

After the initial product design work is completed, the preliminary planning work begins. The product's bill of materials is restructured for compatibility of the firm's planning system. For the given product, analysts determine the specific raw materials required.

2.2.2 AGGREGATE SCHEDULING

The next step in the process is scheduling – first, aggregate scheduling and, then, detailed production scheduling. As forecasts are generated, they are matched against the department's capabilities and capacities which are derived from it's future production and maintenance schedules. Aggregate scheduling is simply a first-pass, broad determination of required materials, and can be made available through careful, detailed planned work.

2.2.3 PRODUCTION SCHEDULING

The ensuing step is the detailed production scheduling work. Start and completion dates for each production cycle are assigned. Specific materials required for each cycle are determined, as the specific routing for the cycle.

2.2.4 RELEASE AND DISPATCHING OF ORDERS

The work completed to this point in the process has developed an operating plan. This operating plan needs to be implemented by the shop floor and therefore, it is accompanied by the bill of materials (operational plan) and detailed operations instructions for the production team.

2.2.5 PROGRESS SURVEILLANCE AND CORRECTION

The last step in the process is the control function. Progress at each stage of the operation is monitored to compare actual performance against the planned schedule. Significant deviations from the schedule need to be corrected as soon as possible and therefore continuous surveillance needs to be a standard operating procedure (Dobler *et al*, 1996:492–494).

2.3 MODERN PRODUCTION PLANNING SYSTEMS

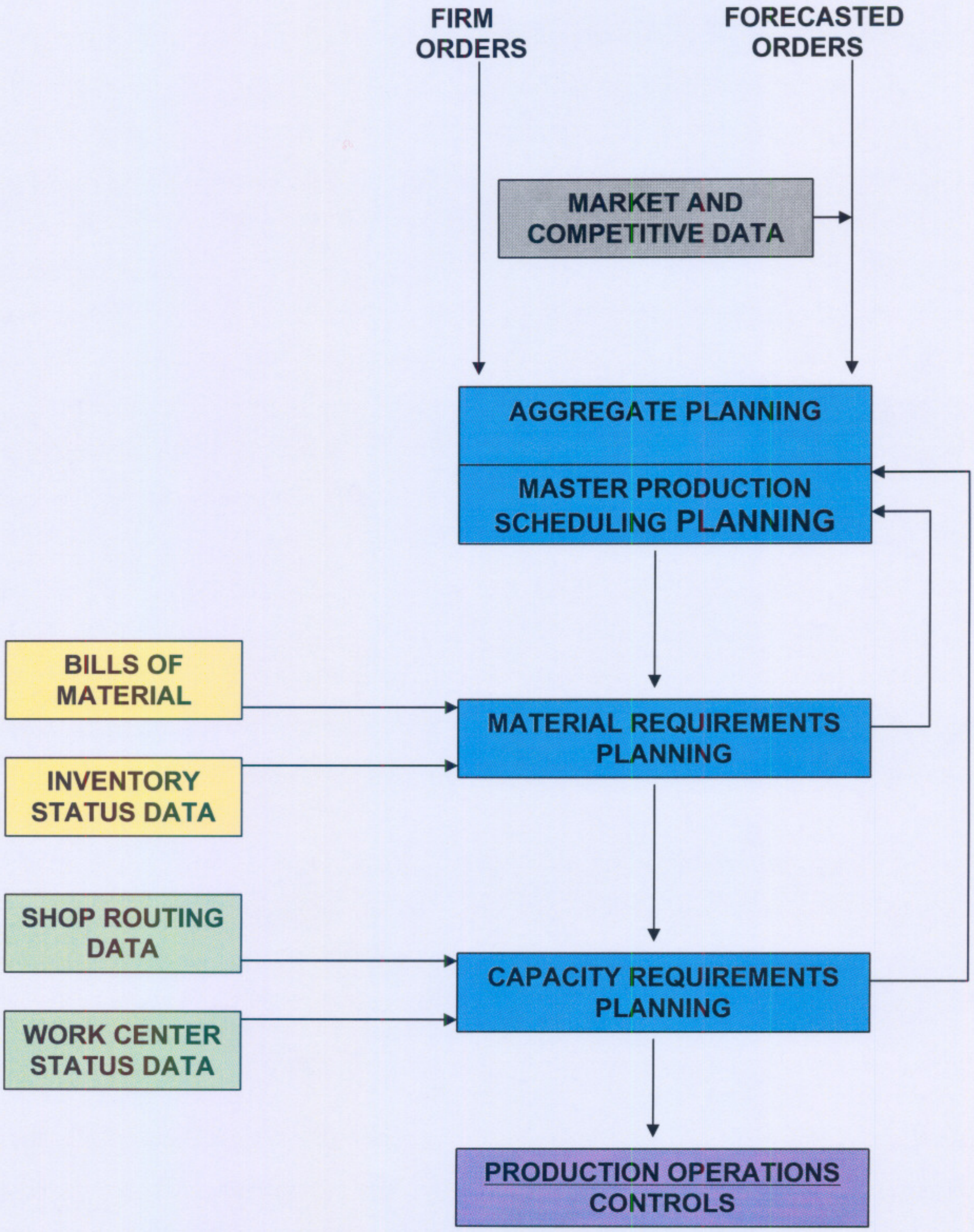
The preceding discussion sketched briefly the fundamental activities that must be accomplished in planning and controlling production operations effectively.

In practice, manufacturing companies conduct these activities in a variety of methods. As competition in the marketplace has become increasingly keen, companies have been forced to meet higher performance standards and to do so cost – effectively.

This economic reality, coupled with the availability of relative inexpensive computing capability, has created a new era in production planning. Although numerous different systems exists, both custom designed and commercial software packages utilises the same basic elements. (Chase, *et al*, 2004:594–598)

2.3.1 A MODERN PRODUCTION PLANNING SYSTEM

Figure 2.1: A BASIC FLOWCHART FOR A MODERN PRODUCTION PLANNING SYSTEM



SOURCE: Adapted by Dobler, *et al,* 1996:495

2.3.2 AGGREGATE PLANNING AND MASTER SCHEDULING

The development of a viable aggregate plan and a coordinated master production schedule is the starting point for the use of a computer – based planning system.

The aggregate plan is based on the expected receipt of certain materials for a given product during the planning period. Various forecasting methods are used to determine an approximate demand for a certain product, for example,

- Bottom-up analysis, utilizing opinion, judgement, and market surveys.
- Time series analysis.
- Exponential smoothing techniques.
- Regression and correlation analysis.

Forecasting activities typically are conducted or coordinated by a specialised staff group and is generally handled as a responsibility separate from the computerised planning system activities.

Development of the aggregate plan itself is usually a top management responsibility. General management and manufacturing personnel jointly develop the initial version of the plan, based on the known and expected data. In most companies a plan is developed for a period of from six to twelve months. The plan must be firmed up for a reasonable period of time, simply because overall production volume cannot be changed abruptly without incurring significant unplanned costs.

Every production volume utilises a given mix of materials, labour, and equipment. When the output rate is changed, a new optimal mix must be achieved by readjusting the usage rate of various resources.

In the longer term this is possible by re-planning the variables, and in this case varying the inventory levels, as needed. In the short term this will be impossible to do it efficiently. (Dobler *et al.,* 1996:494).

2.3.3 MASTER PRODUCTION SCHEDULE (MPS)

The MPS is developed directly from the aggregate plan – and is the instrument that drives the firm's entire production system. The aggregate plan establishes an overall

level of operations that balances the plant's capability with external product demand. The master schedule translates the aggregate plan into specific tons of specific materials, which are needed to produce the product, for a certain period.
The next step in the development of the master schedule is to evaluate its feasibility by simulation, checking the availability and balance of required materials and resources. If bottlenecks or imbalances are encountered, the schedule is modified by trial and error until an acceptable arrangement is found.

Once an acceptable schedule is determined, its outputs – the volume and timing of the production of specific products – become the inputs required for the subsequent detailed computer planning work that drives the production, inventory, and purchasing operations.

The time interval used in master scheduling, depends on the type of products produced, the volume of production, and the lead times of the materials used. However, weekly periods are probably most commonly used, followed by every second week and monthly intervals. Thus, within the time frame of a six to twelve – month aggregate plan, the master schedule is updated weekly to reflect changing production demands and perhaps internal problems that require rescheduling. The schedule needs to be updated on a regular basis for it to work effectively.

2.3.4 MATERIAL REQUIREMENTS PLANNING (MRP)

As technology has developed over the years, production and inventory specialists have developed computer – based systems for ordering and/or scheduling production of demand- dependant type inventories. These systems fall under the general heading of materials requirements planning (MRP). The basic idea behind MRP is that, once finished goods inventory levels are set, it is possible to determine what levels of work – in – progress inventories must exist to meet the need for finished goods.

MRP, however, is based on the precise calculation and timing of orders, including both the point at which they are issued and their delivery lead times. In general, MRP is best suited to batch operation, where the demand for both the end product and its constituent materials are less consistent. This system consists of a set of logically related procedures, decision rules and records designed both to translate a master production schedule into time – phased net inventory requirements and to delineate how these requirements will be satisfied (Ross *et al.*, 2001:593; Gourdin, 2001:74).

2.3.5 MRP LOGIC AND FORMAT

As utilized today, most versions of MRP act as information processing systems, which seek to develop and maintain a set of orders that support the production plan, while simultaneously maintaining inventories within the production system at reasonably low levels. Orders within an MRP system fall into two categories:

- open orders which have been released but have not yet arrived, and
- planned orders which are developed in anticipation of future releases.

As previously noted, each category can contain both purchase orders and shop orders. The processing logic of MRP centres on the development of a materials planning record for each item. The development of the planning record is based on three fundamental concepts, which form the essence of the MRP-based approach to materials planning and control. They are:

- Dependent demand.
- Inventory/open order netting.
- Time phasing (Dobler *et al.*, 1996:498-501).

Dependent demand takes the multistage product into account in the planning for individual items. Clearly, the decisions to acquire purchased materials should be based on anticipated production plans. These decisions include both quantity and timing considerations. Dependent demand logic is used to calculate the gross requirements for each planning record. This projected usage includes the planned production of all other products, which require the item being planned.

The inventory/open order netting concept is used to develop the “on hand” balance row of the planning record. Efficient use of inventory implies that current stocks should be largely depleted prior to the acquisition of additional inventory. The netting process accomplishes this by allocating current inventory and open orders to the earliest requirements. When the on-hand balance falls below zero, additional stock must be ordered. This process not only signals the need to plan an order, but also determines when the order should arrive. This "need date" becomes the due date for the order.

Time phasing utilizes lead-time information and need dates. The "planned order releases" row of the planning record shows time-phased orders, whose placement dates are offset from the need dates of the order by the lead time of the item. Each order, if released in the time period designate by the planned order row, should arrive exactly at the time it is needed by a flowing production stage.

Hence, the MRP system generates a complete set of planned orders for all purchased raw materials based on the information inputs. Clearly, the validity of the plan produced by the system is dependent on both accurate and timely lead-time information from purchasing personnel. At the same time, if system planning is done far enough in advance, the advance knowledge about specific raw material requirements certainly can facilitate planning and conduct of the buying activities.

2.3.6 MRP'S IMPACT OF PURCHASING AND SUPPLY

Sooner or later, most manufacturing firms will use some type of MRP-based system as a central component of their production planning system. If present experience is a reasonable indicator of the future, purchasing operations will be affected in the following important ways.

- Expanded use of the buyer-planner or the supplier scheduler concept
- Expanded use of contract buying
- Necessity of greater supplier flexibility and reliability
- Development of closer relationships with suppliers, including more partnering arrangements
- Increased accuracy and timeliness of materials records

2.3.6.1 BUYER-PLANNER AND SUPPLIER SCHEDULER CONCEPTS

The very nature of an MRP operation places the planner in close, continuing contact with material requirements and their frequently changing schedules. Typically, the planner has a more sensitive feel than the buyer for the probable usage pattern of most raw materials. Consequently, to improve efficiency of the planning-buying activity, as well as communications with suppliers, firms may have used one of several organizational schemes that utilize the planner as the supplier contact person for day-to-day material flow activities.

The buyer-planner concept is one commonly used approach. In essence, the buyer's job and the planner's job are combined into a single job done by one individual. The buyer-planner is responsible for determining raw material requirements, developing material schedules, making order quantity determinations, issuing all raw material releases to suppliers, and handling all of the activities associated with the buying function. Thus, in this integrated role, the buyer-planner maintains close contact with various supplier personnel.

- Another popular approach is simply to assign to the planner the responsibility for dealing directly with suppliers in releasing and following up raw materials orders. In this arrangement, the buyer handles all the normal purchasing responsibilities except requirements releases against existing contracts. The planner handles this latter function – and becomes the buying firm's supplier contact on all day-to-day raw material scheduling matters. Most firms refer to this arrangement as the supplier scheduler concept. (Dobler *et al.*, 1996:498-501).

2.3.6.2 CONTRACT BUYING

Because an MRP system requires the placement of frequent orders for relatively small quantities of materials, it obviously would be inefficient, if not impossible, to make a new buy for every weekly requirement. The alternative, of course, is to place annual or longer-term contracts with suppliers for the required raw materials – and then simply issue a telephone or and MRP schedule release against the contract, as the production operations requires.

Not only is this buying approach required in an MRP-scheduled operation, but, as a general rule it is excellent buying practice. It permits more careful purchasing planning and more thorough market and supplier research – and it need to be done only once every year or two for each material. In addition, such contracts usually produce attractive pricing arrangements and improved supplier relations.

2.3.6.3 SUPPLIER FLEXIBILITY AND RELIABILITY

Because of the weekly updating of most MRP systems, coupled with the frequent rescheduling that sometimes occurs, a supplier has to be more than reasonably flexible. Even if a supplier has the buyer's MRP schedule with weekly or biweekly requirements for the next two months, the irregularity of demand and the short notice given on schedule changes present a difficult operating situation for most suppliers. Resolution of the potential problems requires careful cooperative planning and usually some compromises by both parties.

It is obvious that supplier reliability is a must. The buying firm typically carries some inventory, but not as much as in the traditional operating situation since one of the objectives of the system is to reduce inventory levels. Hence, there is much less cushion in the system to handle the problems of late deliveries and off-spec materials.

The bottom line of these two stringent operating requirements is that supplier selection is a critical, yet a more difficult task.

2.3.6.4 CLOSER RELATIONSHIPS WITH SUPPLIERS

The use of contract buying and the need for unusual supplier flexibility and reliability create an operating situation in which the buyer-supplier relationship must be closer and more cooperative than it might normally be. This type of operating situation requires the ultimate in coordination, cooperation, and teamwork. A mutual understanding of each other's operations and problems is essential in achieving this type of effectiveness. It literally is an informal partnership operation – and it must turn out to be a win-win deal.

The buyer-planner or the supplier scheduler must stay in close touch with the supplier's counterpart on a week-to-week basis as far as scheduling and delivery matters are concerned. And the buyer or buyer-planner must handle the broader issues of the relationship with appropriate supplier sales and technical personnel on a regular and timely basis.

2.3.6.5 MATERIALS RECORDS

As one reviews the MRP segment of the production planning system, it is readily apparent that the accuracy of the system will be no better that the accuracy of the data used in its calculations. If the system is to work effectively, records such as specifications, bills of materials, supplier lead times, receiving reports, inventory balances, and so forth must be as near 100 percent accurate as possible (Dobler, *et al.,* 1996:495–500).

2.4 JUST-IN-TIME (JIT)

2.4.1 WHAT IS JIT

In its most elementary form, just-in-time refers to a method of producing what is required, when it is required, and in just the amount required. It is often called a management philosophy intent on eliminating waste in related activities (Kearney, 1997:72). Among the major objectives are short manufacturing cycle times (or faster throughput), a streamlined workflow, smaller lot sizes, quicker set-ups and reduction in work-in-process inventory. Using just-in-time methods gives the ability to respond more quickly to customer needs (Sheridan, 1990:45).

2.4.2 OBJECTIVES OF JIT

Just-in-time is a strategy for achieving significant continuous improvement in performance through elimination of all waste of time and resources in the total business process. A significant portion of the drive to eliminate waste can be achieved by a process of simplification. Sutton (1990:15) describes just-in-time as another name for simplification. He describes it as a process of establishing the really necessary steps that add value. A sure and truthful measure of reduction of deviation is lead time, because a plant can only reduce it by solving problems that cause delays. There is a direct connection between just-in-time and quality. Because parts flow in small lots (or one at a time in a cell), quality problems are exposed quickly an this results in enforced problem solving (Sheridan, 1990:45). Variability in quality is a major reason for buffer stock. Improved quality thus enhances the just-in-time approach. Just-in-time improves quality as time destroys evidence of the causes of variability. In cutting lead times just-in-time creates a permanent early warning system and better enables the establishment of the cause (Schonberger, 1986:137). In order to establish a responsive production environment, the time line from customer order, to cash, must be shortened by shortening the total business throughput time.

2.4.3 JIT ELEMENTS

The just-in-time elements for shortening the total business throughput time are as follows (Buker, 1990:3):

- Structured flow manufacturing:

This entails arranging and defining manufacturing resources so that products flow most efficiently through the manufacturing process.

- Small lot production:

This is reducing order quantities and lot sizes to the smallest size practically possible.

- Set up reduction:

Reducing the amount of time it takes to prepare machines or production lines for new work.

- Fitness for use:

Meeting the customer's precise needs (both the internal and extemal customers).

The key to a truly functional JIT system lies in the willingness and ability to pull all the elements of a production system into the supply chain. Internal and external systems must be efficient and complement each other. It means changing relationships with customers and suppliers alike and the realisation that none of the links in the chain alone is as strong or effective as all of them together. Total customer satisfaction will not be achieved until the entire supply chain improves (Kearney, 1997:73). There are four just-in-time elements that support the integrated approach (Buker, 1990:5):

- Level load and balanced flow: Continuous flow for the most effective application of manufacturing resources.
- Preventative maintenance: Reducing machine downtime due to equipment failure, the goal being to eliminate the equipment as a source of process defects.
- Supplier partnerships: With an emphasis on partner, which means long-term, stable relationships with vendors that focuses on reducing costs through shared quality goals, shared design responsibility, frequent deliveries, long-term relationships and a total cost perspective.

- Pull systems: A detailed scheduling method whereby materials are pulled only when they are needed.

The pull system is, in a sense, a confirming mechanism which demonstrates the success of all the other elements of just-in-time production. It reveals any weak links that need attention.

Manufacturing cells are a powerful just-in-time tool to reduce lead times and costs and to improve quality. A cell makes a family of products (while a flow line makes just one product). The processes in the cell are quite repetitive, even though the products in the family may differ somewhat. Process flow, human organisation and plant input must be configured for quick product flow and tight process-to-process and person-to-person linkages. The goal is to create responsibility centres (no finger pointing, procrastinating etc) to ensure the conversion to a culture of continuous improvement (Schonberger, 1986:102). Cell workers are cross-trained to operate more than one type of machine. A strong thread in the JIT, TQC and WCM tapestry is good housekeeping (Schonberger, 1986:26). Simplification, cleanliness, discipline and organisation eliminate potential confusion, promote a safer environment and reduce waste of time, motion and resources (Buker, 1990:4). Operator responsibility for housekeeping also provides the first basic inroad into employee involvement (Titone, 1994:65).

Adding automation only serves to make a cumbersome process faster. The solution is to simplify first and then, if necessary, automate to further simplify and then integrate, Cash flow from simplification could even finance automation and integration ie it could be a no cost approach (Sutton, 1990:15). Big machines and long production runs push large lots into the system so that scrap and rework rates apply to huge quantities. Quality without just-in-time, and vice versa, is the fork without the knife. The spoon, TQM, makes a set and the three together resolutely draw employees into a high state of involvement (Schonberger, 1986:203).

Standardisation provides a common focus and discipline to spread improvements across the organisation and sustain them (Kearney, 1997:68). The goal is take all the improvements in speed, cost and quality and spread them across the organisation quickly so that the benefits can be spread across the company. This applies to everything from standard processes of operation and standard instructions in manufacturing cells to standard tooling, methods and parts. Anything non standard is an enemy of quality and an obstacle to the removal of buffer stock (Schonberger, 1986:163).

2.5 INVENTORY MANAGEMENT

It has been estimated that 30 percent of the working capital of a business is tied up in inventories; and that investment in inventory is equivalent to 70 percent of the total investment in plant and equipment. It has also been estimated that inventory costs are equal to 25 percent of the cost of goods.

"Inventory is defined as the stock of any item or resource used in a business. An inventory system is the set of policies and controls that monitors levels of inventory and determines (I) what levels should be maintained, (II) when stock should be replenished, and (III) how large orders should be". In its complete scope, inventory can include inputs, such as human, financial, energy, equipment and physical items, such as raw materials; outputs such as partially finished goods or work-in-process. The choice of which items to include in inventory depends on the business. Inventory of a manufacturing operation can include human resources, machines and working capital, as well as raw materials and finished goods (Aquilano *et al.*, 1995:422).

The conclusions drawn from the above are firstly that the major problem of inventory management is the stock-out situation since customer relations are hurt and the reputation of the business damaged. The second problem can be the excessive investment in inventory.

2.5.1 TYPES OF INVENTORY

- *Normal* inventory is required to support the replenishment process under conditions of certainty. Therefore this inventory is needed during the normal functioning of a business.
- *Safety* stock is held in addition to normal inventory to cover uncertainty in demand and lead-time. Safety stock prevents inventory shortages. This safety stock

should be set at a point that delivery of the reorder will take place before the item runs out of stock completely.

- *In-transit* inventory is en route from one location to another.
- *Speculative* stock is held for reasons other than meeting current demand needs.
- *Seasonal* inventory is accumulated in advance of a selling season.
- *Dead stock* is inventory that no one wants, at least immediately. These items may cost more to get rid of than to keep them. But the most compelling reason for maintaining these goods is customer services. Perhaps an important buyer as an occasional need for some of these items, so management keeps them on hand (Gourdin, 2001:61).

A general problem is identified, when too much inventory on hand, creates a problem of carrying costs and too little, creates a customer service problem. Management should thoroughly examine whether inventory should be available or whether no additional inventory should be carried in order to determine which option will provide the most benefits and profits to the business.

2.5.2 PURPOSE OF INVENTORY

Inventory should be carried for the following reasons:

- to protect against uncertainty,
- to support a strategic plan, and
- to take advantage of economies of sale (Aquilano *et al.*, 1995:423).

2.5.3 SETTING THE RIGHT INVENTORY LEVELS

The goal in setting the right inventory levels is to maintain a balanced inventory so that customer service for each inventory item is maintained within its proper limits. The time at which inventory levels can be influenced most effectively is when orders are places. At this point the major opportunity occurs for ensuring a balanced inventory and where customer satisfaction or excess inventories are created. A reorder level and minimum inventory level are required in a inventory control system. When inventory reaches the minimum inventory level a decision whether to reorder is made (Wild, 2002:112).

Safety inventory is primarily to cover random variation in demand, but it can also cover many other situations such as:

- supply failure,
- production shortfall,
- transport failure,
- slow, unreliable or inaccurate information and
- any other source of disruption of service.

Safety inventory is the buffer between supply and demand. It decouples customer service from manufacturing and enables each to operate independently and more effectively (Wild, 2002:99).

2.5.4 SYMPTOMS ASSOCIATED WITH POOR INVENTORY MANAGEMENT

The following eight are symptoms associated with poor inventory management.

- Increasing numbers of back-orders.
- Increasing rand investment in inventory with back-orders remaining constant.
- High customer turnover rate.
- Increasing number of orders cancelled.
- Periodic lack of sufficient storage space.
- Wild variance in turnover of major inventory items between distribution centres.
- Deteriorating relationships with intermediaries, as typified by dealer cancellations and declining orders.
- A large quantity of obsolete items (Lambert *et al.*, 1998:168).

2.6 COUNTING INVENTORY

All companies take some kind of physical inventory (in other words, physically count the stock on hand) to correct the inventory records. This must be done at least once a year for cost accounting and tax purposes since it is impossible to know the correct profits of a firm without accurate figures. Corrections are also needed in the inventory figures. Errors in records are serious when they affect deliveries because of unsuspected shortages. Not all errors are due to posting; some arise from pilferage and "shrinkage". Some deviations have been great enough to seriously affect the profit of the firm.

Inventories may be taken once a year, in which case the plant is usually shut down for a few days to stop the flow of materials so that the checkers can get an accurate count. Unfortunately this method makes use of untrained personnel because it requires many checkers, and errors in counting and proper crediting of items can be as serious as posting errors. The problems are especially acute in firms where thousands of items must be verified, identified, and costed out.

The costs of taking inventory are great, and the questionable results from using untrained people, (sometimes workers directly from the floor) has been a problem since the dawn of time. A number of methods have been developed to work around the problem, two of which are being increasing adapted by industry. The first of these is called *cycle counting.*

2.6.1 CYCLE COUNTING

Cycle counting is a relatively recent procedure, which makes use of trained crews who count one-twelfth of the inventory every month. Errors in records are corrected on the spot. The result is that the overall record-keeping system is being audited continually and is being improved.

The system of counting requires some planning to assure meaningful cut-off figures during production. In-process inventories cannot be counted, normally, by cycle counting because of the fluid state of the inventory. But most inventories do lend themselves to cycle counting. The usual procedure is to count the fast moving items more than once a year because these items tend to generate more posting errors. Slow movers can sometimes be skipped entirely if they are physically tow-binned because they are counted automatically once a year when they hit the second bin and are reordered. When the "bag" is broken open, a precise count will be known on that day.

Also, when stock is received, and the second bin is re-setup, a count can be obtained. For accounting purposes, the total two-bin value is reduced by one-twelfth usage each month and is increased by all incoming materials that are added into stock.

Total error by this method is low because orders are placed only when stock is at the physical reorder point. Hence, the typical errors caused by posting to a computer are avoided. The advantages of using cycle counting, in addition to working with trained full-time crews, are greater accuracy, lower costs, and elimination of annual inventory.

2.6.2 SAMPLE-CHECK

A less widely used system is to sample-check the inventory by methods not unlike those used in work sampling and quality control. This method assumes that all records have inherent errors. By establishing an acceptable level of errors as a base, a sampling procedure can be determined mathematically that will tell us whether the records meet the requirement or not. Since actual total counting introduces errors, the sampling method can be made more accurate than total counting, and is considerably less expensive. Corrections are made to those records found to be in error.

This method has in several cases been accepted by the Internal Revenue Service (USA) as a valid means for determining inventory value. Several airlines use sampling for determining revenue demurrage between lines. When United Airlines, for example, sells a ticket that involves travel over three other airlines, the other airlines must be reimbursed for their share of the fare. United Airlines must also verify that it is not being overcharged. The original method was for all companies involved to compute all fare breakdowns and demurrages monthly, for every ticket issued and collected, today, the demurrage charges are calculated by sampling only a part of the mass of tickets. The results are generally more accurate than those obtained with detailed computation, ticket by ticket, and are much less expensive (Reinfeld, 1982:136).

2.6.3 KEY AREAS OF NEGLECT

In addition to the problems created by poor systems design and control, there are a number of other areas that need management attention because each of them can affect the size of the inventory. These problems come about through lack of attention to detail, through misunderstanding, or simply through neglect. They can be solved by formally established operating procedures spelled out by management. In total, there are eight such areas. These are (Reinfeld, 1982:136–137):

2.6.3.1 STOCK BALANCES AND ORDER QUANTITIES

The first of these determines how much to carry.

2.6.3.2 OBSOLESCENCE

Is frequently accepted as part of the cost of doing business. Many style goods companies are continually caught with excessive inventories; and yet with a little care in planning and forecasting, it is possible to achieve considerable improvement. By developing a basic approach, using historical forecasts, it is possible to obtain dependable records of usage and on-hand stocks, and to determine accurate means of ordering.

2.6.3.3 SPAN OF CONTROL

The span of control over inventory works best when a single party assumes overall responsibility. A fractured system of control is an invitation to excesses, just as the free use of my cheque book by four kids, a wife, and myself would invite calamity. Likewise, when the sales department controls finished goods, purchasing controls supplies and materials, distribution controls the warehouses, and manufacturing controls in-process and parts inventories, the conditions are not significantly different from the cheque book example.

2.6.3.4 NEW ITEMS

Should be added most carefully and with approval of someone at the top. A new item added is a new mouth to feed and should be accompanied by a few planned funerals.

2.6.3.5 STORAGE – SYSTEMS, LOCATION

Storage, in terms of carefully planned centres, can be most useful in helping cut in-process inventories and greatly shorten lead times. The location of stocks and the storage area layout should be looked into carefully. The best way to clean up a shop is to move it every ten years. One company in a tight cash position rented out over 35% of its floor space. Manufacturing insisted that the space was needed. But the president persisted, and afterwards, the new floor layout resulted in an improved materials flow.

2.6.3.6 ENGINEERING

Engineering changes must be coordinated with the sales, inventory, and production people through the use of meetings to avoid being caught with unsaleable goods, and to avoid building obsolete items for which engineering changes have been made, but for which manufacturing has not been notified.

2.6.3.7 SIMPLIFICATION AND STANDARDISATION

These are essential features of good inventory control. Steps should be undertaken to prune the line of "slow movers" and to combine "like" products. In some cases, over 50% of the line can be eliminated by studying the slow movers, without experiencing any loss of sales.

2.6.3.8 SETUPS AND TOOL CONTROL

These are important factors in determining inventory investments because setup costs are one side of the cost of production. Just as cost controls can be applied to manufacturing and product costs, it also is possible to reduce setup costs by product design (Reinfeld, 1982:135–138).

2.6.4 METHODS OF REDUCING INVENTORY LEVELS

In many instances one or more of the following steps can reduce inventory levels:

- Multi-echelon inventory planning, ABC analysis is an example of such planning.
- Lead time analysis.
- Delivery time analysis. This may lead to a change in carriers or negotiation with existing carriers.
- Elimination of low turnover and/or obsolete items.
- Analysis of pack size and discount structure.
- Examination of procedures for returned goods.
- Encouragement/automation of product substitution.
- Installations of formal reorder review systems.
- Measurements of fill rates by stock keeping units (SKU's).
- Analysis of customer demand characteristics.
- Development of a formal sales plan and demand forecast by predetermined logic.

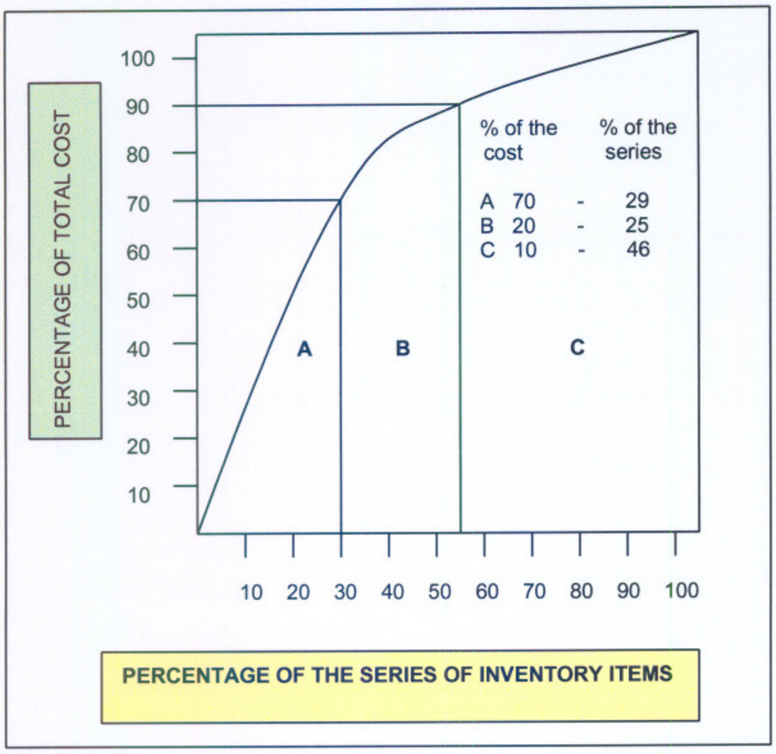
- Expand view of inventory to include inventory management and information sharing at various levels in the supply chain.
- Reengineering inventory management practices (include warehousing and transportation) to realise improvements in product flow (Lambert *et al.*, 1998:169).

It is important to discuss the different inventory management techniques. A few techniques are discussed in this section, ranging from the relatively simple to the very complex.

2.6.5 THE ABC APPROACH

The ABC approach is a simple approach to inventory management where the basic idea is to divide all inventory items into three groups. Pareto's law states that inventory items are divided into categories/groups based upon their contribution to the total cost of holding inventory for a business. Category/group A represents inventory, which adds up to 70% of the cost. Category/group B the next 20 and the last category/group C the final 10%. Figure 2.2 illustrates a hypothetical example of the ABC comparison of items in terms of the percentage of inventory value represented by each group versus the percentage of items represented. Category A items can be fewer in quantity than category B items. Category C items will usually include the majority of the inventory items of the business. If managers are aware of which inventory items contribute most towards the total cost of keeping inventory, these items can be carefully managed (Ross, *et al.,* 2001:588; Fawcett *et al.*, 1992:63).

Figure 2.2: ABC INVENTORY ANALYSIS

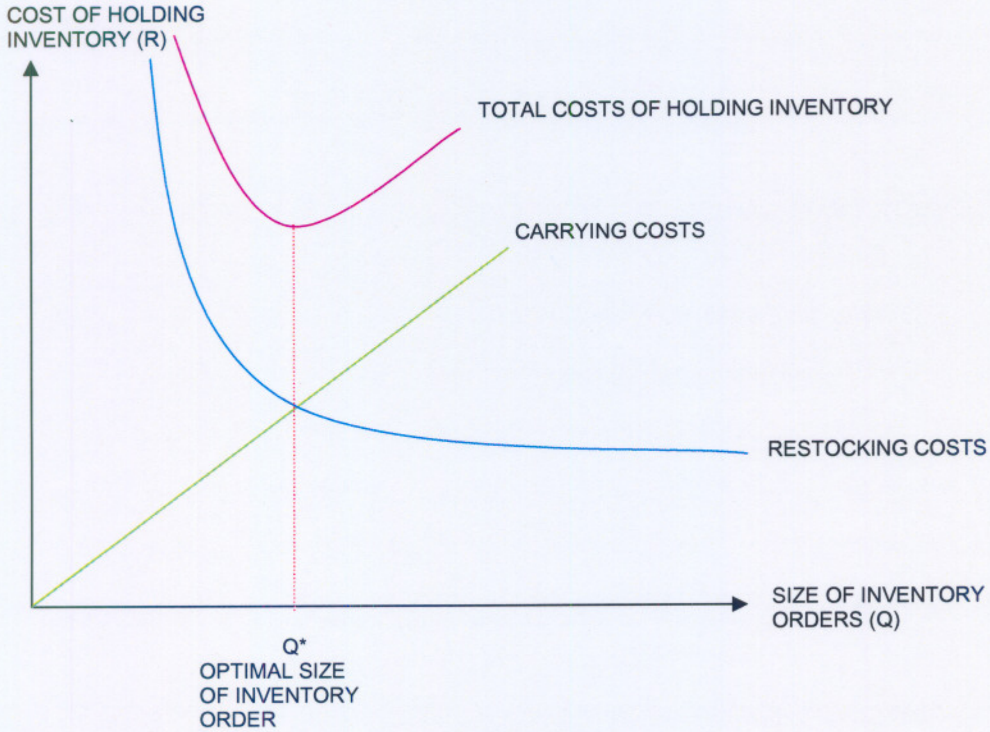


SOURCE: Adapted from Steyn, 2002:140.

2.6.6 THE ECONOMIC ORDER QUANTITY (EOQ) MODEL

The economic order quantity (EOQ) model is the best-known approach to explicitly establish an optimal inventory level. The EOQ model provides on order size in units that minimises the total inventory costs, which includes carrying and ordering costs in a situation where demand and the lead time are known for certain, this can be seen in figure 2.3. Figure 2.3 illustrates the various costs associated with holding inventory (on the vertical axis) against inventory levels (on the horizontal axis). As shown, inventory carrying costs rise and restocking costs decrease as inventory levels increase. With the EOQ model, an attempt is made to locate the minimum total cost point, called Q*.

Figure 2.3: COST OF HOLDING INVENTORY



SOURCE: Adapted from Ross *et al.,* 2001:589

In this case it is important to remember that the actual cost of the inventory itself is not included. The reason is that the *total* amount of inventory the business needs in a given year is dictated by sales. Management should determine how much inventory the business should have on hand at any particular time. More precisely, with this model management can determine what order size the business should use when its inventory is restocked. The EOQ can be calculated using the formula:

$$EOQ = \sqrt{\frac{2\,OD}{C}}$$ where:

EOQ = number of units to be ordered
O = order cost per order
D = annual demand in number of units
C = carry cost per unit (Ross *et al.*, 2001:589; Gourdin, 2001:63).

2.7 THE NATURE OF LOGISTICS

2.7.1 INTRODUCTION

Although logistics as a concept originated in the military, its application in the business environment has led many authors to appreciate the strategic value logistics has for a business (McGinnis 1992:22). Many authors also point out that the absence of a logistics policy can be seen as a strategic disaster. It is therefore necessary to firstly examine and understand the concept of logistics.

In this chapter a literature study regarding the concept logistics and the different logistics activities will be discussed. To understand logistics in practice, it is essential to examine logistics in the business and in the economy.

2.7.2 LOGISTICS DEFINED

The concept logistics is also known as:

- Business logistics
- Channel management
- Distribution
- Industrial logistics
- Logistical management
- Materials management
- Physical distribution
- Quick-response system
- Supply chain management
- Supply management

What the above terms have in common is that they deal with the management of the flow of goods or materials from the point of origin to the point of consumption and in some cases even to the point of disposal. There are many definitions of logistics coined by authors, consultant and practitioners. The Council of Logistics Management (CLM), one of the leading professional organisations for logistics personnel, uses the term *logistics management* to describe:

"The process of planning, implementing and controlling the efficient, effective flow and storage of goods, services, and related information from point of origin to point of consumption for the purpose of conforming to customer requirements." (Lambert *et al.*,1998:3) Stock and Lambert (1993) have also adopted this definition. In South Africa, this definition is found to be popular amongst logisticians.

Simply stated, logistics refers to the way whereby value is added to a product. Four types of utility can be distinguished, namely form utility, possession utility, time utility and place utility. Time and place utility are intimately supported by logistics. Coyle, Bardi and Langley (1992) argue that the value created by manufacturing a product is called "form utility".

- **Form utility** is the process of creating the goods or service. Form utility is also putting it in the proper form for the customer to use. Marketing adds a further value dimension called "possession utility".
- **Possession utility** is the value added to a product or service since the customer is able to take actual possession. This is, for example, made possible by credit arrangements and loans. Form and possession utility are not specifically related to logistics, but neither would be possible without getting the right items needed for consumption or production to the right place at the right time and in the right condition at the right cost.
- **Time utility** is the value added by having an item available when it is needed. This means to have all the materials and parts for manufacturing, so that the production line does not have to shut down. If items are not on time, it does the customer no good. A sale will be lost and/or a customer may be lost. Time utility is closely related to place utility.
- **Place utility** means having the item or service available where it is needed. Items which are in the right form and available at the right time means nothing to a customer if it is not available at the place where it is needed. For example, if a product desired by consumers are in transit, in a warehouse, or in another store, it does not create any place utility for them. A customer cannot be satisfied without both time and place utility, which logistics directly supports (Lambert *et al.*, 1998:11). In strategic terms, logistics could be viewed as the interface between production and marketing. As far as quality is concerned, this could perhaps best be demonstrated by the following view: "Leading-edge firms typically implement a portfolio of unique logistical solution to accommodate the quality-driven expectations of each key customer" (Bowersox and Closs, 1996:483).

2.7.3 DEVELOPMENT OF LOGISTICS

Logistics dates back to the earliest forms of organised trade. In the early 1900's, when farm products were distributed, logistics gained attention as an area of study for the first time (Lambert *et al.*, 1998:5).

2.7.3.1 COMPETITIVE PRESSURES

Logistics received more attention as a major cost driver, at the time when interest rates were rising and energy costs increased in 1970. For many businesses, logistics costs became a more critical issue because of the globalisation of industries. This has affected logistics in two primary ways.

Firstly, new ways to differentiate businesses and product offerings have evolved due to the growth of world-class competitors. Logistics is a logical place to look, because domestic businesses should be able to provide a more reliable, responsive service to nearby markets than overseas competitors.

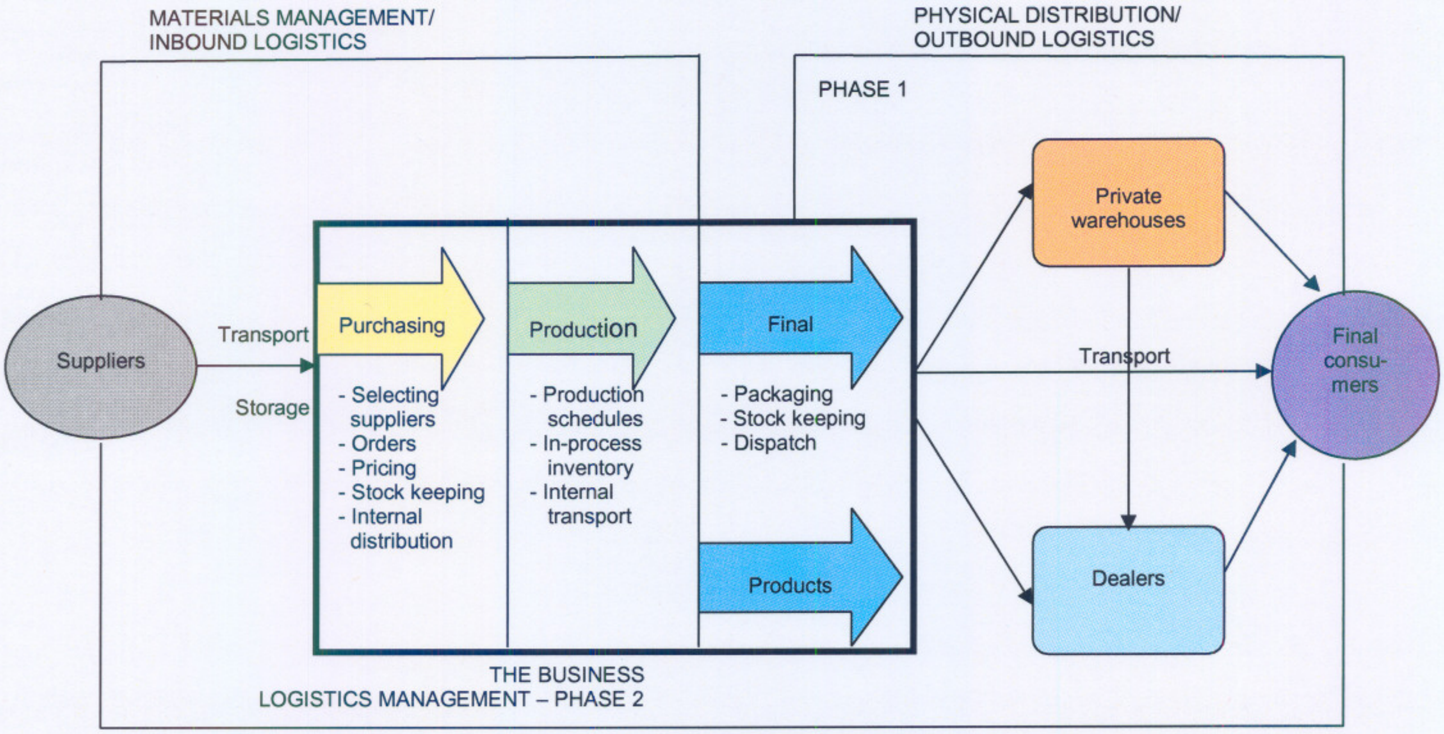
Secondly, the supply chain between the business and those it does business with become longer, more costly, and more complex because businesses increasingly buy and sell offshore. Excellent logistics management is needed to fully leverage global opportunities (Lambert *et al.*, 1998:6).

2.7.4 INFORMATION TECHNOLOGY

At that time information technology started exploding. This enabled businesses to better monitor transaction intensive activities, such as the ordering, movement and storage of goods and materials. All this combined with the availability of computerised quantitative models, increased the ability to manage flows and to optimise inventory levels and movements. Factors, such as advanced information systems technology, and increased emphasis on customer service, growing recognition of the systems approach and total cost concept, the profit leverage from logistics, and the realisation that logistics can be used as a strategic weapon in competing in the marketplace, contributed to the growing interest in logistics (Lambert *et al.*, 1998:7).

Subsequently, the phases in the development of logistics management will be explained. In figure 2.4 two of the three phases are depicted.

Figure 2.4: THE LOGISTICS PROCESS



SOURCE: Adapted from van Rensburg, L.R.J., 2000:4.

THE DEVELOPMENT OF LOGISTICS MANAGEMENT IN THREE PHASES

During phase 1 attention was focused on physical distribution, which refers the final step of the logistics process. Every business strives to establish a competitive advantage by using different methods and exploiting opportunities. Businesses soon realised that another way of identifying a competitive advantage was by delivering a better service to customers.

Phase 2 is the development of logistics management characterised by the concept called integrated logistics management. Activities related to the procurement of resources in order to make the finished goods available, are influenced by physical distribution, and not only by the effective delivering of requirements. The inbound and outbound logistics should be co-ordinated and this process is then called *integrated logistics management*

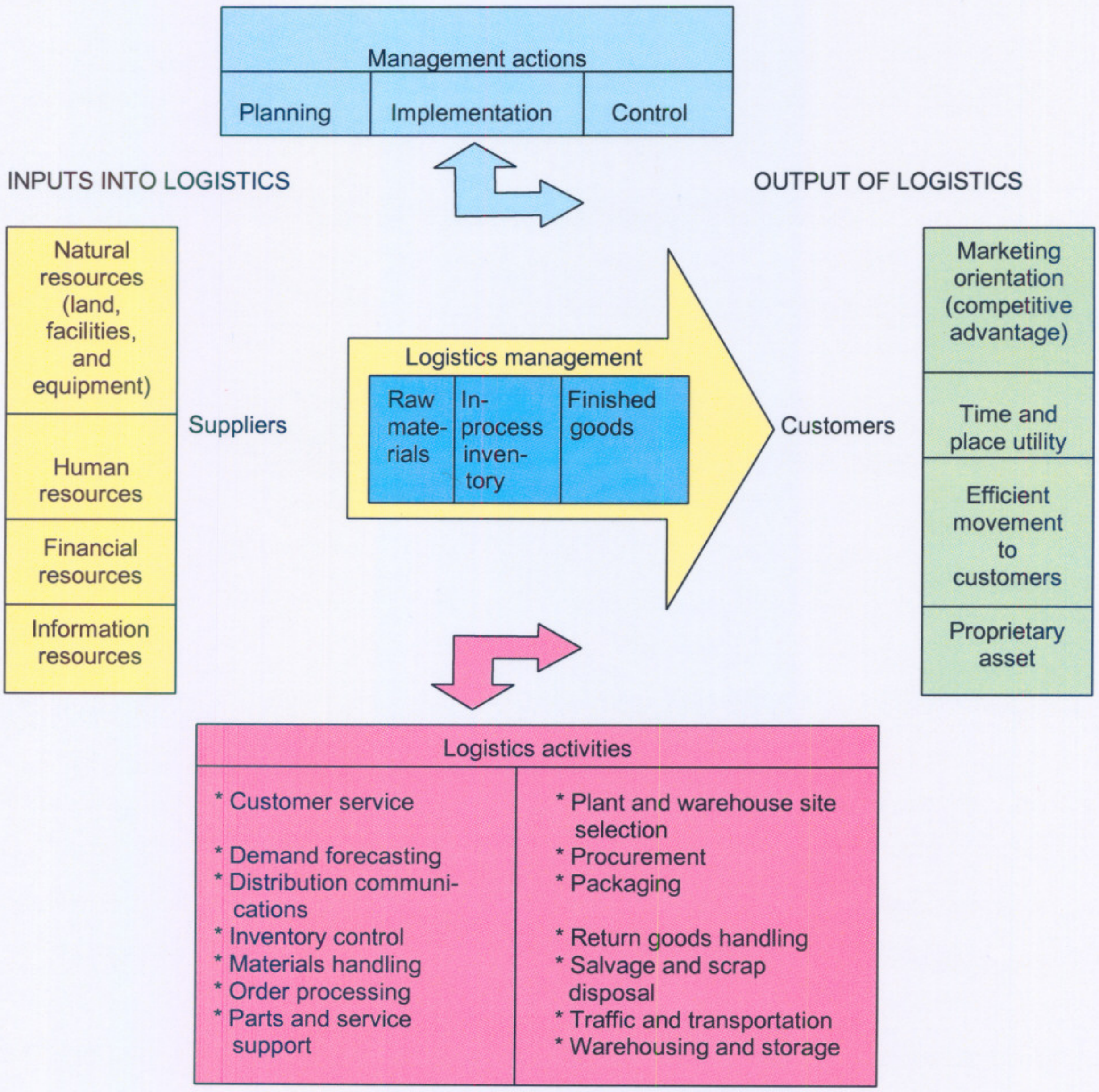
Phase 3 can be described as the management of the flow of materials in an industrial column or supply chain. The flow of components of certain products (referring to raw materials or semi-finished goods) should be co-ordinated (van Rensburg, L.R.J., 2000:4).

If the inbound side of logistics (materials management) is combined with the outbound side of logistics (physical distribution, which is closely related to customer service), additional opportunities for savings can occur. The inbound side of logistics combined with the outbound side of logistics can be described as business logistics or the logistics system (Coyle *et al.*, 1996:6).

2.8 THE STUDY FIELD AND THE COMPONENTS OF LOGISTICS MANAGEMENT

Some of the many activities encompassed under logistics are given in figure 2.5. Suppliers provide raw materials, which logistics manage in the form of raw materials, in-process inventory and finished goods. The framework for logistics activities is provided by management actions through the process of planning, implementation and control. Competitive advantage, time and place utility, efficient movement to the customer and providing a logistics service mix, such that logistics become a proprietary asset of the business, are the outputs of the logistics system (Lambert *et* *al.*, 1998:4). These outputs are made possible by the effective and efficient performance of the logistics activities shown at the bottom of figure 2.5.

Figure 2.5: COMPONENTS OF LOGISTICS MANAGEMENT



SOURCE: Adapted from Lambert *et al.*, 1998:5.

The effective management of the logistics activities should result in effective customer service.

2.9 THE LOGISTICS ACTIVITIES

The following was complied by using information from various authors named after each activity. The following activities exists:

2.9.1 CUSTOMER SERVICE

Customer service levels in many ways glue together other logistics areas. While customarily the logistics area does not completely control customer service decisions, logistics plays an extremely important role in ensuring that the customer gets the right product at the right place and time. Customer service is multi-dimensional. In a broad sense, it is the output of the entire logistics effort. That is, customer service and some resulting level of satisfaction are what the logistics system ultimately provides the buyer. Good customer service supports customer satisfaction. It is a process that ensures that consumer needs are satisfied (Coyle *et al.*, 1996:46; Lambert *et al.*, 1998:17; Gourdin, 2001:5).

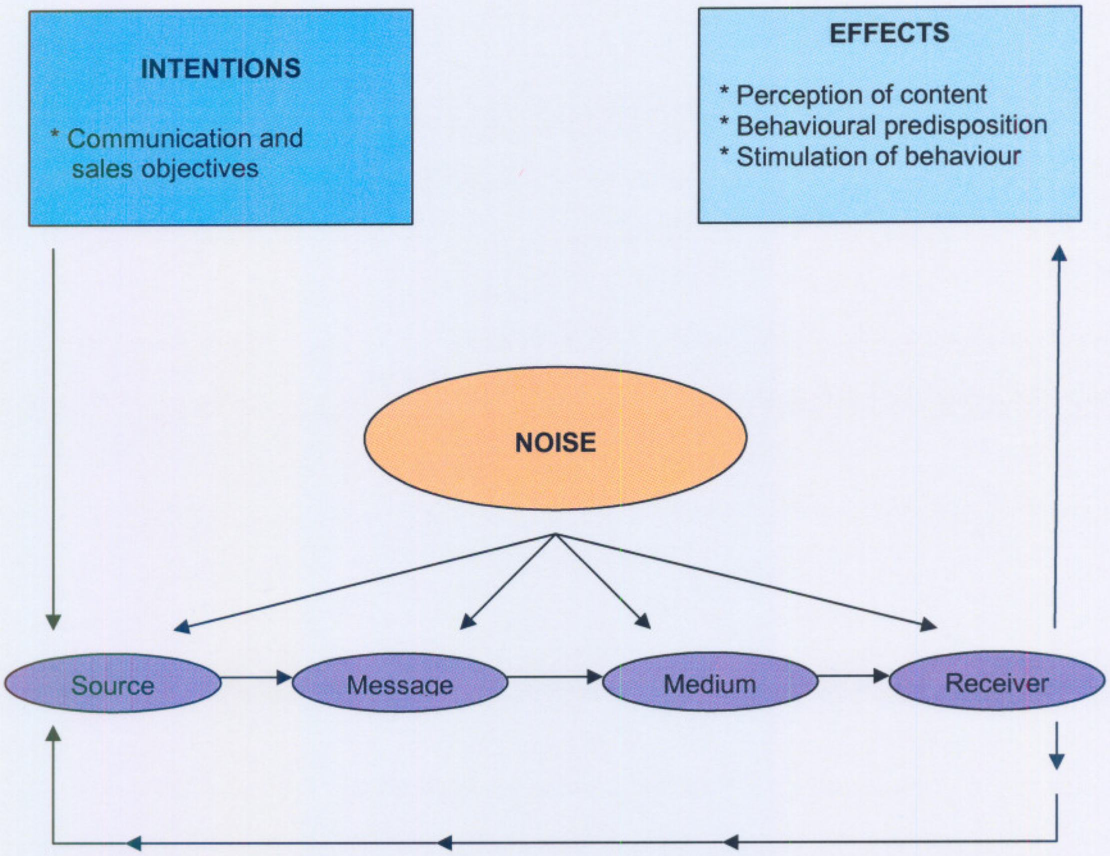
2.9.2 ORDER PROCESSING

The processing of order refers to an activity, which is involved with the completing of customer orders. Order processing is a broad, highly automated area which consists of getting the orders from customers, checking on the status of orders and communicating to customers about them and actually filling out the order and making it available to the customer. The importance of this activity lies in the effectiveness and speed of processing orders (Coyle *et al.*, 1996:45; Lambert *et al.*, 1998:18).

2.9.3 LOGISTICS COMMUNICATION

According to marketing theories, communications are becoming increasingly automated, complex and rapid. In general, communication refers to transmitting a message in order to evoke a discriminating response. According to Semenik (2002:176), communication is the process of sending a message to a receiver. A reason exists for communication efforts. Communication efforts in marketing begin with intentions. This is the beginning of the communication process. This can also be the case when logistics activities are performed.

Figure 2.6: THE COMMUNICATION PROCESS



SOURCE: Adapted from Semenik, 2002:177.

After the communication and sales objectives have been formed, as source is needed to carry these intentions further. A source is the marketer of the brand and in personal selling, the salesperson who represents the marketer. The source needs a message, which contains the information designed to inform or persuade consumers and business buyers or to broadcast what the intention of the message is. The medium such as the newspapers, radio, television, magazines, billboards, the internet and direct mail are examples of "vehicles" whereby messages are transmitted to receivers. The consumers or business buyers targeted by a business are the receivers of messages. The effects in a communication process are determined by identifying receivers' perception of message content. During the entire process noise exists. Noise is any disturbance that inhabits message transmission to the intended receiver. Many forms of noise exist and all these forms should be avoided when a message is transmitted. Feedback is necessary in the communication process to evaluate and improve all situations (Semenik, 2002:176). During the communication process, in the case of logistics, it is necessary to make sure that everybody understands what is communicated, therefore making sure that all goes according to plan, for example, providing the right products at the right place.

2.9.4 INVENTORY MANAGEMENT/CONTROL

The activity which, organises the availability of items to the customers, is named inventory control. This activity coordinates the purchasing, manufacturing and distribution functions to meet the marketing needs. It includes the supply of current sales items, new products, consumables, spare parts and all other supplies. Inventory enables a business to support the customer service, logistics or manufacturing activities. There should be enough items in stock to ensure the functioning of the business and to ensure that consumers can purchase according to their needs. Different inventory control methods can be used (Wild, 2002:4).

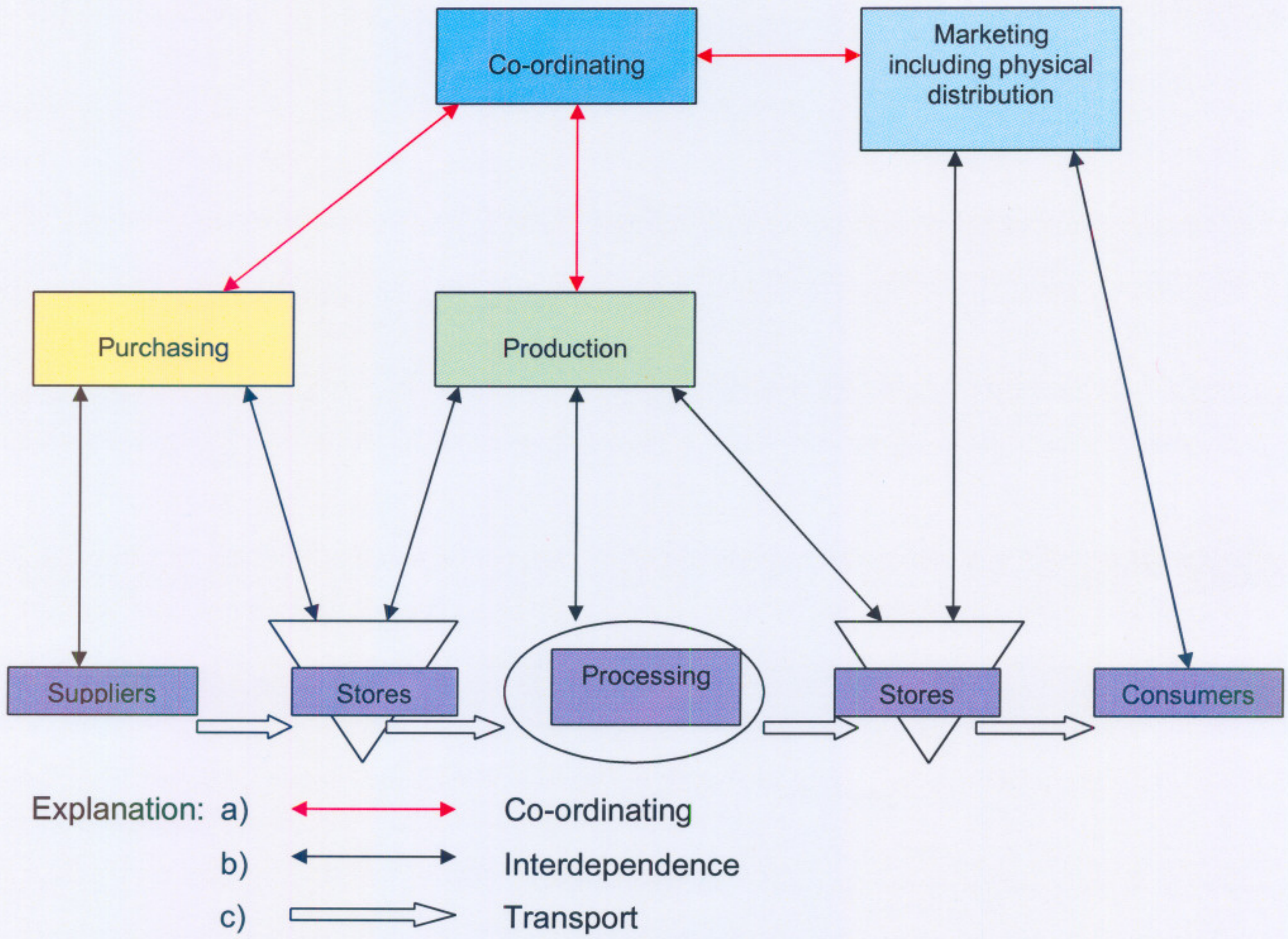
2.9.5 FORECASTING DEMAND

Forecasting refers to the process of organising a phenomenon's past in order to predict a future. To manipulate objectives, quantitative data by mathematical rules and to analyse the opinions of experts are ways to determine phenomenon pasts. It should be determined how many manufactured items should be distributed to various outlets in order to satisfy demand (Frechtling, 2001:8).

2.9.6 TRANSPORTATION

Transportation systems are needed for the ever-growing needs for contracts between individuals as societies and for the movement of commodities. Commodities are part of national and global economies (Tolley *et al.,* 1995:1). It includes selecting the best mode of transportation. The role of transportation in the logistics system can be seen in perspective by noting the frequency or transport decisions. Figure 2.7 shows that transport is directly involved in the flow of products (raw material, semi-finished and finished products), but also indirectly involved in the co-ordination of several activities of the logistics system.

Figure 2.7: THE ROLE OF TRANSPORT IN THE LOGISTICS SYSTEM



SOURCE: Adapted from van Rensburg, A.M.J., 2000:103.

Figure 2.7 represents a logistical system where, the red arrows indicate the elements in the system, which require co-ordination. The black arrows indicate the interdependence between suppliers, purchasing, stores, production, marketing, physical delivery and consumers during the entire process of delivering the product to the final consumer. The white arrow indicates the role of transport in the logistics process concerning the delivering o the products. Transport therefore not only involve physical movement, but also has a direct effect on decision-making throughout the logistics system. Transport costs are directly influenced by the location of the factories, warehouses, suppliers and customers of the business. Inventory requirements are also influenced by the transport mode used, because costly, but fast transport services make smaller inventory levels possible. The form of transport largely determines the packaging required and the handling equipment for the loading and unloading of cargo. The design of loading docks primarily depends on the type of carrier. A method of order processing that makes maximum consolidation of consignments possible, has the advantage of volume discount, since carriers can transport larger consignments. The type of carrier selected, influences customer service objectives. Transport costs also represent the most substantial cost element of the logistics system (van Rensburg, A.M.J., 2000:104).

The transportation link permits goods to flow from one point to another, thereby bridging the buyer-seller gap in trading. The way and time in which this bridging is performed determine the efficiency of the operation supply chain facility and determines the competitive edge of the business (Coyle *et al.*, 1996:318). The geographical differences between suppliers and consumers result in the value added by transportation to a company by creating time and place utility. The value added is the physical movement of the goods to the place desired at the time desired (Coyle *et al.*, 1996:318). Transportation costs in the USA in 1994 was 6.3% of the GDP. In South Africa transportation costs increased from 7.82% of the GDP in 1994 to 8.25% of GDP in 1998, which emphasises the importance of transportation in a country's economy (Engler, 1997). In determining the transportation mode to be used in the conveyance of a consignment, a cost-service trade-off is necessary. If a business for example, switches from rail to air transportation, the result can increase speed, lower transit time, lower inventories, decreased warehousing space and less stringent product packaging. The business realises these advantages at the expense of higher transportation costs (Coyle *et al.*, 1996:319).

Although transport is the most important activity in logistics, it should be regarded as a sub-function of logistics together with storage, handling and inventory control. Optimisation of the transport activity does not necessarily lead to optimisation of the logistics function as a whole. The influence of a transport decision on other elements in the logistics system should therefore be taken into account, which implies a continuous application of the total cost approach (Coyle *et al.*, 1996:319; van Rensburg, A.M.J., 2000:105).

Transport can also influence the following company decisions, namely production decisions, marketing decisions, purchase decisions and more importantly price decisions. Since transport costs constitute a significant part of the total cost of the end product, these costs should be considered during pricing decisions (van Rensburg, A.M.J., 2000:105).

It should be emphasised that although efficient transport can raise the value of the product, this increased value is not through physical change or processing of the product. Transport creates value by providing time and place utility to raw materials and purchased products by making them available at the right time and place. Through this increase in value, transport contributes directly to increasing business revenue (van Rensburg, A.M.J., 2000:106).

2.9.7 WAREHOUSING AND STORAGE

Warehousing refers to the management of the space required to hold inventories. It involves problems, such as site selection, space determination, stock layout, stock retrieval, stock design and warehousing configuration. A number of important decisions are related to storage activities including how many warehouses, how much inventory, where to locate the warehouses and what size the warehouse should be (Coyle *et al.*, 1996:44).

2.9.8 ESTABLISHING WAREHOUSES AND PLANTS

Before these decisions can be made thorough research needs to be performed. Making wrong decisions can be detrimental to the business's competitive advantage (van Rensburg, L.R.J., 2000:3).

2.9.9 MATERIALS HANDLING

Materials handling is the art and science of implementing movement in an economical and safe manner. This is important because a total logistics management system depends upon well-organised and integrated materials handling in order to provide the proper flow of materials to all essential parts of the business. Materials handling is usually concerned with mechanical equipment for short distance movements. Examples of materials handling equipment, includes conveyors, forklift trucks, overhead cranes and containers (Coyle *et al.*, 1996:45; Magad *et al.*, 1995:327).

2.9.10 AFTER-SALES SERVICE

To follow-up, after a product has been purchased and the way customer problems are handled will influence the quality of customer service and whether the customer will return (van Rensburg, L.R.J., 2000:3).

2.9.11 SALVAGE AND SCRAP DISPOSAL (reverse logistics)

Material, which is not used, should not be thrown away. An alternative use for it should be found (van Rensburg, L.R.J., 2000:4).

2.9.12 RETURN GOODS HANDLING

This activity must take place if there is a problem with the performance of the item or simply because the customer has changed his or her mind. All businesses should clearly state their policy regarding returned goods, since it can influence customer service (Lambert *et al.*, 1998:20).

2.9.13 PACKAGING

One of the objectives of logistics is to move goods with no more damage than is economically reasonable. A good design of the package for the product's protection helps to ensure damage-free movement (Gourdin, 2001:6).

2.9.14 PROCUREMENT

The purchase of materials and services from outside businesses to support the operations from production to marketing, sales, and logistics is called procurement (Lambert *et al.*, 1998:20).

2.9.15 PRODUCTION PLANNING

To satisfy customer needs by giving them a product, the manufacturing department needs components and raw materials in order to make the finished product. It is important that the primary focus should not shift, this will lead to customer dissatisfaction (Gourdin, 2001:6).

2.9.16 INFORMATION PROCESSING

All areas of the logistics system are linked together through information processing (Gourdin, 2001:6).

2.10 SUMMARY

In this chapter the concepts, planning, inventory management and logistics, was introduced. The development and study field of planning, inventory management and logistics were described. The different planning, inventories and logistics activities were briefly discussed. The relevance of planning, inventories and logistics to the business and economy as a whole was introduced. The concept of the systems approach was introduced and related to the role of planning, inventory management and logistics and its interface with manufacturing. Planning, inventory and logistics as a source of competitive advantage was briefly discussed.

Out of the theoretical applications and information that was studied in this chapter the production planning and inventory control systems, at Mittal Steel, needs to be investigated in detail so that the best practical solutions can be derived from the non-compliances, if any. It is therefore necessary to conduct a thorough survey on these systems. It is also important to investigate the logistics behind the transport of bulk raw materials, because of the high costs involved in supplying these expensive materials (coking coal blends) in time, with the best quality, to the Works.

In chapter three the planning, inventory management and logistics system will be examined.

CHAPTER 3

THE COKE PLANT PRODUCTION PROCESS AND RESEARCH RESULTS

Due to the complexity of the coke manufacturing process, the inventory control of raw materials for this process needs to be understood and managed effectively. In this chapter a detailed audit will be conducted on the current inventory control system to determine deficiencies which contributes to inventory losses or changes. As discussed in chapter one, these deficiencies contributes to a large financial impact on the iron making business and also influence the bottom line of Mittal Steel.

In order to conduct this investigation it is necessary to discuss the production process of coke making, because the different inventory control systems are included in the raw materials handling and coke making process. This pipeline of processes all includes a critical part of the total inventory control system, thus whenever a deficiency exists, it has a direct influence on the effective management of the pipeline. The different processes will be discussed to emphasise the role of bulk materials handling, which includes inventory control systems.

3.1 MANUFACTURE OF METALLURGICAL COKE

3.1.1 INTRODUCTION

Although the oxides of iron may be reduced to metallic iron by many agents, carbon (directly or indirectly) is the reducing agent found to be best suited for the economical production of iron. Carbon of suitable reactivity and physical strength was at one time produced from wood by distillation, yielding wood charcoal; but for the operation of a modern large blast furnace the carbon required for the smelting of iron is obtained from the destructive distillation of selected coking coals at temperatures in the range from 900°C to 1095°C.

3.1.2 CHEMICAL EFFECTS OF COKING

Coal is a complex mixture of organic compounds, the principal elements of which are carbon and hydrogen with smaller amounts of oxygen, nitrogen and sulphur. It also contains some non-combustible components called ash. The ash consists primarily of inorganic compounds which became imbedded in the coal matrix during the coalification process.

The chemical compounds making up coals, are unstable when subjected to a high degree of heat or thermal treatment. When heated to high temperatures, in the absence of air, the complex organic molecules break down to yield gases, together with liquid and solid organic compounds of lower molecular weight and a relatively non-volatile carbonaceous residue (coke). Coke, then, is the residue from the destructive distillation of coal.

3.1.3 KINDS OF COKE

There are three principal kinds of coke, classified according to the methods by which they are manufactured: low-, medium- and high temperature coke. Coke used for metallurgical purposes must be carbonized in the higher ranges of temperature (between 900°C and 1095°C) if the product is to have satisfactory physical properties. Even with good coking coal, the product obtained by low temperature carbonization between 480°C and 760°C is unacceptable for good blast furnace operation.

3.1.4 IMPORTANT PROPERTIES OF METALLURGICAL COKE

Probably the most important physical property of metallurgical coke is its strength to withstand breakage and abrasion during handling and its use in the blast furnace. The standard ASTM tests used to evaluate these properties are the stability index for breakage and the hardness index for abrasion. Both of these tests involve tumbling coke of selected size in a standard drum rotated for a specific time at a specific rate. The stability index and the hardness index are the percentages of coke remaining on 25mm and 6mm screens, respectively, when the coke is screened after tumbling.

3.1.5 METHODS OF MANUFACTURING METALLURGICAL COKE

There are two proven processes for manufacturing metallurgical coke, known as the beehive process and the by-product process. In the beehive process, air is admitted to the coking chamber in controlled amounts for the purpose of burning therein the volatile products distilled from coal to generate heat for further distillation. In the by-product method, air is excluded from the coking chambers, and the necessary heat for distillation is supplied from external combustion of some of the gas recovered from the coking process. With modern by-product ovens, properly operated, all the volatile products liberated during coking are recovered as gas and coal chemicals, and, when coke oven gas alone is used as fuel, about 40% of the gas produced is returned to the ovens for heating purposes.

3.1.6 PRODUCTS OF COAL CARBONIZATION

Table 3.1. Coke and coal chemical typical yields following carbonization

	PER METRIC TON
Blast furnace coke	600 – 800 kg
Coke breeze	50 – 100 kg
Coke oven gas	296 – 358 m^3
Tar	30.3 – 45.4 litres
Ammonium sulphate	10 – 13.8 kg
Ammonia liquor	56.8 – 132.5 litres
Light oil	9.5 – 15.1 litres

3.2 COALS FOR METALLURGICAL COKE PRODUCTION

3.2.1 SELECTING COALS FOR QUALITY COKE - INTRODUCTION

Most coal and coke producers follow the practice of coal blending, in order to conserve the limited resources of high cost, prime coking coals. This is also due to the fact that a single coal does not usually meet all the requirements of coke quality and coke-making. The challenge to a coke producer is in designing a blend that on carbonization would consistently produce a low cost, high quality coke with safe oven pushing performance. More rigid coke quality requirements will be placed on coke producers as iron makers try to increase productivity and reduce costs by reducing the coke rate and by increasing the pulverized coal injection rate.

With the above requirements in mind, the coal design efforts can be grouped into the following categories:-

- Coal blend design to satisfy coke physical properties.
- Coal blend design to satisfy coke chemical properties.
- Coal blend design to satisfy coke oven pushing performance.

- Coal blend design to satisfy maximum usage of low value carbon materials.
- Economic evaluation of the designed blend
- Assurance of high quality coal shipments.

3.2.2 PREPARATION OF COAL CHARGE FOR BYPRODUCT OVENS

The importance of coal preparation cannot be overemphasized. It is a very important step in the coke-making process in terms of coke quality and uniformity. The proper preparation of the coal blend affects both the smoothness of operation and the productivity of the coke battery.

3.2.3 COAL UNLOADING (*See figure 3.1: COKING COAL RECEIVING & STORAGE, page 102*)

Coals are received at the coke plants by rail. Railroad cars are unloaded by rotary dumpers (tipplers) or bottom dumping. Rotary car dumpers usually are preferred. Throughout the unloading operation, coal identity must be maintained so that selected coals always are unloaded to the proper silo or stockpile. Any coal misplaced to the wrong storage silo or stockpile, can cause serious operating problems and possibly damage the coke batteries in addition to having a negative affect on coke quality. At Mittal Steel the coal is offloaded by means of; four tipplers, from where the coal is conveyed on a conveyor system to the stockyard. The coal is stacked on individual stockpiles according to the quality of the coal components. A stacker/reclaimer bucket wheel system are utilized to do the stacking and reclaiming of the coal components. The current infrastructure of the coal offloading facility includes a conveying system that covers over 1,2km and includes 17 transfer stations.

3.2.4 COAL RECLAIMING (*See figure 3.1: COKING COAL RECEIVING & STORAGE, page 102*)

The coals as received can vary in sulphur and ash content and therefore each coal component are being reclaimed individually to separate storage silos at the blending plant. During the reclaiming the coal components is send through a crushing plant to pulverize the coal to a specific size grading. When coal is reclaimed and blended, it is conveyed to the coke plant batteries over a distance of 2,1km which include 24 transfer stations.

The coal is delivered in component silos by means of a shuttle conveyor which can move over all seven silos to fill up the silos with the different coal components, so that blending can be done at the bottom by means of way feeders.

3.2.5 CRUSHING (PULVERIZING) (*See figure 3.1: COKING COAL RECEIVING & STORAGE, page 102*)

Crushers are used to break up the large coal with a minimum of fines generation. Each coal component utilized for metallurgical coke production has a different hardness and therefore selective crushing is being done to obtain a optimal size distribution for each component.

The importance and effect of crushing on inventory control is that the bulk density of coal changes when crushed, therefore more coal can be loaded into the coke ovens, which in turn can have an effect on inventory changes.

Many different types of pulverizers are available for crushing coal, but three types find wide application in coke plants: these are the hammer mill, the impact mill and cage mill.

The type of pulverizer used by Mittal Steel in coal pulverization is the cage mill. In this machine, two cages, one inside the other, are rotated in opposite directions at speeds of up to 500 rpm. Coal enters the centre of the machine, is struck by the impact plates of the inside cage and thrown into the plates of the outside cage, which is rotating in the opposite direction, and is discharged out of the machine. The degree of pulverization is controlled by the rotational speed and the spacing between the cages. The advantage of this machine is that it provides a high level of pulverization and good control of top size, with low levels of fine coal generation. The disadvantages are its susceptibility to damage by tramp metal and plugging by softer material such as wood and rags. Each cage mill installation are protected by magnets and metal alarms on the conveyors ahead of the pulverizers. With this protection, the cage mill is the best pulverizer for coal preparation in coke plants.

Constant monitoring of the performance of the crushers by screen analysis of the crushed-coal product is essential if consistently high quality coke is to be produced. When the pulverization level falls, immediate corrective action must be taken to assure a production of high quality coke.

Each coal component is crushed before being conveyed to the blending silos. A typical coal size grading after crushing will consist of 86%, smaller than 3mm size particles in the final feed.

3.2.6 BLENDING SILOS AND WEIGH FEEDERS (*See figure 3.2: COAL SILOS, page 103*)

Blending silos and weigh feeders are used for blending the individual coals in proportion to the final coal blend which will be charged to the coke ovens from the bunker located above the coke batteries.

Blending silos are provided for each coal or groups of coal. The number and size of the bins is determined by the number of coals to be blended and the daily throughput of coal. The silos can be either round or rectangular with conical bottoms constructed of concrete or steel. However, they should be designed with mass-flow bottom discharge. Silos usually are grouped together to facilitate distribution of coal to the top of the silos and to shorten the conveyor lengths required at the bottom discharge. At Mittal Steel, 14 blend silos are utilized for blending purposes.

Quality analysis proves that a consistently well-proportioned coal blend is essential to the production of the highest quality, most uniform coke possible from the coals supplied. In any given situation every effort should be made to get the maximum performance from the combined mixing silo and feeder systems. Each silo is provided with a discharge weigh belt for controlling the weight of the coal delivered. Coal weight control is accomplished by scales and control circuitry which regulates either the speed of the belt carrying a constant depth of coal or the depth of the coal on a constant-speed belt. If the flow from the bin is not constant because of poor silo design or because of wet coal or extraneous material, the weigh feeder cannot deliver the required flow rate. Suffice it to say that the silo and feeder must be treated as an integral unit if accurate proportioning is to be accomplished. The best feeder is useless without a proper silo above it.

Moisture compensation needs to be done on each silo containing a different quality coal component. The moisture content of each coal is determined on a shift basis (3 times per 24 hours) for effective moisture compensation. The reason for doing this is that each weigh feeder will discharge the exact dry tonnages for each coal component and to ensure effective blending

3.2.7 BULK DENSITY CONTROL (*See figure 3.3: COAL CONVEYORS TO COKE OVEN BATTERIES, page 104*)

The last step in the process of preparing coal for coking is adjustment of the bulk density of the coal blend. A coke battery cannot be operated smoothly and efficiently without bulk density control. Bulk density of the coal blends is affected by moisture content. For example, coal with a bulk density of 700kg/m3 containing 8% moisture actually contains only 644kg of dry coal per cubic metre. Consequently, it is desirable to maintain a constant moisture content in the coal blend by adding water if necessary. Bulk density control systems are based on the use of diesel, oil, or other similar oils, to increase bulk density of the coal blend. In a manual system, as operated by Mittal Steel, bulk density measurements are made regularly by hand in an ASTM bulk density box, and the oil flow rate is adjusted manually as required to hold bulk density at the control point.

This final prepared coal blend is loaded into the coking chambers with a charging car which moves on rails on top of the coke battery.

3.3 GENERAL DESIGN OF MODERN BY-PRODUCT COKE PLANTS IN OPERATION AT MITTAL STEEL

The by-product coking process, being a true distillation process, involves the use of retort ovens. While there are many modifications, these ovens consist essentially of three main parts, namely: the coking chambers, the heating flues and the regenerative chambers – all constructed of refractory brick. Ovens are constructed in batteries that have contained 55 ovens.

Coking chambers in a battery alternate with heating chambers so that, in effect, there is a heating chamber on each side of a coking chamber. The regenerative chambers are underneath the heating and coking chambers. Separating walls between regenerators also serve as foundation walls for the heating and coking chambers. The entire structure is supported either from the ground or by columns under a reinforced concrete or structural steel base.

The coal is charged through openings in the top of the oven and, after the coal has become coke, the coke is pushed out from one end by a power driven ram, or pusher. During the coking period, the ends of the coking chamber are closed by refractory lined doors, which are constructed to completely seal the ends of the ovens. The ovens first constructed in the industry provided a space between the door and the jamb which was filled with a special doping mixture to seal the oven prior to charging. Later, several types of self-sealing doors were developed, which seal the opening when put in place and require no doping.

To permit the escape of volatile matter driven from the coal during coking, an opening is provided at the top of the oven at either one or both ends of the coking chamber. Each such opening is fitted with an off-take pipe, which connects the oven with the gas collecting main for the battery.

The combustion chambers consist of a large number of flues which permit uniform heating of the entire length of the coking chamber. Ovens have been built with either horizontal heating flues or vertical heating flues, but vertical flues are used almost exclusively in present installations. Some of the older ovens employed the recuperative principle for preheating combustion air. Modern practice utilizes the regenerative principle to achieve higher thermal efficiency whereby less gas is required to heat the ovens. In all modern oven batteries, individual regenerators are provided for each heating wall and re located under each oven. This permits separate control of the flow of preheated air for combustion to individual vertical heating flue walls and allows close control of heating. An advantage of individual regenerators is that the control of heating for each oven is relatively independent of the operation of the remainder of the battery.

The importance of inventory lies in the fact that Mittal Steel there are 354 ovens which are distributed over 6 coke oven batteries. Each of these 354 ovens contains 13,5 tons of blended coal thus a total of 4780 tons of blended coal. This coal inventory is also included in the counting of inventory. This inventory changes to metallurgical coke by means of the coking process and is replaced every 18 hours.

3.4 SYSTEM DESCRIPTION: COAL INVENTORY

The production process of coke making has been discussed and the focus is now on the raw materials handling system description of coal inventory management.

3.4.1 RECEIVING, TIPPING AND STACKING OF INVENTORY

The following shift personnel are responsible for the receipt and storage of the coal inventory: *(See figure 3.4: ORGANIZATION CHART, page 105)*

- Superintendent, Coal Plant Production
- Two tippler Operators
- Two stacker Drivers
- One conveyer belt Operator
- Three cleaners

- The coal requirements are determined according to the coke requirements, the inventory levels of the bunkers, silos and in the stockyard as well as the required blend. The inventory levels in the bunkers and silos are measured every shift. The shift personnel estimate the stockyard inventory every evening. An official inventory count of the stockyard inventory is carried out on a monthly basis via aerial photographs. *(See figure 3.5: COAL STOCKYARD AREA, page 106)*

- The coal blend is changed from time to time. The Manager, Coking determine the required blend. When a blend component has been fully utilized the blend is changed. A memorandum regarding the blend change is prepared which has to be authorised by the Plant Manager, Coke Plant as well as the Works Manager, Iron Making.

- The Coal requirements are determined a month in advance. The Coordinator uses the estimated Coke demand, the available plant capacity (with provision made for any planned short stops and maintenance) and the applicable coal blend to calculate the daily throughput and thus the daily coal requirements. This is done on an excel spreadsheet. There are standard minimum and maximum inventory levels, for local coal it is a minimum of 10 days' supply and for imported coal it is 20 days' supply. The Coordinator uses the information regarding the coke requirements, the inventory levels as well as the prescribed blend (month plan) to estimate the coal requirements. A planning document (*see table 3.2: COKE OVENS PLANNING, STOCK AND DEMAND, page 107*) is prepared on a monthly basis and is discussed on the monthly coal workgroup meeting. Logistics is informed in respect of the time and amount of coal inventory needed (*see table 3.3: PRODUCTION PLANNING AND INVENTORY CONTROL, BLENDS AND CONSUMPTION, page 108*). When there are any changes and/or coal is required urgently the Coordinator liaise with Logistics.

- The Coordinator places the necessary coal order (bill of materials). The order, memorandum, is forwarded to Commercial Services. Commercial Services places the relevant coal order on SAP. For local coal the order is placed per trainload and for imported coal per shipload (consignment number). The Coordinator verifies that the SAP order has been created thus to ensure that the coal can be received against the order upon arrival at the Works. A new order for local coal is placed every month.

- The Coordinator daily receives information from Logistics personnel at Head Office via electronic mail, which enables the tracking of the order, for example when the train will arrive, any delays etc. Delays could lead to coal blend changes and production losses, which in the end will cause imbalances in inventory levels, due to these un-efficiencies.

- The import contracts are usually negotiated for a year. The Commodity Managers, Raw Materials, is responsible to manage the coal contracts. A monthly coal workgroup meeting is held to discuss any problems in respect of the coal supply.
- There are four types of imported coal that are received at the Coke Plant:
  - Burton ⟹ Australia
  - Riverside Goonyela blend ⟹ Australia

- Bulli ⟹ Australia
- West Coast Premium ⟹ New Zealand

- The two types of local coal received at the Coke Plant are:
  - Tshikondeni ⟹ Musina
  - Grootegeluk ⟹ Ellisras

Tshikondeni is an ongoing contract. For the Grootegeluk coal a ten-year contract has been negotiated but has not yet been signed by all the parties. Line management is not satisfied with the exchange rate clause. The plant personnel monitor the receipt and quality of the coal according to the contract but the Commodity Manager manages it.

- The imported coal and the local coal are used to make up the blend that is used in the coke batteries.

- The imported coal is offloaded at the Richardsbay harbour. When there is no available space at Richardsbay, the inventory is received at the Durban harbour – this recently happened for the first time in five years. The coal is either dispatched to the Vanderbijlpark and/or Newcastle Works or is kept in a store at the harbour. This ratio is determined on the monthly coal workgroup meeting where the coal requirements for Vanderbijlpark and Newcastle are estimated for the next eighteen months. The inventory in the store is however dispatched as soon as possible. The store space at the harbour can accommodate 250 000 tons of coking coal and it is managed by Mittal Steel personnel.

- Delays are sometimes experienced in respect of the delivery of the coal due to insufficient performance from Spoornet and Portnet. Logistics is responsible to monitor and manage the contracts and to ensure the applicable penalties are raised.

- When either imported/local coal is dispatched to the Works a fax is forwarded from either the harbour or the mine to the Coordinator. The fax details the following information:
  - Consignment number
  - Coal grade

- Tonnage
- Number of trucks
- Departure time
- Departure date
- Mittal Steel train number
- Spoornet train number
- Destination
- Wagon numbers
- Gross mass per wagon
- Tare mass per wagon
- Nett mass per wagon

Every type of coal has a different batch number and a SAP article number for identification purposes. Problems have been experienced in the past when the wrong coal component has been offloaded due to the fact that the wrong batch number has been stated on the documentation. The different coal components can't be distinguished from one another through visual inspection. When there is uncertainty in respect of a coal component laboratory tests are performed to verify the type of coal.

- The coal inventory at the Vanderbijlpark Works is received via rail transport only (tip trucks). Upon arrival at the Works the responsible Superintendent, Coal Plant verifies the truck numbers with the applicable fax received. When there is any variance the material is not offloaded until it has been verified with either the mine or the Logistics Controller/Coordinator at the harbour. It has happened in the past that railway trucks have been switched on route to the Works.

- The ships' cargo is weighed before and after the cargo has been offloaded by means of a draft survey. The coal is not weighed at the incoming weighbridge. The Superintendent on shift does not compare the advised mass with the actual weighed mass received. The Coordinator compares the weighed mass with the mine/harbour advised mass on a weekly basis on an excel spreadsheet. The deviation is recorded per trainload. The actual mass is always less than the advised mass. The information is forwarded to the Manager, Coal Plant for monitoring purposes. The information is included on his weekly report. No corrective action is taken as payment is made according to the advised mass.

- The railway trucks are offloaded at the 4 tipplers. The coal to be stacked in the stockyard is weighed with a conveyer belt scale, CR3, when offloaded. CR3 has two belt scales, which measure tons per hour, and total tons:
  - North scale for tippler 1,4 (Belt CR1)
  - South scale for tippler 2,3 (Belt CR2)

The Process Controllers zero the scales, take the readings and record the results on a shift sheet.

- The offloading time of the railway trucks are measured from the time the trucks have been requested. The time is recorded from the start of the first truck being tipped until the last truck has been tipped. An average per railway truck is calculated (the standard is seven minutes per truck). The information is recorded on the applicable shift sheet. Graphs are prepared on a monthly basis to monitor any variances. Results are discussed on the monthly quality meeting.

Rail transport also measures the time taken to offload the trucks. Penalties are raised on a regular basis for standing time. These problems are mainly experienced due to the fact that there isn't an allocated locomotive for the coal inventory off-loading facility, but it is shared by other departments as well.

- The coal that is wasted while being offloaded is dumped on the GGL stockpile in the stockyard with a front-end loader or dump trucks. Coal that fall from the conveyer belts is loaded back onto the conveyers, if possible. The sweepings for the past three months accumulated to ±15 000 tons. The sweepings are recorded at R100-00 per ton. Sweepings are also consumed in the batteries, if possible.

- The coal inventory that is offloaded is stored in the stockyard area and/or is routed to the silos.

The coal inventory for the coke ovens (batteries) is stored in the silos. There is nine silos on both sides thus a total of eighteen. There are 14 silos for the coke batteries. Each coal component is stored in a separate silo. Each silo has a storage capacity of 1515 tons (35m high x 43 tons per meter). The level of every silo is measured and recorded per shift as follows:

- A rope with measure knots and a weight at the end is lowered into the silo until the weight rests on the coal.
- Three measurements are taken – left side, right side and center.
- The rope is pulled up and the amount of knots is counted.
- The average of the three levels is calculated.
- The Superintendent in charge calculates the tonnage – no adjustment for moisture.

- The ideal situation is to store all incoming inventory in the stockyard, this is done in an attempt to prevent the aging of inventory. As few as possible components are kept on hand. There is a designated area for each type of coal in the stockyard that is identified with signboards. The coal components are reclaimed from the stockyard storage area on conveyer belt CS4, through the crushing plant and thereafter on CR6B conveyor, where it passes over a belt scale. The belt scale measures tons per hour as well as total tons and stores the information on a PLC. The conveyer belt scales are tested on a weekly basis by Instrumentation. From the silos the coal is transported via a conveyer belt that is equipped with a scale to the blend bunkers.

3.4.2. PREPARATION OF INVENTORY

- The following shift personnel is responsible for the preparation of the coal inventory:
  - Superintendent, Coal Plant Production
  - One Control Centre Operator
  - Two conveyer belt Operators
  - Two feeder Operators

- The responsible Superintendent receives the official authorized memorandum when there are any changes to the coal blend. The applicable coal component percentages are used as input on the process computer system.

- Every side of the silos has weigh feeders at the bottom that are controlled by a process computer on which a set point has been captured. The weigh feeders release the different coal components out of the silos according to the set percentages. All is available on the MIS system which details the tonnage per coal component thus to record and monitor all deviations from set point. For each shift the Superintendent calculates the percentage of each coal component according to the printout thus to verify that the correct blend is used. An absolute variance of 3 percent and less on the total blend is accepted. Variances larger than 3 percent are usually due to human error during the input of the information onto the computer system / moisture / a blockage. The Manager monitors the blend and when required the discipline is increased. There is an alarm system installed which systematically stops the plant when a blockage occur for more than five minutes.

- The coal in the silos is tested on a daily basis for moisture content, type of coal etc. The results in respect of the moisture content is used as input onto the process computer system at the control room, the blend is adjusted systematically.

- Each feed mechanism has its own scale. Information from the weigh feeders is available. The shift personnel zero the weigh feeders on a daily basis and are calibrated by Instrumentation on a fortnightly basis (seven is calibrated one week and the other seven the next week). Instrumentation is responsible to keep the necessary records. Any problems are rectified immediately. Instrumentation is notified of any interim problems experienced. A record of all inspections by Instrumentation is kept in the control room.

- Certain coal components have to be crushed for example Burton and GG. The size of the coals determines the grade of the blend. There are 10 final coal blend silos (4 x 450 tons; 6 x 900 tons). Laboratory samples are taken during every shift. The coal can go through the crusher or can be bypassed through the chute before the components are mixed. The blend is weighed with the vibrating feeders at the bottom of the silos to determine whether the coal is being fed. The coal blend is released onto conveyer belts TO316 and TO317 (A Block) and TO318 and TO319 (B Block). The belts pass over a belt scale, that measures mass in tons per hour. The levels of the silos are assessed twice per shift by means of the dip rope method.

- The coal is transferred to the four service bunkers. Each bunker consists of 3 compartments and each bunker services two batteries. The four bunkers each have a storage capacity of 1650 tons. Visual estimate of inventory at the beginning and end of each shift. The service bunkers are equipped with a scale at the bottom of the bunker.

- The empty and loaded load car is weighed at the bottom of each service bunker and the information is automatically captured on the PLC. Mass accumulates daily to 22h00. When a scale is not operational the amount of ovens loaded is multiplied by 13.9 tons (dry mass).

3.4.3 INVENTORY RECORDS

- The opening inventory on the monthly inventory control schedule is the closing inventory of the previous month.

- The coal receipt is recorded on the tabulation according to the advised mine mass. The Controller at Raw Materials, Commercial Services does the necessary input onto system 500-08 (transport system). The wet as well as the dry mass on the advise is used as input. System 500-08 interfaces with SAP. Only the total dry mass appears on SAP. The Controller verifies the information on SAP on a weekly basis.

- The Coal consumption is recorded on the PLC (Programmable Logical Controller) and the information is systematically transferred to the Process Computer in the control room and is available on the MES system. The information is used as input onto SAP on a daily basis by the Senior Planner.

- An inventory count is carried out on a monthly basis. Premier mapping is responsible to take the aerial photographs at month end. Premier mapping has to provide the responsible Coordinator at the Coke Plant with the following information:
  - The map of the coal stockpiles that were photographed. The Superintendents at the Coke Plant then had to identify the stockpiles.
  - The volumes per stockpile.

The inventory adjustment is only carried out at the end of the next month.

- The Coordinator at the Coke Plant uses the same densities on a monthly basis to determine the mass of each stockpile of coal (densities X volume = mass). The density factors used already make provision for the moisture component.

- The Superintendents determine the mass of coal in the bunkers and silos at month end by taking a dip measurement. The wet mass is multiplied by a factor using the weigh feeder moisture to determine the dry mass.

- The mass received according to the tabulation is already the dry mass. The production system which records the consumption also record the dry mass, thus the monthly inventory control schedule is compiled by using the dry mass of the different types of coal. The Coordinator verifies the information with the advised mass.

- The rand values of the different coal types also remain the same on a monthly basis. The Coordinator does the necessary calculations to determine the inventory adjustment. An official memorandum detailing the adjustment is compiled and authorised by the Manager Raw Materials and the Works Manager, Iron Making before the adjustments are carried out on SAP by Commercial Services.

- A draft survey is carried out at the harbour on the imported coal. A fax is forwarded to the Coordinator at the Coke Plant in accordance with the dispatches.

- Both the manual and SAP inventory control schedules are forwarded to Finance.

3.4.4 MANAGEMENT ACCOUNTING

- The Senior Accountant receives both the manual and the SAP generated monthly inventory control schedules. The SAP schedule is considered to be the official document. The Senior Accountant ensures that the inventory balances on the two schedules agree. Differences are sometimes experienced due to SAP reservations, which have not been released; the necessary corrective action is taken. The posting to the general ledger accounts take place systematically.

- There is a control account to determine the input and output ratios.

- The Coke production is not captured on SAP and still has to be journalized by the Senior Accountant.

- Imported and local coal both has a separate general ledger.

- SFIN – is coal that is in transit (coal is still on the ship/ in the harbour). SFCS – as soon as the truckload of coal is received at the Works its status is changed systematically to SFCS by the Controller at Raw Materials, Commercial Services - now the coal can be consumed.

3.4.5 PURCHASE VARIANCE

- A fax is received from Logistics which details the type of coal, wet mass as well as the dry mass of the coal destined for Mittal Steel, Vanderbijlpark.

- A fax is received from the harbour that details the tonnage, the U.S. dollar value as well as the split between Mittal Steel, Vanderbijlpark and Mittal Steel, Newcastle. The invoice date is also stated and this is supposed to agree with the bill of lading date. The documentation in respect of the bill of lading is kept at the harbour.

- The Senior Accountant prepares a schedule that details the material code and tonnage. This is forwarded to the Controller at Raw Materials that does the input on SAP (only tonnage). SAP systematically calculates a provisional purchase variance between the standard value and the exchange rate on the date of input. The information is captured in a provision account.

- The harbour fax is also forwarded to Treasury. Treasury is responsible to transfer the funds to the bank account (exchange rate as on bill of lading date). There is no control over the time period before the transfer is carried out.

- Creditors are notified that a payment is due. The account has to be cleared. Payment has to be matched against the SAP order. SAP systematically calculates another purchase variance between the exchange rate on the date of input on SAP and the payment date. Payment is matched against the provision accounts.

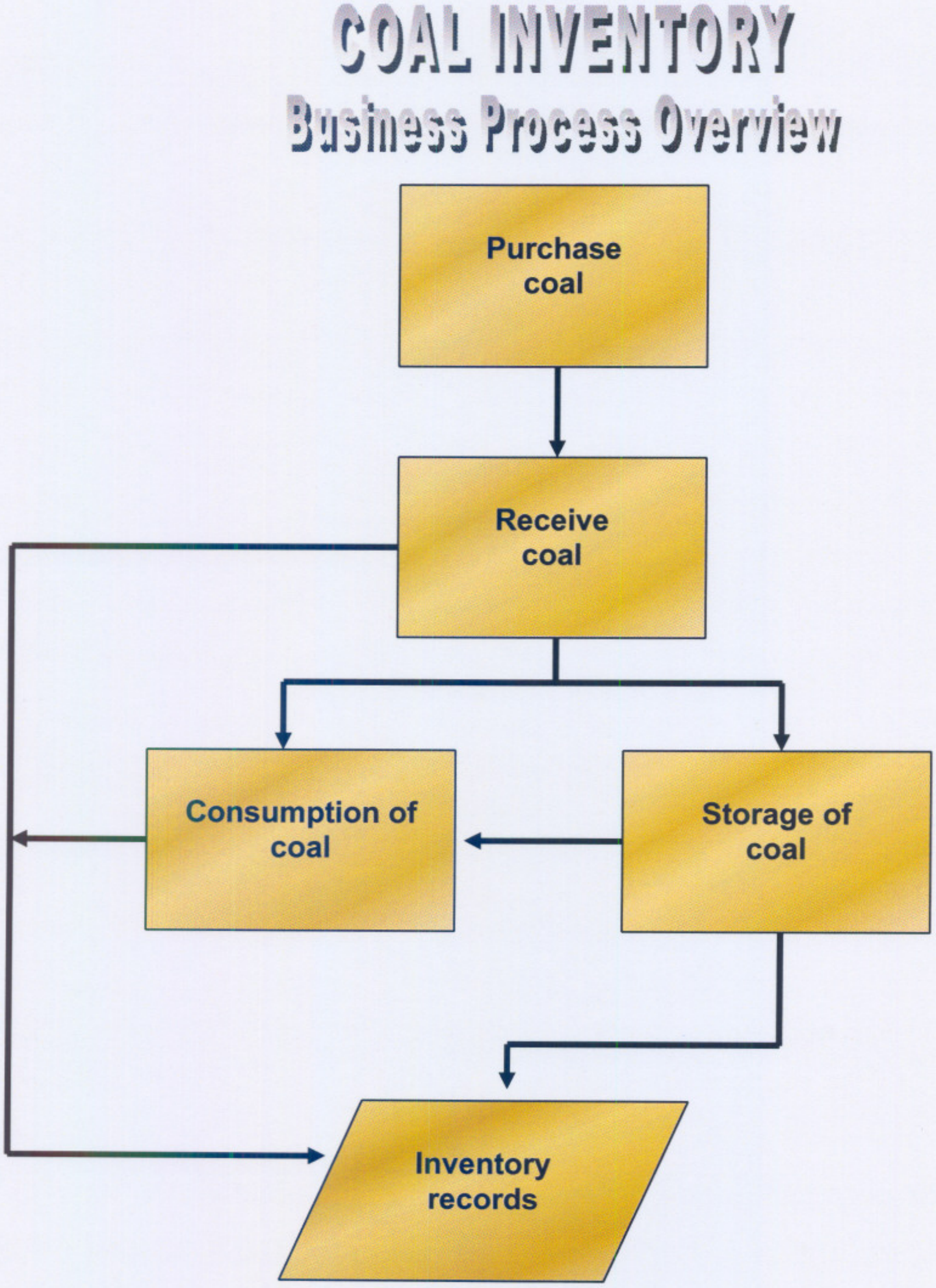
- Provisions are raised against the standard rate. Provision is also raised for:
  - Freight
  - Railage
  - Customs
  - Insurance
- A final fax is received from the harbour for all $ linked costs. Payment is matched against the provision. When the provision is insufficient the remainder of the payment forms part of the purchase variance.

3.4.6 DISTRIBUTION OF A SHIPLOAD COAL

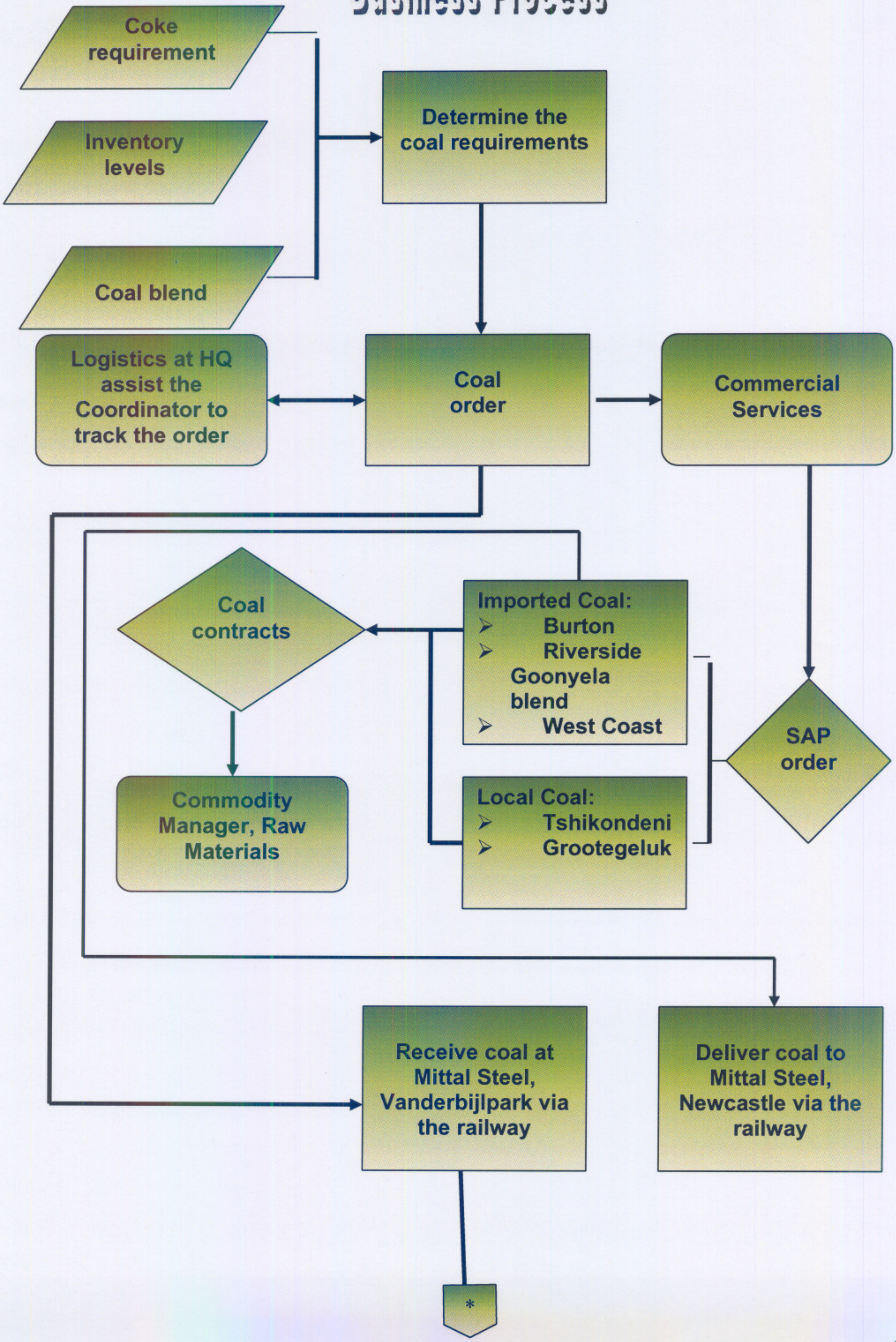
- Payment is made for the material.
- When the status of the coal changes to SFCS the Controller at Raw Materials prepares an excel spreadsheet with the following information, that is forwarded to the Senior Accountant:
  - Wet mass
  - Dry mass
  - Consignment number
  - Name of the ship.
- SAP only records the total tonnages received.
- The Senior Accountant receives a daily coal report from the harbour that details the coal that has been dispatched to the Works according to their records.
- The Senior Accountant reconciles the aforementioned information. Variances are followed up. It sometimes happens that a shortage of material is experienced and that coal is then re-routed.
- When a ship has been closed the reconciliation is finalized.
- The procedure will now be followed for every shipload.

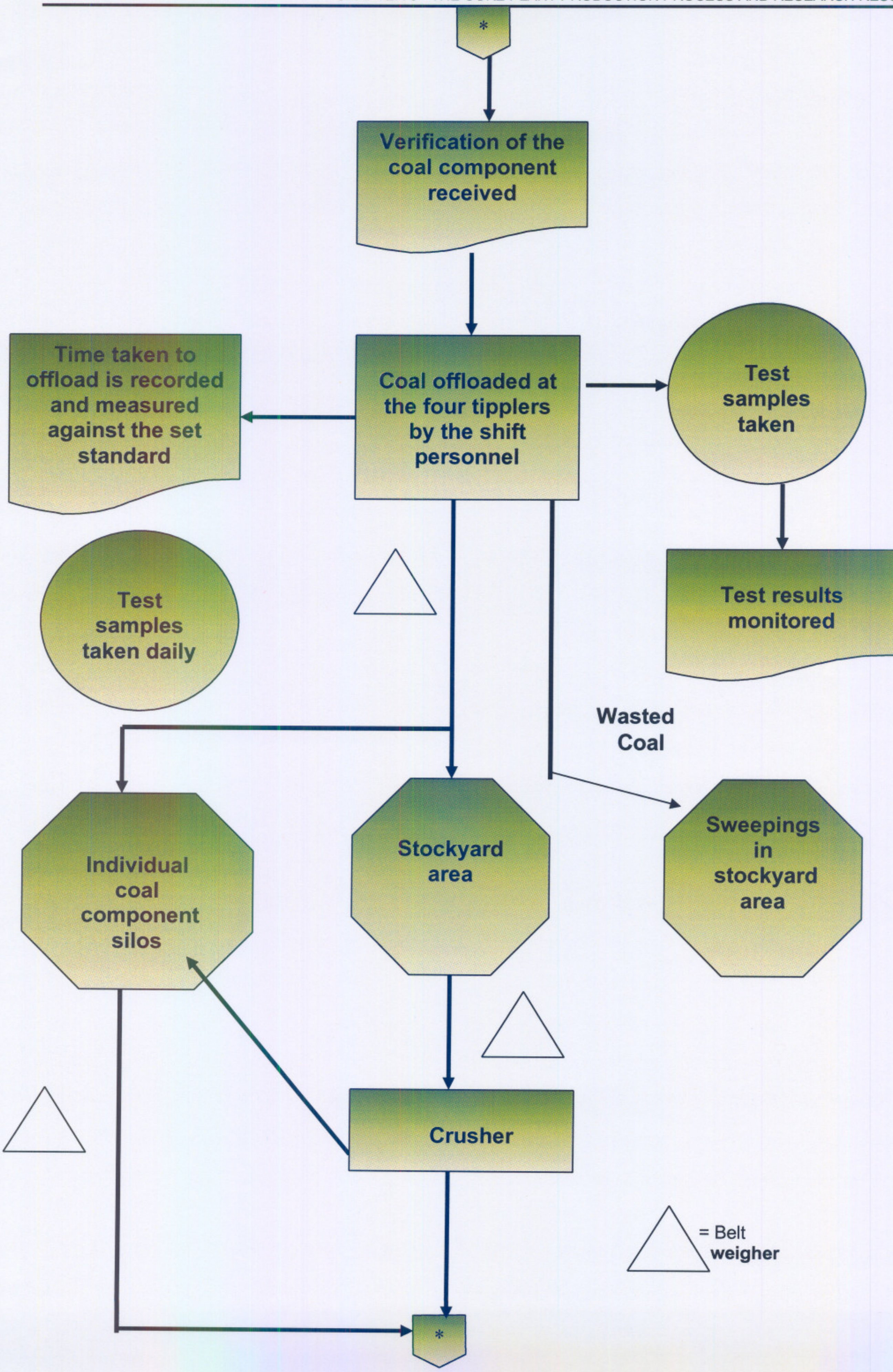
3.4.7 COAL INVENTORY – BUSINESS PROCESS OVERVIEW

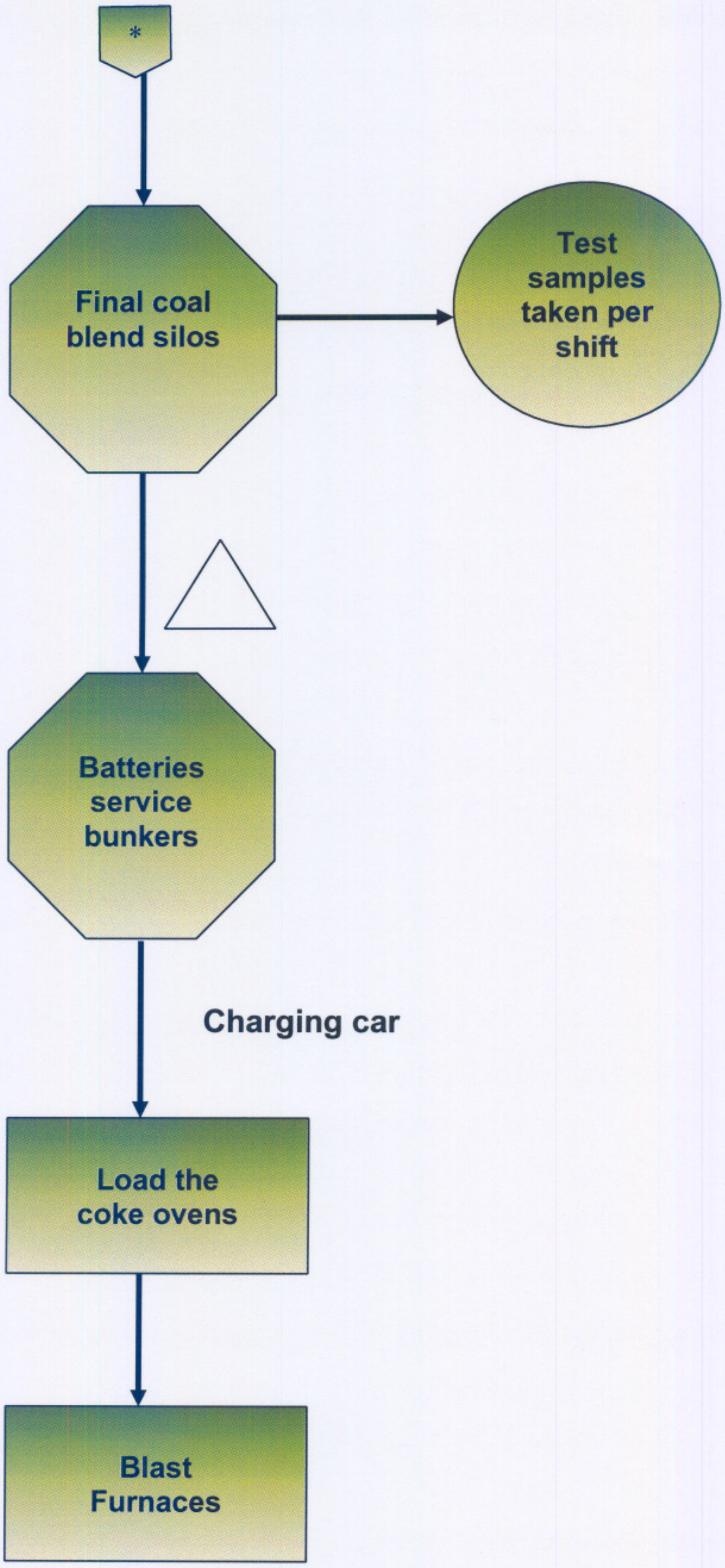
Figure 3.6: COAL INVENTORY – BUSINESS PROCESS OVERVIEW



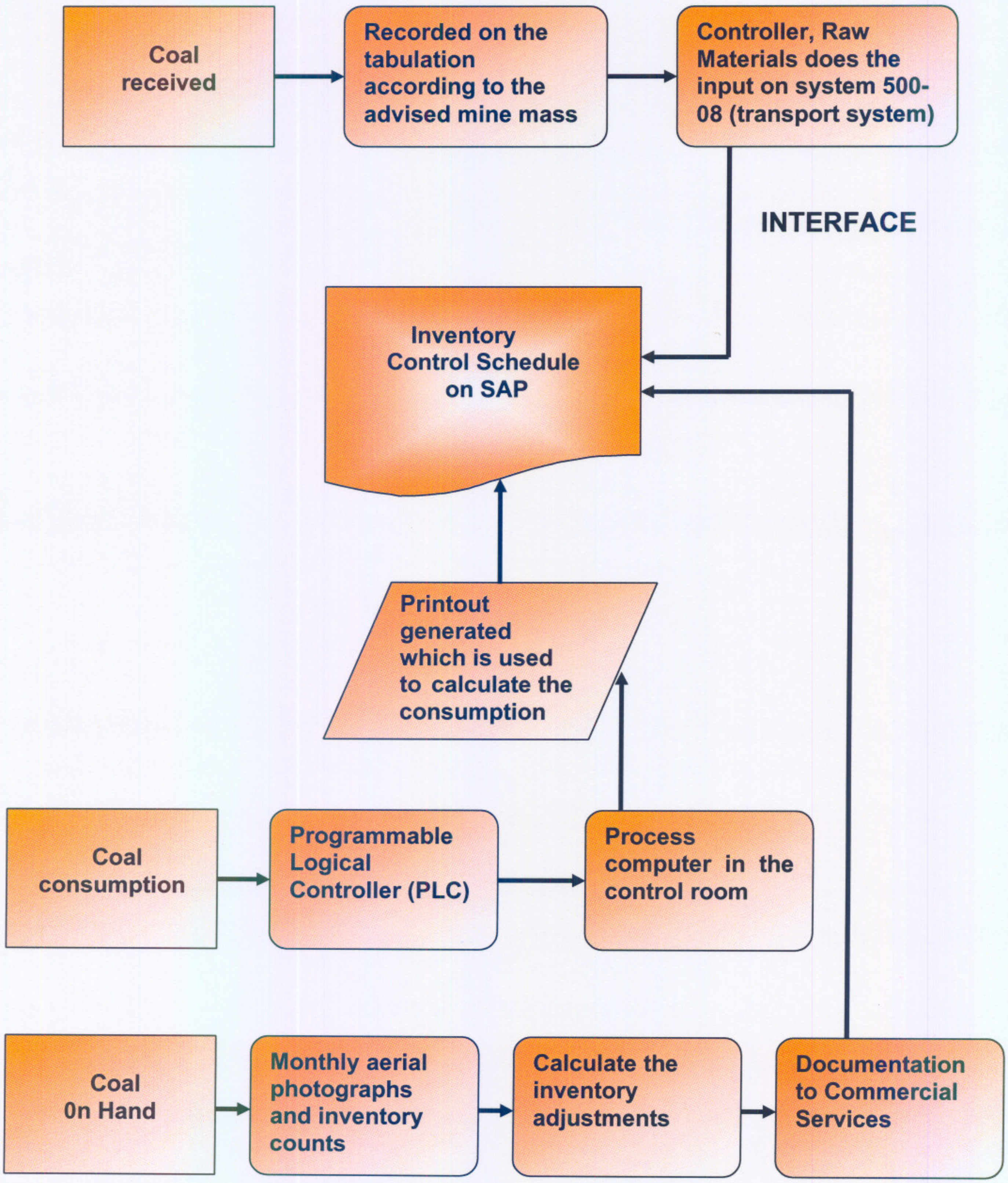
Business Process




*
Verification of the coal component received
Time taken to offload is recorded and measured against the set standard
Coal offloaded at the four tipplers by the shift personnel
Test samples taken
Test results monitored
Test samples taken daily
Wasted Coal
Individual coal component silos
Stockyard area
Sweepings in stockyard area
Crusher
= Belt weigher
*


*
Final coal blend silos
Test samples taken per shift
Batteries service bunkers
Charging car
Load the coke ovens
Blast Furnaces

Information Systems



3.5 CONTROL ENVIRONMENT ASSESSMENT

3.5.1 ASSESSMENT

An integral part of the internal control framework is the Control Environment.

The control environment has a pervasive influence over the way business activities and processes are conducted. It originates with Top Management, who set the tone within the company that influences the behaviour and attitude of employees.

Due to the nebulous nature of the topic, the control environment is assessed via a departmental survey of opinions. (*See questionnaire: CONTROL ENVIRONMENT, pages 95 – 97*)

As part of the audit process, the opinions of the Departmental Manager (2), Coke Plant (Top Management), the Manager (2), Coal Plant and the Manager (1), Coking (Senior Management) Engineers (4), Superintendents (6), (Middle Management) and Supporting Staff (7), (logistics personnel,) were canvassed relating to the *Importance* of a number of risk assertions/control measures as well as the *Compliance* with the control measure presented to them. The total respondents amounted to 22.

The contribution of this assessment was to determine the overall awareness and climate to what extent work (which includes inventory management systems) is being conducted.

These relate to the control environment within the Coke Plant department. Broad categories of risks assessed are:

- Integrity and ethical values.
- Management philosophy and operating style.
- Assignment of authority and responsibility.
- Organisational structure.
- Commitment to competence and quality.

The *Importance* of each risk assertion/control measure and the *Compliance* with the control measure were assessed on a scale of 1(low) to 10 (high).

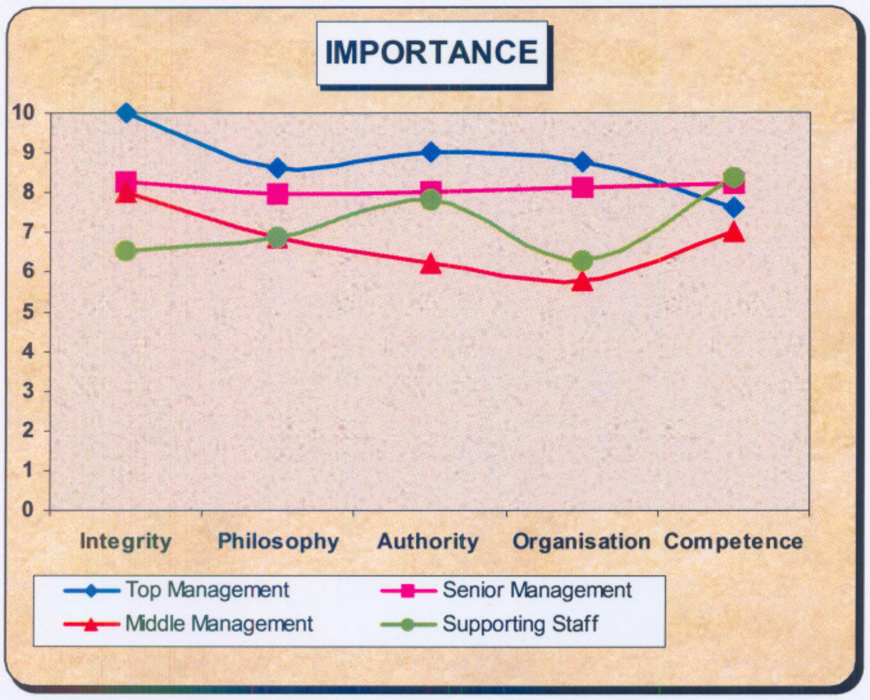
On interpreting the results it is necessary to be wary of the fact that assertion interpretation may be skewed between management and operational personnel due to interpretation and skill differences.

The scores are expressed graphically in the section below.

3.5.2 CONCLUSION AND AVERAGE SCORING GRAPHS

3.5.2.1 Importance *(Graph 3.1)*

Overall, the respondents regard the *Importance* of the risk components as medium to high, with a minimum score of 6.20 and a maximum score of 10.00.

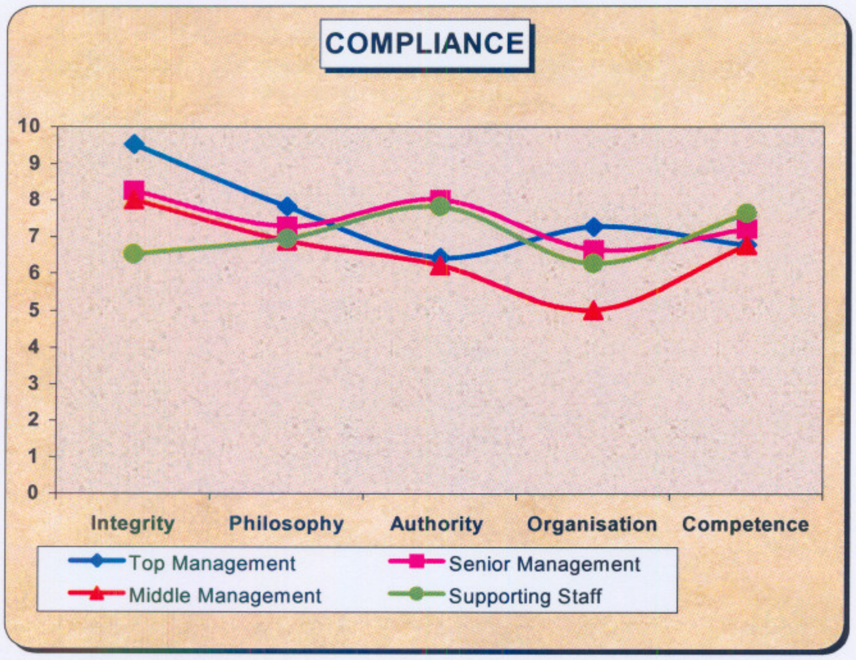


3.5.2.2 Compliance *(Graph 3.2)*

Overall, the respondents regard the *Compliance* with the control measures as medium to high, with a minimum score of 5.00 and a maximum score of 9.50.

The three risk categories that revealed the greatest deviation in opinion regarding *Compliance* are:

- *Integrity and ethical values.*
- *Assignment of authority and responsibility.*
- *Organisational structure.*



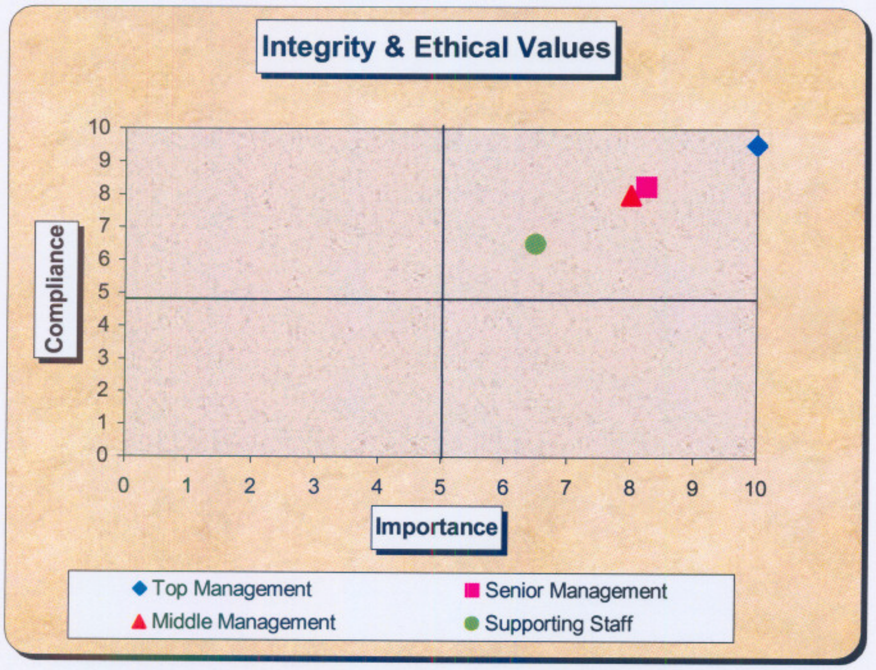
3.5.3 SCORING OF INDIVIDUAL RISK CATEGORIES

3.5.3.1 INTEGRITY AND ETHICAL VALUES *(Graph 3.3)*

The average *Compliance* scoring covered a range from 6.50 to 9.50.

Concern was expressed regarding the following:

- Management's commitment to integrity, ethical values and moral behaviour and their communication thereof through word and deed.
- Management's response towards violations of behavioural standards.



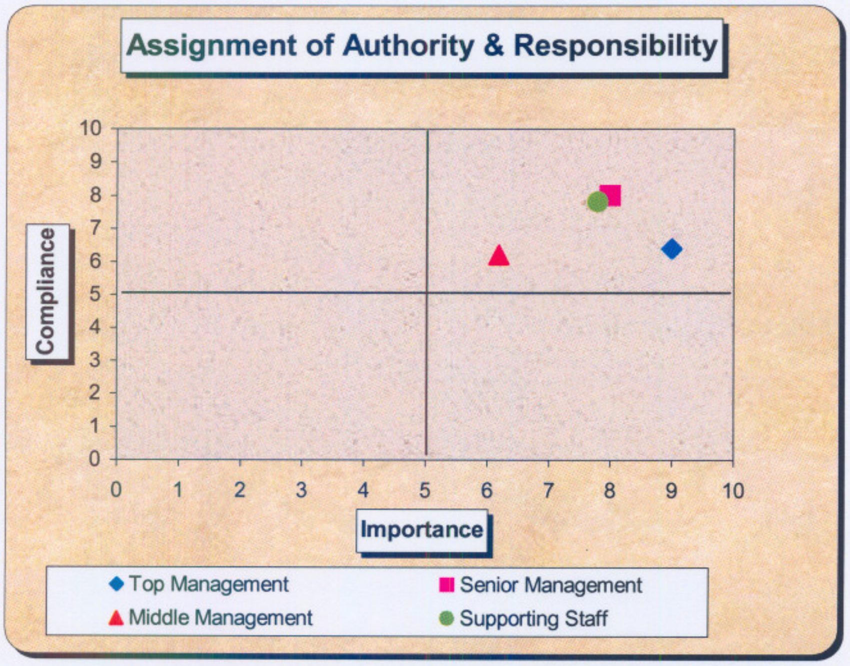
3.5.3.2 MANAGEMENT'S PHILOSOPHY & OPERATING STYLE *(Graph 3.4)*

3.5.3.3 ASSIGNMENT OF AUTHORITY AND RESPONSIBILITY *(Graph 3.5)*

The average *Compliance* scoring covered a range from 6.20 to 8.00.

The respondents documented the following shortcomings:

- The assignment of responsibility and authority to employees in agreement with their contracted objectives.
- The effective management of target dates.

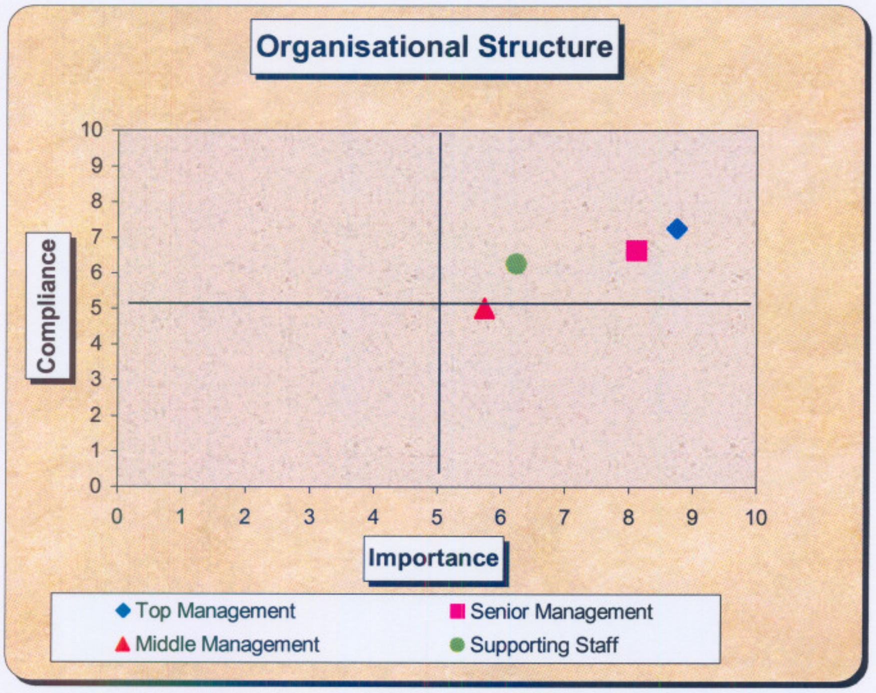


3.5.3.4 ORGANISATIONAL STRUCTURE *(Graph 3.6)*

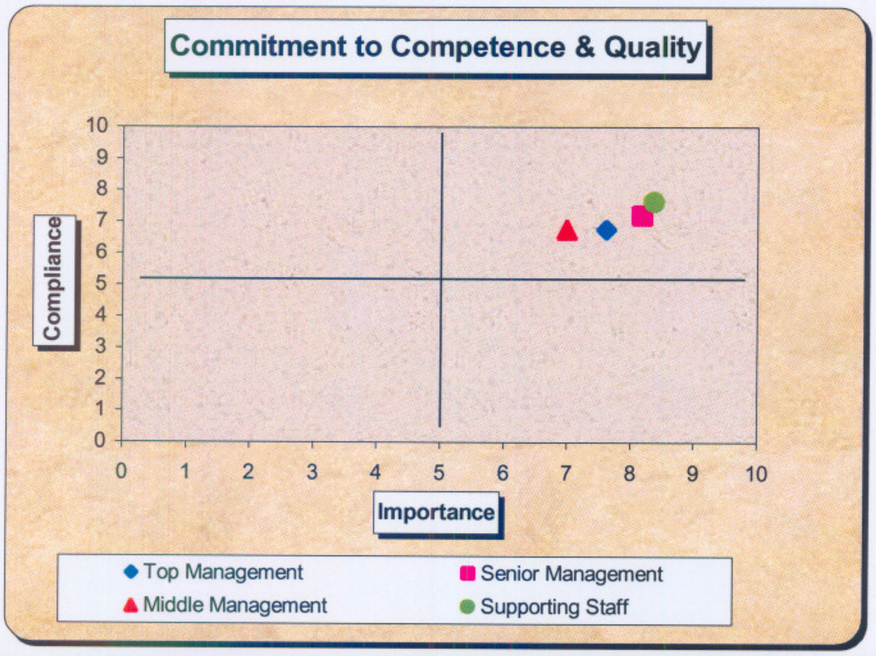
The average *Compliance* scoring covered a range from 5.00 to 7.25.

The respondents documented the fact that the related operational and service departments' do not assist sufficiently in achieving the objectives of the department.

Improving the control environment primarily via **communication and training** should increase the control environment's effectiveness.



3.5.3.5 COMMITMENT TO COMPETENCE AND QUALITY *(Graph 3.7)*



3.6 COKE PLANT – COAL INVENTORY

- As part of production planning and inventory control it is necessary to do detail audits on a two year basis to ensure that all the risks involved in any system are checked and preventative measures put in place to comply to legal demands.
- Furthermore new control techniques can be developed and improvements on practicalities in the systems can lead to better control and ensure audit compliance.
- Due to this fact a audit was conducted on the production planning and inventory control systems of the coke plant and the following audit report was compiled.
- Risks were identified by plant personnel in conjunction with the audit team.

RISK AND CONTROL MATRIX

Ref no	Risk	I	Control Technique	C	Audit Test	Test Result
1.	The coal requirements, quality and quantity, are not determined on a timely basis, thus resulting in a coal shortage.	9	1. The coal requirements are determined according to the coke requirements, the inventory levels of the bunkers, silos and in the stockyard as well as the required blend. The inventory levels in the bunkers and silos are measured every shift. The shift personnel estimate the stockyard inventory every evening. An official inventory count of the stockyard inventory is carried out on a monthly basis via aerial photographs. 2. Detail planning is carried out a month in advance. Import horizon is three months. Total planning is done 18 to 24 months in advance. The coal requirements are determined a month in advance. The Coordinator uses the estimated coke demand, the available plant capacity (with provision made for any planned short stops and maintenance) and the applicable coal blend to calculate the daily throughput and thus the daily coal requirements. This is done on an excel spreadsheet. There are standard minimum and maximum inventory levels, for local coal it is a minimum of 10 days' supply and for imported coal it is 20 days' supply. 3. A planning document is prepared on a monthly basis and is discussed on the monthly coal workgroup meeting. Logistics is informed in respect of the time and amount of coal inventory needed (train schedule).	9	➢ Review the calculation of the coal requirements for one month. ➢ Review the documentation forwarded to Logistics i.e. the coal requirements.	➢ The planning document for August was reviewed. ➢ The planning document with trains, truck and stocks schedules are forwarded to Logistics. ➢ The planning document was authorised by the Departmental Manager, Coke Plant.
2.	Changes in respect of coal requirements are not determined and communicated on a timely basis.	8	When there are any changes to the estimated coal requirements and/or coal is required urgently, the Coordinator liase with Logistics.	8	Review the communication document i.e. the last requirement change.	➢ The monthly coal requirements are discussed in the monthly coal workgroup meeting.

I = Importance rated 1 – 10
C = Compliance rated 1 – 10
(1 = low, 10 = high)

Ref no	Risk	I	Control Technique	C	Audit Test	Test Result
						➢ The Coordinator communicates with Logistics on a weekly basis. ➢ The destination plan is forwarded to Logistics on a weekly basis.
3.	Failure to order the required coal inventory.	9	1. The Coordinator places the necessary coal order. 2. The order memorandum, which is forwarded to Commercial Services, has to be authorised by the Departmental Manager, Coke Plant as well as the Business Unit Manager, Iron Making. 3. Commercial Services places the relevant coal order on SAP. For local coal the order is placed per trainload and for imported coal per shipload (consignment number). 4. The Coordinator verifies that the SAP order has been created thus to ensure that the coal can be received against the order upon arrival at the Works. 5. A new order for local coal is placed every month.	9	➢ Review the coal orders for the last six months. ➢ Authorisation of the order memorandum for the last six months. ➢ View the latest order on SAP to ensure accuracy. ➢ Ensure that the Coordinator does not have access to change the order on SAP.	➢ The coal orders for the period January 2005 to August 2005 was available. ➢ The coal orders were authorised. ➢ The order for February 2005 has been captured accurately on the system. ➢ The Coordinator does not have access to change or add an order on SAP.
4.	Placement of an unauthorised coal order.	4	The order memorandum, which is forwarded to Commercial Services, has to be authorised by the Departmental Manager, Coke Plant as well as the Business Unit Manager, Iron Making.	8	Authorisation of the order memorandum for the last six months.	The order memorandums for the period February 2005 to August 2005 have been authorised.
5.	Failure to monitor the supply of coal that has been ordered could result in a coal shortage.	8	The Coordinator daily receives information from Logistics personnel at Head Office via electronic mail, which enables the tracking of the order for example when the train will arrive, any delays etc. Delays could lead to a blend change, cut back in production and ultimately an in-/decrease in inventory levels to allow for any delays. Unforeseen circumstances i.e. non-performance from Spoornet can result in shortages.	9	➢ Review communication i.e. the tracking of the last order. ➢ Enquire about delays experienced. ➢ Discuss the actions taken i.e. delays with the Commodity Manager, Raw Materials.	**Report** ➢ Daily communication received from Logistics via electronic mail. (Weekly program Monday to Sunday). ➢ ***Delays are experienced on a regular basis due to non-performance from Spoornet.*** ➢ ***There is not a non-performance clause included in the Spoornet contract.***
6.	Changes in the coal blend are not properly authorised.	2	1. The coal blend is changed from time to time. The Manager, Coal Plant and the Manager, Coking determine the required blend. 2. When a blend component has been fully utilized the blend is changed.	9	➢ Review the documentation for the last three blend changes. ➢ Authorisation of the last three blend changes	➢ The documentation for the last three blend changes was available. ➢ The last three blend change

I = Importance rated 1 – 10
C = Compliance rated 1 – 10
(1 = low, 10 = high)

Ref no	Risk	I	Control Technique	C	Audit Test	Test Result
			3. A memorandum regarding the blend change is prepared which has to be authorised by the Departmental Manager, Coke Plant as well as the Business Unit Manager, Iron Making.		memorandums.	memorandums have been authorised.
7.	Changes to the coal blend are not forwarded timely to the Coordinator to determine the coal requirements.	7	The Coordinator is at all times aware of blend changes.	8	➢ Enquire from the Coordinator how and when he is informed of a blend change. ➢ Actions taken by him as result of the blend change.	➢ Any planned blend change is taken into account when the monthly planning is prepared. ➢ Discussed as part of the monthly coal workgroup. ➢ The Coordinator receives the authorised blend change memorandum.
8.	The contract specifications in respect of coal received are not being enforced.	8	1. The import contracts are usually negotiated for a year. The Commodity Manager, Raw Materials is responsible to manage the coal contracts. A monthly coal workgroup meeting is held to discuss any problems in respect of the coal supply. 2. The two types of local coal received at the Coke Plant are: ➢ Tshikondeni ➢ Grootegeluk. Tshikondeni is an ongoing contract. For the Grootegeluk coal a ten-year contract has been negotiated but has not yet been signed by all the parties. Line management is not satisfied with the exchange rate clause. The plant personnel monitor the receiving and quality of the coal according to the contract but the Commodity Manager manages it. Line management is not responsible to enforce penalties.	8	➢ Review the agenda and notes from the last coal workgroup meeting. ➢ Discuss the actions taken by the Commodity Manager, Raw Materials i.e. the enforcement of contract specifications. ➢ Enquire from the Commodity Manager who is responsible to ensure that the agreed discount is granted.	➢ **Report** ➢ The agenda and notes from the July workgroup meeting were available. ➢ The Grootegeluk contact has not yet been finalised due to disputes regarding the volume and price. ➢ Import contracts are negotiated on a yearly basis. (Addendums used for adjustments). ➢ For import coal Logistics at Vdbp office is responsible to enforce the quality specifications and ensure that the penalties are raised. They agree the certificate that accompanies the shipment with the certificate provided when the train is offloaded. ➢ For local coal the Departmental Manager, Finance is responsible to ensure the quality specifications are met. According to the Departmental Manager, Finance it is line management's

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C = Compliance rated 1 – 10
(1 = low, 10 = high)

Ref no	Risk	I	Control Technique	C	Audit Test	Test Result
						responsibility. ➢ ***Currently no formal Works procedure and corporate policy in place.*** ➢ ***Communication gaps.***
9.	The imported coal is not allocated correctly between Mittal Steel, Vanderbijlpark and Mittal Steel, Newcastle.	9	1. The imported coal is offloaded at the Richardsbay harbour. When there is no available space at Richardsbay the inventory is received at the Durban harbour – this recently happened for the first time in five years. 2. The coal is either dispatched to the Vanderbijlpark and/or Newcastle Works or is kept in a store at the harbour. The allocation ratio is determined on the monthly coal workgroup meeting when the coal requirements for Vanderbijlpark and Newcastle are estimated for the next eighteen months (excel spreadsheet). 3. The inventory in the store is dispatched as soon as possible.	6	➢ Review the allocation ratio determined for the last shipment. ➢ Agree to the coal received at the Vanderbijlpark Works.	➢ The documentation from Mittal Steel Logistics for the allocation of the last shipment is available. ➢ Information is received from Logistics i.e. of progress with the dispatch of the imported coal. ➢ The Senior Accountant carries out the reconciliation (see risk 34).
10.	The incoming coal cannot be identified resulting in the incorrect type of coal being used at the coke batteries.	9	1. There are four types of imported coal that are received at the coke plant: ➢ Burton - Australia ➢ Goonyela - Australia ➢ Bulli - Australia ➢ West Coast Premium - Nieu-Zeeland 2. The two types of local coal received at the Coke Plant are: ➢ Tshikondeni. ➢ Grootegeluk. 3. The imported coal and the local coal are used to make up the blend that is used in the coke batteries. 4. When either imported/local coal is dispatched to the Works a fax is forwarded from either the harbour or the mine to the Coordinator. The fax details the following information: ➢ Consignment number ➢ Coal grade ➢ Tonnage ➢ Number of trucks ➢ Departure time ➢ Departure date ➢ Mittal Steel train number ➢ Spoornet train number ➢ Destination ➢ Wagon numbers ➢ Gross mass per wagon ➢ Tare mass per wagon ➢ Nett mass per wagon Every type of coal has a different	7	➢ Review the fax received from the mine for the last three consignments. ➢ Review the fax received from the harbour for the last three consignments. ➢ Agree the mass received to SAP. ➢ Enquire about the extent of the problem i.e. incorrect documentation.	➢ The faxes for the last three consignments from the mines were available. ➢ The faxes from the harbour for the last three consignments were available. ➢ The mass of a consignment number was agreed to the information on SAP. Found to be in order. ➢ No problems experienced recently. Coal is not offloaded when the documents are inaccurate.

I = Importance rated 1 – 10
C = Compliance rated 1 – 10
(1 = low, 10 = high)

Ref no	Risk	I	Control Technique	C	Audit Test	Test Result
			batch number and a SAP article number for identification purposes. ***Problems have been experienced in the past when the wrong coal component has been offloaded due to the fact that the wrong batch number has been stated on the documentation.*** 5. The different coal components can't be distinguished from one another through visual inspection. When there is uncertainty in respect of a coal component laboratory tests are performed to verify the type of coal. Sampling of each train is carried out.			
11.	The incorrect zone has been identified for the offloading of the coal. This could result in the contamination/ mixing of the coal.	**9**	1. The coal inventory at the Vanderbijlpark Works is received via rail transport only (tip trucks). 2. Upon arrival at the Works the responsible Superintendent, Coal Plant verifies the truck numbers with the applicable fax received. When there is any variance the material is not offloaded until it has been verified with either, the mine or the Logistics Controller /Coordinator at the harbour. It has happened in the past that railway trucks have been switched on route to the Works. 3. The coal inventory that is offloaded is stored in the stockyard and/or is routed to the silos. 4. The ideal situation is to store all incoming inventory in the stock-yard. This is done in an attempt to prevent the aging of inventory. As few as possible components are kept on hand. There is a designated area for each type of coal in the stockyard that is identified with signboards. The official chart of the stockyard area has not yet been updated since it has been extended and changes have been made to its layout. This has been done to increase the storage capacity. The coal components are reclaimed from the stockyard storage area on conveyer belt CS4 and thereafter CR6B where it passes over a belt scale. The belt scale measures tons per hour as well as total tons and stores the information on a PLC. 5. The PLC system is set thus to prevent the coal from being offloaded at the wrong place.	**6**	View the identification of the different areas in the stockyard for the offloading of the different types of coal.	Visited the stockyard area on 25 July 2005. The signboards are clearly visible.
12.	A shortage of coal is experienced at the	**8**	Delays are experienced in respect of the delivery of the coal due to	**5**	Discuss actions taken with the Commodity	**Report** ➢ ***Delays are***

I = Importance rated 1 – 10
C = Compliance rated 1 – 10
(1 = low, 10 = high)

Ref no	Risk	I	Control Technique	C	Audit Test	Test Result
	Coke Plant.		insufficient performance from Spoornet and Portnet. Logistics is responsible to monitor and manage the contracts and to ensure the applicable penalties are raised.		Manager, Raw Materials.	***experienced on a regular basis due to non-performance from Spoornet.*** ➢ ***There is not a non-performance clause included in the Spoornet contract.*** ➢ ***The risk will increase if the decision to lower inventory levels is enforced.***
13.	The railway trucks are not being offloaded at the coke plant within the specified time period. This could result in penalties being raised by Spoornet.	**5**	1. The offloading time of the railway trucks are measured from the time the trucks have been requested. 2. The time is recorded from the start of the first truck being tipped until the last truck has been tipped. An average per railway truck is calculated (the standard is seven minutes per truck). The information is recorded on the applicable shift sheet. Turnaround time is monitored. 3. Graphs are prepared on a monthly basis to monitor any variances. Results are discussed on the monthly Quality meeting. 4. Rail Transport also measures the time taken to offload the trucks. Penalties are raised on a regular basis for standing time. These problems are mainly experienced due to the fact that there isn't an allocated locomotive for the coal inventory alone.	**7**	➢ Review the measurement of the time taken to offload a trainload coal. ➢ Review the graphs for the last month. ➢ Discuss monitoring with the Manager, Coal Plant as well as the corrective actions taken. ➢ Enquire from the Commodity Manager, Raw Materials about the penalties raised for standing time.	**Report.** ➢ Documentation in respect of trains offloaded within a 24 hour period is available. ➢ ***The graphs for July are available. Actual time taken is out of the planned limits.*** ➢ ***Standing time is being raised and paid.*** ➢ The Manager, Coal Plant, monitors the graphs on a monthly basis. The fact that the coal is sometimes very wet has an impact on the performance. Currently no corrective actions. ➢ Reported as part of the month plan. Reported to the Departmental Manager, Coke Plant.
14.	The coal mass received is not verified.	**8**	1. The ship is weighed before and after the cargo has been offloaded. 2. The coal is not weighed at the incoming weighbridge. 3. The Superintendent on shift does not compare the advised mass with the actual weighed mass received. 4. The Coordinator compares the weighed mass with the mine/harbour advised mass on a weekly basis on an excel spreadsheet. This was only up to date until March 2005. The deviation is recorded per	**8**	➢ Review the comparison for the last two months prepared by the Coordinator between the actual weighed mass and the advised mass. ➢ Discuss monitoring with the Manager, Coal Plant as well as action taken.	**Report.** ➢ ***The comparison for January 2005 and February 2005 are available. The information is however inaccurate and incomplete.*** ➢ ***Clause in the contract that specifies a 2 % variance.*** ➢ Followed up when there is a large

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			trainload. The actual mass is always less than the advised mass. 5. The information is forwarded to the Manager, Coal Plant for monitoring purposes. The information is included on his weekly report. No corrective action is taken as payment is made according to the advised mass. 6. The railway trucks are offloaded at the 4 tipplers. The coal to be stacked in the stockyard is weighed with a conveyer belt scale, CR3, when offloaded. Calibration of scales carried out once per month. CR3 has two belt scales, which measure tons per hour, and total tons: ➢ North scale for Tipper 1,4 (Belt CR1) ➢ South scale for Tipper 2,3 (Belt CR2) The Process Controllers zero the scales take the readings and record the results on a shift sheet. The information is stored in the PLC (Programmable Logic Controller) as well. The scales measure "wet" mass and no compensation is made for the moisture content.		➢ Discuss the contract specifications i.e. mass variances with the Commodity Manager, Raw Materials.	variance.
15.	There are no documents in respect of the analysis of the coal received at the coke plant from the harbour/ mine.	6	1. A draft survey is carried out at the harbour on the imported coal. A fax is forwarded to the Coordinator at the coke plant in accordance with the dispatches. 2. The fax received from the harbour/ mine contains information in respect of the mass and sometimes the ash. The information is used when the dry mass is captured on system 500-08.	7	➢ Review the draft survey certificate from the harbour for the last coal shipment. ➢ Review the fax received from the mine for the last three consignments. ➢ Review the fax received from the harbour for the last three consignments.	➢ The quality certificates are received at Logistics. ➢ The draft survey certificate was available. ➢ The faxes for the last three consignments from the mines were available. ➢ The faxes from the harbour for the last three consignments were available.
16.	The coal received is not tested on a regular basis at the plant to ensure the quality of the material.	8	1. Samples are taken at the offloading of the first ten railway trucks as well as the last ten trucks. 2. Tests are performed to determine the coal component, volatile elements as well as the moisture content. 3. The information is available via the database. Graphs are prepared on a monthly basis to monitor any variances. 4. Results are discussed on the monthly quality meeting. Any	8	➢ Review the graphs for the previous month. ➢ Discuss the monitoring and corrective action taken with the Manager, Coal Plant.	➢ The graphs for July were available. ➢ Daily monitored by the Manager, Coal Plant. Contact the mine when problems are experienced. ➢ A complaint system will be implemented. ➢ Samples need to be analyzed more

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			variances are also discussed with the sales representative thus to ensure that corrective action is taken.			frequently, especially for moisture content.
17.	When the coal is not according to specifications no preventative action is taken.	7	1. Tests are performed to determine the coal component, volatile elements as well as the moisture content. 2. The information is available via the database. Graphs are prepared on a monthly basis to monitor any variances. 3. Results are discussed on the monthly quality meeting. Any variances are also discussed with the sales representative thus to ensure that corrective action is taken.	8	See risk 16.	
18.	The coal that is wasted when the railway trucks are offloaded is not recovered.	6	1. The coal that is wasted while being offloaded is dumped on the sweepings stockpile in the stock-yard with a front-end loader or dump trucks. 2. Coals which fall from the conveyer belts are loaded back onto the conveyer. 3. The sweepings for the past three months accumulated to ± 15 000 tons. The sweepings coal does not have a value on the monthly Inventory Control sheet (SAP). 4. The sweepings are recorded at R100-00 per ton. 5. Sweepings are also consumed in the batteries.	8	➢ Review the recording of sweepings on SAP. ➢ Agree to the monthly inventory count. ➢ Enquire about the recording of the sweepings.	➢ Sweepings are not recorded on SAP. The Senior Accountant prepares a manual journal. ➢ Sweepings are recorded against the rail tariff (R100/tons). ➢ High volume. Sweepings 15000 tons.
19.	The sweepings are not being monitored.	2	Low volume. Monitored as part of the monthly inventory counts.	9	Discuss monitoring with the Manager, Coal Plant.	Monitored as part of the monthly inventory counts. An average density is used.
20.	The mass measurements from the conveyer belt scales are inaccurate.	7	1. The conveyer belt scales are tested on a weekly basis by Instrumentation. Calibration of scales once per month. 2. Each feed mechanism has its own scale. Information from the weigh feeders is available. The shift personnel zero the weigh feeders on a daily basis and are calibrated by Instrumentation on a fortnightly basis (seven is calibrated in one week and the other seven the next week). Instrumentation is responsible to keep the necessary records. Any problems are rectified immediately. Instrumentation is notified of any interim problems experienced. A record of all inspections by Instrumentation is kept in the control room.	7	➢ Review the records of the inspections carried out by Instrumentation kept in the control room. ➢ Review the documentation kept by Instrumentation.	**Report.** ➢ No records kept in the control room. ➢ ***No schedule available at present at Instrumentation Usually once per month depending on the availability of the plant. Last calibration carried out on 20 April 2005.***
21.	The incorrect coal	1	1. The responsible Superintendent	9	➢ Review the	➢ A graph in respect

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	blend is used in the coke batteries.	0	receives the official authorized memorandum when there are any changes to the coal blend. The applicable coal component percentages are used as input on the process computer system. 2. Every side of the silos has weigh feeders at the bottom that are controlled by a process computer on which a set point has been captured. The weigh feeders release the different coal components out of the silos according to the set percentages. 3. A printout is available which details the tonnage per coal component thus to record and monitor all deviations from set point. For each shift the Superintendent calculates the percentage of each coal component according to the printout thus to verify that the correct blend is used. An absolute variance of 3 percent and less on the total blend is accepted. Variances larger than 3 percent are usually due to human error during the input of the information onto the computer system / moisture / a blockage. 4. The manager monitors the blend and when required the discipline is increased. 5. There is an alarm system installed which automatically stops the plant when a blockage occur for more than five minutes. 6. The coal in the silos is tested on a daily basis for moisture content, type of coal etc. The results in respect of the moisture content is used as input onto the process computer system at the control room, the blend is adjusted programmatically.		calculation of the deviation by the Superintendent for one shift. ➢ Report to management. ➢ Monitoring by Manager, Coal Plant and corrective actions taken. ➢ Test results in respect of moisture for one day.	of the deviations for the period 1 to 24 July is available. ➢ Monitored by the Manager, Coal Plant on a daily basis per shift. Deviations usually due to blockage (wet coal). ➢ No in-time test result exists, and therefore moisture compensation is not done timely, which can and will result in inventory losses.
22.	Failure to crush the coal as required.	8	1. Certain coal components have to be crushed for example Burton and GG. The size of the coals determines the grade of the blend. 2. There are 10 crushed coal silos (4 x 450 tons; 6 x 900 tons). 3. Laboratory samples are taken during every shift. 4. The coal can go through the crusher or can be bypassed through the chute before the components are mixed. 5. The blend is weighed with the vibrating feeders at the bottom of the silos to determine whether the coal is being fed. The coal blend is released onto conveyer belts TO316 and TO317 (A Block) and	7	Discuss monitoring actions with the Manager, Coal Plant.	➢ Monitored on a daily basis. Crushers are changed every second day. ➢ A selective crushing plant is in operation when reclaiming of components is being done. Components are crushed individually, when out of operation the blend crushers are utilized.

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			TO318 and TO319 (B Block). The belts pass over a belt scale which measures mass in tons per hour. 6. The levels of the silos are assessed twice per shift by means of the dip rope method. 7.			
23.	Failure to weigh the consumption of coal at the coke batteries.	8	1. The coal is transferred to the four service bunkers. Each bunker consists of 3 compartments and each bunker services two batteries. The four bunkers each have a storage capacity of 1650 tons. 2. Visual estimate of inventory at the beginning and end of each shift. 3. The service bunkers are equipped with a scale at the bottom of the bunker. 4. The empty and loaded load car is weighed at the bottom of each service bunker and the information is programmatically captured on the PLC. Mass accumulates daily to 22h00. When a scale is not operational the amount of ovens loaded is multiplied by 13.9 tons (dry mass).	8	➢ Review the daily report i.e. of the visual estimate of the inventory levels for one day. ➢ Review the consumption report prepared by the Superintendent for one day.	➢ Daily reports are available. ➢ The consumption report was available.
24.	Physical inventory counts are not carried out on a regular basis.	7	1. The level of every silo is measured and recorded per shift (recorded on the daily report) as follows: ➢ A rope with measure knots and a weight at the end is lowered into the silo until the weight rests on the coal. ➢ Three measurements are taken – left side, right side and centre. ➢ The rope is pulled up and the amount of knots is counted. ➢ The average of the three levels is calculated. ➢ The Superintendent in charge calculates the tonnage – no adjustment for moisture. 2. An inventory count is carried out on a monthly basis. Premier Mapping is responsible to take the aerial photographs at month end. Premier Mapping has to provide the responsible Coordinator at the Coke Plant with the following information: ➢ The map of the coal stockpiles that were photographed. The Superintendents at the coke plant then had to identify the stockpiles. For the past two months the Superintendents were however requested to draw a map of the stockpiles in advance thus to ensure the accuracy and completeness thereof.	8	➢ Review the daily report i.e. of the visual estimate of the inventory levels for one day. ➢ Review the calculation of one month's inventory adjustments. ➢ Enquire about the accuracy of the aerial photographs. ➢ Enquire how regularly the densities used are verified.	**Report.** ➢ Daily reports are available. ➢ Reviewed the calculation of the inventory adjustments for the last two months. ➢ The densities were determined during the week of 18 February 2005. To be adjusted on the inventory adjustment calculations by the Coordinator as soon as the information is received. ***Not tested and calculated on a regular basis.*** ➢ ***Aerial photographs not considered to be accurate. No inventory adjustments made according to aerial photographs taken on 4 April 2005.***

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			➢ The volumes per stockpile. The inventory adjustment is only carried out at the end of the next month. The Coordinator at the coke plant uses the same densities on a monthly basis to determine the mass of each stockpile of coal (densities X volume = mass). Two to three months ago there was a project to determine the densities of the different coal types. There were however little variance with the densities that are currently being used. The density factors used already make provision for the moisture component. The Superintendents determine the mass of coal in the bunkers and silos at month end by taking a dip measurement. The wet mass is multiplied by a factor of 0.94 to determine the dry mass. The mass received according to the tabulation is already the dry mass. The production system which records the consumption also record the dry mass, thus the monthly Inventory Control schedule is compiled by using the dry mass of the different types of coal. The Coordinator verifies the information with the advised mass.			➢ ***The authorised policy in respect of inventory adjustments is not being adhered to. "Accounting records will only be adjusted in cases where the counted inventory of a total of a commodity exceeds the book inventory by 5% or more, or where the counted inventory of a total of a commodity reflects a shortage of more than 2.5%."***
25.	The inventory adjustments are not properly authorised.	**4**	1. The rand values of the different coal types also remain the same on a monthly basis. 2. The Coordinator does the necessary calculations to determine the inventory adjustment. 3. An official memorandum detailing the adjustment is compiled and authorised by the Departmental Manager, Coke Making and the Business Unit Manager, Iron Making before the adjustments are carried out on SAP by Commercial Services.	**7**	Review the documentation i.e. the inventory adjustments for the last three months.	Adjustments were authorised by the Departmental Manager, Coke Plant; Departmental Manager, Finance and the Business Unit Manager.
26.	Inventory adjustments are not being monitored on a monthly basis to determine trends and thus whether corrective actions need to be taken.	**6**	The inventory adjustments are authorized by the Departmental Manager, Coke Plant, the Departmental Manager, Finance and the Business Unit Manager.	**7**	Review the documentation i.e. the inventory adjustments for the last three months.	Adjustments were authorised by the Departmental Manager, Coke Plant; Departmental Manager, Finance and the Business Unit Manager.
27.	The purchase of coal is not recorded completely, accurately and on a	**8**	1. The coal receipt is recorded on the tabulation according to the advised mine mass. The Controller at Raw Materials,	**8**	Agree one month's mine advice with the information on SAP.	Was done for July 2005.

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	timely basis on the monthly inventory control schedule.		Commercial Services does the necessary input onto system 500-08 (transport system). The wet as well as the dry mass on the advise is used as input. 2. System 500-08 interfaces with SAP. Only the total dry mass appears on SAP. The Controller verifies the information on SAP on a weekly basis. Problems are currently experienced with the integrity of data transferred from system 500-08 to SAP.			
28.	The consumption of coal at the coke plant is not recorded completely, accurately and on a timely basis on the monthly inventory control schedule.	**8**	1. The Coal consumption is recorded on the PLC (Programmable Logical Controller) and the information is programmatically transferred to the process computer in the control room. 2. A printout is generated by the process computer which is used by the Superintendent to calculate the consumption and prepare an excel spreadsheet. 3. The information is used as input onto SAP on a weekly basis (Thursdays) by the Coordinator.	**8**	➢ Review the consumption report prepared by the Superintendent for one day. ➢ View the input of the information on SAP for one month.	➢ The consumption report was available. ➢ Input on SAP was accurate.
29.	The monthly inventory control schedule is incomplete and inaccurate.	**7**	4. The Senior Accountant receives both the manual and the SAP generated monthly inventory control schedules. The SAP schedule is considered to be the official document. The Senior Accountant ensures that the inventory balances on the two schedules agree. Differences are sometimes experienced due to SAP reservations, which have not been released; the necessary corrective action is taken. 5. The posting to the general ledger accounts take place programmatically. 6. There is a control account to determine the input and output ratios. 7. The coke production is not captured on SAP and still has to be journalized by the Senior Accountant. 8. Imported and local coal both has a separate general ledger. 9. SFIN – is coal that is in transit (coal is still on the ship / in the harbour). 10. SFCS – as soon as the truckload of coal is received at the Works its status is changed systematically to SFCS by the Controller at Raw Materials, Commercial Services – now the coal can be consumed.	**7**	➢ Agree the SAP inventory schedule to the manual inventory schedule for the last month. ➢ Postings to the general ledger accounts for three transactions. ➢ Control account calculations. ➢ Coke production journals for one month.	➢ Agreed the SAP schedule to the manual schedule for June 2005. ➢ Postings were reviewed. ➢ The control account calculations were reviewed on the excel spreadsheet used (tonnage x standard value). ➢ Coke production journals were reviewed.

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30.	Unauthorised adjustments/ changes are made to the monthly inventory control schedule.	6	Restricted access to SAP.	8	Identification of responsible person who made the entry on SAP.	➢ The Coordinator has access to do input of consumption and transfers on SAP. Not able to make adjustments. ➢ Identification of responsible person who made the entry on SAP.
31.	Opening balances are incorrectly transferred from the previous month's inventory control schedule.	8	SAP programmatically updates information.	8	Agree the previous month's closing balance with the current month's opening balance.	In order. Is also checked on a monthly basis by the Senior Accountant.
32.	The purchase variance is not calculated and recorded accurately.	8	1. A fax is received from Logistics which details the type of coal, wet mass as well as the dry mass of the coal destined for Mittal Steel, Vanderbijlpark. 2. A fax is received from the harbour that details the tonnage, the U.S. dollar value as well as the split between Mittal Steel, Vanderbijlpark and Mittal Steel, Newcastle. The invoice date is also stated and this is supposed to agree with the bill of lading date. The documentation in respect of the bill of lading is kept at the harbour. 3. The Senior Accountant prepares a schedule that details the material code and tonnage. This is forwarded to the Controller at Raw Materials that does the input on SAP (only tonnage). SAP programmatically calculates a provisional purchase variance between the standard value and the exchange rate on the date of input. The information is captured in a provision account. 4. The harbour fax is also forwarded to Treasury. Treasury is responsible to transfer the funds to the bank account (exchange rate as on bill of lading date). There is no control over the time period before the transfer is carried out. 5. Creditors are notified that a payment is due. The account has to be cleared. Payment has to be matched against the SAP order. SAP programmatically calculates another purchase variance between the exchange rate on the date of input on SAP and the payment date. Payment is matched against the provision accounts.	6	Review the procedure followed to determine the purchase variance.	Tracked the financial entries for one ship for the first variance calculated by SAP.

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			6. Provisions are raised against the standard rate. Provision is also raised for: a. Freight b. Railage c. Customs d. Insurance 7. A final fax is received from the harbour for all $ linked costs. Payment is matched against the provision. When the provision is insufficient the remainder of the payment forms part of the purchase variance.			
33.	The payment for imported coal is not allocated correctly between Mittal Steel, Vanderbijlpark and Mittal Steel, Newcastle.	**8**	1. Payment is made for the material. 2. When the status of the coal changes to SFCS the Controller at Raw Materials prepares an excel spreadsheet with the following information, that is forwarded to the Senior Accountant: ➢ Wet mass ➢ Dry mass ➢ Consignment number ➢ Name of the ship. 3. On SAP only the total tonnage is recorded. 4. The Senior Accountant receives a daily coal report from the harbour that details the coal that has been dispatched to the Works according to their records. 5. The Senior Accountant reconciles the aforementioned information. Variances are followed up. It sometimes happens that a shortage of material is experienced and that coal is then re-routed. 6. When a ship has been closed the reconciliation is finalized. 7. The procedure will now be followed for every shipload.	**7**	Review the reconciliation done for the last shipment received.	The reconciliation was available. A meeting was held with Newcastle on 26 May 2005 Payment will be made.
34.	There is no control carried out in respect of access to information (passwords used, file and field protection etc.) especially with regards to the numerous excel files in use.	**8**	No formal control in place except for SAP.	**8**	Determine whether the excel files used by the Coordinator is password protected.	**Report.** ***Files are not password protected.***
35.	No formal written Works Instructions in place in respect of the handling and recording of coal at the coke plant.	**8**	1. IMCPSA0028 – Determination of B- Block silo's coal levels. 2. IMCPSA0020 – Tipping of trucks on tipplers. 3. Standard work procedures and task observations.	8	View the Works procedure used by the Coordinator to prepare the monthly information.	**Report.** ***No official Works procedure in place.***
36.	No formal	**3**	Balance scorecards are in place.	**10**	Discuss monitoring	Updated every three

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	performance contracts with personnel are in place to ensure the alignment of the department's objectives.		Reviewed on a monthly basis.		actions with the Manager, Coal Plant.	months.
37.	No alignment of performance contracts with those of the Business Unit's i.e. clear targets and measurements.	**2**	Balance scorecards are in line with those of the Departmental Manager. Reviewed on a monthly basis.	**10**	Discuss monitoring actions with the Manager, Coal Plant.	Performance measurements include: ➢ % inventory adjustments. ➢ Grading of coal components. ➢ T-blend variance. ➢ Offloading time of railway wagons.

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3.6 PRACTICAL MEASUREMENT OF COAL SPILLAGES

During the audit process the following procedures were followed to determine the amount of spillages accruing during operations.

3.6.1 METHOD

- Five offloading and five reclaiming transfer stations were chosen.
- All ten of these transfer stations were cleaned.
- Normal operations were carried out for one day (24 hrs).

- Operations were stopped and all the wasted material (coal sweepings) at the abovementioned transfer stations were cleaned up and weighed on a static weigh bridge.

- After rail trucks were unloaded on the tipplers, cleaning teams existing of five workers were used to clean up the coal that was left behind in the trucks.

- This coal was also weighed to determine the coal sweepings, which in the past was not calculated or reclaimed.

3.6.2 RESULTS

The following results were determined by the abovementioned methods used to reclaim coal sweepings:-

- Tons of coal reclaimed at the ten transfer stations = 392 tons/day. The tons of coal handled for the same period amounts to 17900 tons/day. Thus the spillages = 2,2%/day. (9504 tons offloaded/day, 8396 tons reclaimed/day.)

- Tons of coal reclaim after the rail trucks were emptied = 237,6 tons/day. The total tons that were tipped were 9504 tons/day. Thus the reclaimed coal was 2,5%/day of the total tonnages handled.

3.7 SUMMARY

- In this chapter production planning and inventory control, as performed by the Coke Plant, was studied in detail to determine whether the systems complied to Mittal Steel's standards.

- Out of the results it is clear that a few areas where inventory losses occur due to improper managing of identified risks.

- The current infrastructure of the coal handling plants allows for excessive coal losses because of the outlay of the plant. When material is offloaded it is conveyed on a conveyor system stretching over 1,2km which include 17 transfer stations. When coal is reclaimed and blended, it is conveyed to the coke plant batteries over a distance of 2,1km which include 24 transfer stations.

- Recommendations will follow in chapter four that will address the following:
  - Decrease amount of coal components reclaimed.
  - Moisture compensation in the system.
  - Cleaning out of coal trucks.
  - Reclaiming of wasted coal (sweepings.)
  - Interlocking between reclaimer position and shuttle position when coal is reclaimed or offloaded.
  - Coal shortage due to poor Spoornet performance.
  - Calibration of weighing equipment.
  - Authorization on production planning and inventory systems.

CHAPTER 4

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

4.1 OVERVIEW OF THE STUDY

The main reason of the study was to examine the current raw material inventory control system at the Coke Plant, at Mittal Steel, Vanderbijlpark Works. To examine this, it was necessary to study production, inventory control, and logistics of raw materials in detail. Therefore chapter 1 identified the reason for this study, the objectives, the study population and the method used to achieve the objectives.

Chapter two was devoted to an in depth study of literature, including production planning, inventory control and logistics. Chapter three was dedicated to a detailed audit on the current inventory system as well as a detailed description of the coke making processes and raw materials handling. Furthermore a questionnaire was distributed between top-, and middle management, as well as supporting staff, to determine the control environments' influence over the way business activities and processes are conducted. Due to the nature of the topic the environment is assessed via a departmental survey.

4.2 CONCLUSIONS

The following needs to be addressed to effectively minimise inventory losses and to comply to identified risks:

- Too many coal components are reclaimed which results in coal spillages and production delays.
- Moisture compensation is not done on a regular basis and therefore it results in coal inventory write-offs.
- The coal rail trucks are not totally emptied. Because these trucks are not ring-fenced the coal that stays in the trucks is written-off.
- Not all wasted coal (sweepings) is recovered with clean-up operations.
- There is no interlocking between reclaimer position and shuttle position when coal is reclaimed or offloaded.
- Coal shortages do occur due to poor Spoornet performance.
- Calibration of weighing equipment is not done on a regular basis.

- Authorization on production planning and inventory systems is not password protected.

4.3 RECOMMENDATIONS

4.3.1 DECREASE AMOUNT OF COAL COMPONENTS RECLAIMED

At present there are six different types of coking coal to produce the blend needed at the coke plant batteries. These different types of coal are delivered to the Vanderbijlpark works by rail and offloaded at the coal tipplers, after which they are carried by conveyor and temporarily stored in a stockpile area which has a capacity of approximately 120 000 tons. The coal is stacked and reclaimed by two combined stacker/reclaimers after which it is crushed and conveyed to 14 coal silos where it is blended from the silos and conveyed to the coke plant batteries.

The following problems arise when reclaiming the different components:

- Due to wet coal, the chutes and the conveyer belts get blocked
- If the silo's run out of one component, the whole process have to be stopped
- The stockyard area in which the coal is buffered/stored is 1,9km away from the silos. Every time if the component have to be switched, the conveyer belt have to run empty before it can start reclaiming another component

The recommendation would be to build a blending bed, blending the coal inside the storage/buffer area and then convey one blended material to the coke plant batteries.

4.3.2 BENEFITS OF COAL BLENDING BEDS

Blending is a pre-programmed combination of orderly stockpiled and reclaimed material to produce a physically and chemically uniform product for industrial use. Building a coal blending bed to blend the coal before it is sent to the coke plant batteries would have the advantages namely the following:

- Improving the homogeneity of the coal blends
- Improving stability in the mixture directly relating to stability in the Blast Furnace
- Eliminating the delays between conveying batches of the different types of coal to the silos

- The coke plant batteries will never stand without mixed coal (Components cannot run out – see below)
- Minimise coal spillages

Currently it takes about 20 minutes of delays between every change in coal components. If there are 12 coal component changes in one day, the production losses will result in approximately 180 minutes (3 hours).

The biggest non-quantifiable benefit is that there will be "stock" available inside the component silos "under roof". This total stock is about 5 days worth of coal blend.

The recommendation is to have two rows of two parallel beds, each of a hundred metres in length, lying at the south end side of the coal storage area (*see figure 4.1: DIAGRAMMATIC REPRESENTATION OF COAL BLENDING BEDS INSIDE CURRENT COAL STORAGE AREA, page 101)*

The following changes to the current infrastructure needs to be implemented:

- Two reclaimers salvaged from Raw Materials Handling (abundant)
- 200m of conveyor in the air
- 400m of conveyor on the ground (for reclaiming)
- 50m of conveyor on the ground (to get blended coal back onto conveyors to convey it to the plant)
- 50m of conveyor in the air (to get coal to stacker to be blended)

Figure 4.1 DIAGRAMMATIC REPRESENTATION OF COAL BLENDING BEDS INSIDE CURRENT COAL STORAGE AREA

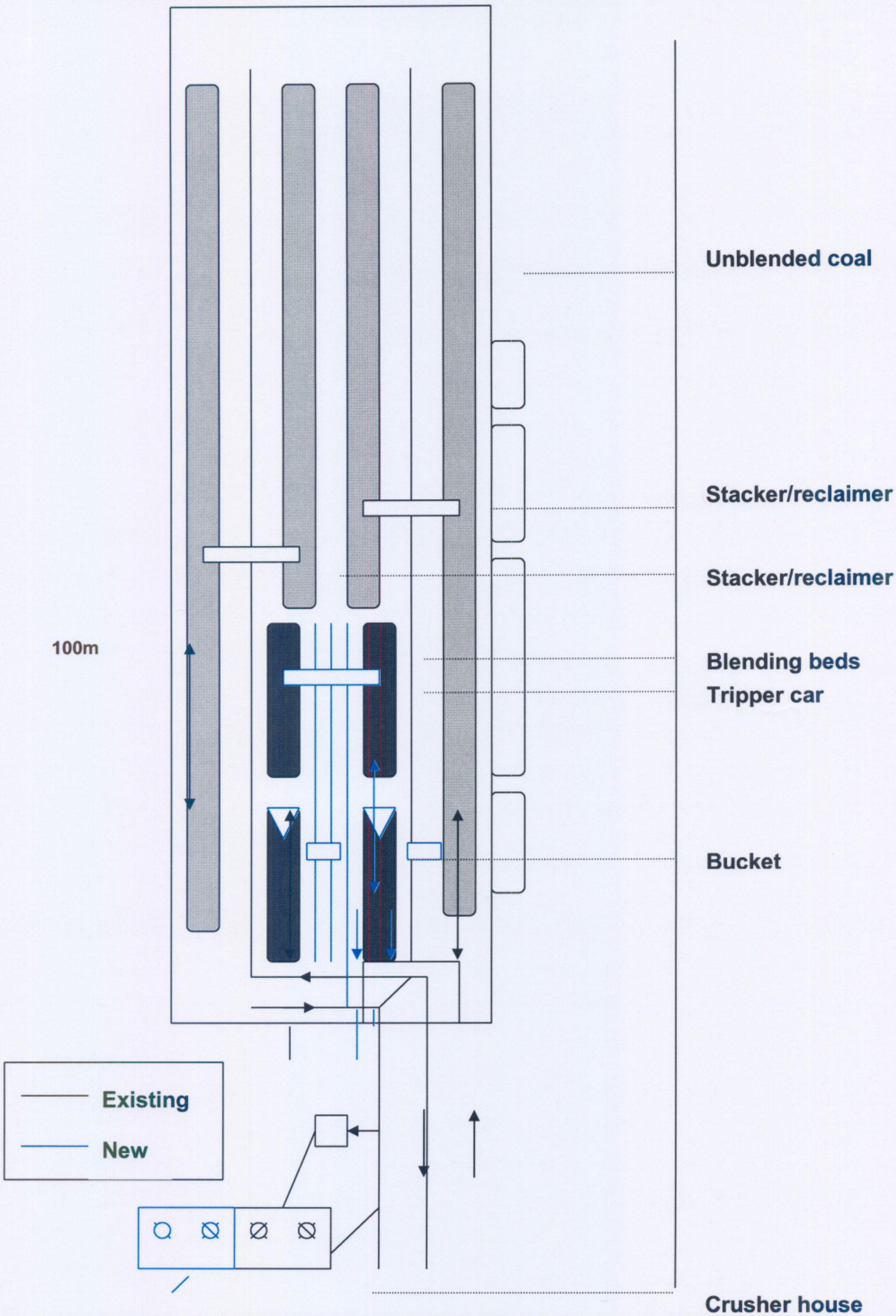

FIGURE: 4.1 Diagrammatic representation of coal blending beds inside current coal storage area

4.3.2.1 COSTS INVOLVED

TABLE 4.1: TWO ROWS OF TWO PARALLEL BEDS

	Cost per unit	Cost
Materials handling equipment		
Two bucket reclaimers (salvaged)	R 0.00	R 0.00
200m of conveyor in the air (stacking)	R 22,000.00	R 4,400,000.00
400m of conveyor on the ground (reclaiming)	R 10,000.00	R 4,000,000.00
50m conveyor on ground	R 10,000.00	R 500,000.00
50m conveyor in air	R 22,000.00	R 1,100,000.00
Tripper	R 700,000.00	R 700,000.00
Rotatable stacker	R 3,500,000.00	R 3,500,000.00
Civil works:		
11 columns	R 175,000.00	R 1,925,000.00
		R 16,125,000.00

4.3.3 MOISTURE COMPENSATION IN THE SYSTEM

Inline moisture analyzers need to be installed at the off-loading and reclaiming facility as well as after coal blending. This will ensure that correct moisture compensation can be done in time. These analyzers gives a moisture result every 15 seconds and are ±0,2% accurate. The moisture analyzer can be purchased from Australia at a cost of R155 000 per analyzer, which means that the total cost for this project amounts to R465 000.

4.3.4 CLEANING OUT OF COAL TRUCKS

The coal trucks needs to be cleaned out continuously. This means that 5 workers per shift (3 shifts per 24 hrs) need to be put in place to do this task. The costs will amount to R40 500/month.

4.3.5 RECLAIMING OF WASTED COAL (SWEEPINGS)

A cleaning contract are already in place, but only the discipline with the cleaning operations needs attention and the coal sweepings needs to be taken to the same stockpile at all times. It happened that coal sweepings are dumped at the dumpsite and this needs to be managed effectively

4.3.6 INTERLOCKING BETWEEN RECLAIMER POSITION AND SHUTTLE POSITION WHEN COAL IS RECLAIMED OR OFFLOADED

The software exists for this system to be interlocked but some hardware like for instance the limit switches on the stackers and shuttles are not yet installed. When this installation is finished the necessary programming needs to be done.

4.3.7 COAL SHORTAGE DUE TO POOR SPOORNET PERFORMANCE

Regardless of their relative importance, the company must coordinate all functional efforts aimed at supplier agreements and customer service. Providing extraordinary levels of these services is a wise investment for any company. Good relations will provide the basis for enduring relations based on trust and commitment. Commitments and trust needs to be negotiated at CEO level between Mittal Steel and Spoornet.

4.3.8 CALIBRATION OF WEIGHING EQUIPMENT

The calibration of weighing equipment needs to be done once a week and the production personnel need to clean this equipment every day. When this equipment is not cleaned regularly and properly, the accuracy of this equipment is at stake.

4.3.9 AUTHORIZATION ON PRODUCTION PLANNING AND INVENTORY SYSTEMS

A works procedure needs to be put in place where it is stated who exactly have authority to change documents or sheets in the production and inventory planning systems. These authorities must be password protected. This works procedure must be reviewed every six months.

If abovementioned recommendations are all implemented the following costs will be incurred:

- New blending bed = R16 125 000
- In-time moisture analyzers = R465 000
- Truck cleaners = R40 500/month

TOTAL COST = R16 630 500

The percentage write-offs will come down by 5,7% (see chapter 3.6.2) which will result in minimizing inventory write-offs by 71%. In monetary value this means R54m /year when compared to write-offs in 2004. This means by implementing abovementioned recommendations the capital expenditure needed for the blending beds and moisture analyzers will be paid for in four months. The truck cleaners will be a continuous cost, this can't be taken in consideration when applying for capital.

4.4 FUTURE FIELDS OF STUDY

- A supporting study that may assist businesses to deliver a better quality of service.
- This study can be duplicated using a broader population. This may lead to better and more meaningful results.
- This study can be performed in other sectors.
- A more in-depth study of internal customer demands can be performed.

After conducting both a literature and empirical study, it can now be concluded that all the objectives of this study have successfully been accomplished on the basis of the conclusions and recommendations.

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CONTROL ENVIRONMENT

The control environment is influenced by a company's history and culture and sets the tone of the organization, influencing the control consciousness of its personnel. its personnel. The control environment is evaluated based on the following factors:

- Integrity and Ethical Values
- Organizational Structure
- Commitment to Competence
- Assignment of Authority and Responsibility
- Management Philosophy and Operating Style

INTEGRITY AND ETHICAL VALUES

A company's objectives and the way they are achieved are based on preferences, value judgments, and management styles. Those preferences and value judgments that translate into standards of behavior reflect management's integrity and its commitment to ethical values

		1	2	3	4	5	6	7	8	9	10	N/A
1)	The Company's Code of Conduct and other policies regarding acceptable business practices, conflicts of interest, and expected standards of ethical and moral behavior are comprehensive, relevant and address matters of significance to you.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
2)	Employees fully and clearly understand what behavior is acceptable and unacceptable under the Company's Code of Conduct and know what to do when they encounter improper behavior.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
3)	Management frequently and clearly communicates the importance of integrity and ethical behavior during staff meetings and/or one-on-one discussions.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
4)	Management demonstrates a commitment to integrity and ethical behavior by example in their day-to-day activities.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
5)	Employees are generally inclined to do the "right thing" when faced with pressures to cut corners with regard to policies and procedures.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
6)	Management addresses and resolves violations of behavioral and ethical standards consistently, timely, and equitably in accordance with the provisions of the Company's Code of Conduct.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
7)	The existence of the Company's Code of Conduct and the consequences of its breach are an effective deterrent to unethical behavior.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
8)	Management strictly prohibits circumvention of established policies and procedures, except where specific guidance has been provided, and demonstrates commitment to this principle.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

CONTROL ENVIRONMENT

COMMITMENT TO COMPETENCE

Management should specify the competence levels for particular jobs and translate those levels into requisite knowledge and skills. Among the many factors considered in developing knowledge and skill levels are the nature and degree of judgment to be applied to a specific job

		1	2	3	4	5	6	7	8	9	10	N/A
9)	Management has adequately defined the knowledge and skills needed to perform jobs within your function.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
10)	Management has the specialized knowledge, experience, and training required to perform their duties and do not rely extensively on technical specialists or outside consultants.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
11)	Employees are properly trained and are capable of performing all jobs within their function.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
12)	Individual performance targets focus on both the long-term and short-term and address a broad spectrum of criteria (e.g., quality, productivity, leadership, teamwork, and self-development).	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

MANAGEMENT'S PHILOSOPHY AND OPERATING STYLE

Management's philosophy and operating style affect the way the Company is managed, including the kinds of business risk accepted. An informally managed company may control operations largely by face-to-face contact with key managers. A more formally managed one may rely more on written policies, performance indicators and exception reports

		1	2	3	4	5	6	7	8	9	10	N/A
19)	Management accepts the appropriate amount of business risk.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
20)	Key personnel have not resigned unexpectedly or on short notice, and employee turnover is not excessive.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
21)	Employees in your function feel they are adding value within the Company's overall strategy.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
22)	Management meetings are held periodically within your function and are frequently attended by senior management.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
23)	Objectives established by senior management are realistic and achievable.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
24)	Management views accounting treatment for transactions or activities in a balanced manner, neither too aggressive nor too conservative.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
25)	Management views accounting function as an important element in the overall system of internal control rather than an obstacle to be avoided or overcome.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
26)	Management routinely assesses various risks to achieving business objectives.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
27)	Management appropriately balances the focus on short-term reported results with long-term business objectives and does not exert inappropriate pressure to achieve earnings objectives.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
28)	Estimates required for your function's activities are based on sound models, verifiable market data, and fair assumptions.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

CONTROL ENVIRONMENT

ORGANIZATIONAL STRUCTURE

A company's organizational structure provides the framework within which its activities for achieving company-wide objectives are planned, executed, controlled, and monitored. Significant aspects of establishing a relevant organizational structure include defining key areas of authority and responsibility and establishing appropriate lines of reporting

		1	2	3	4	5	6	7	8	9	10	N/A
29)	Management treats your function as an integral part of the Company's overall operations.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
30)	The current organizational structure facilitates the flow of information both up and down within your function and across to other functions.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
31)	Managers and process owners in your function have ready access to senior management in addressing significant issues.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
32)	The organizational structure in your function provides adequate supervisory and managerial oversight.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
33)	Management periodically evaluates the organizational structure relevant to your function in light of changes in the scope, nature, or extent of your operations.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
34)	Employees do not work excessive overtime and do not fulfill the responsibilities of more than one employee.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

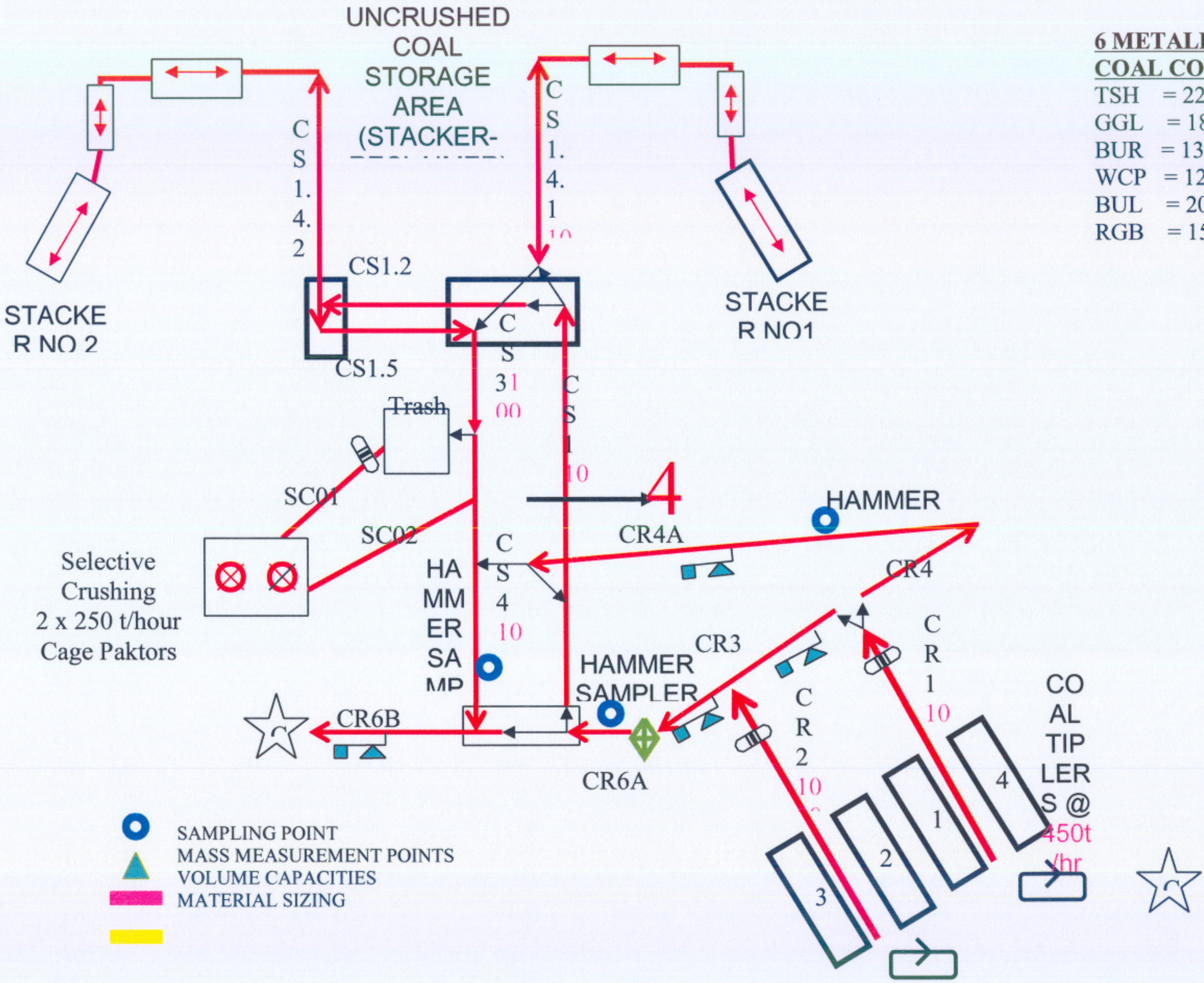
ASSIGNMENT OF AUTHORITY AND RESPONSIBILITIES

Assignment of authority and responsibilities involves the degree to which individuals and teams are encouraged to use initiative in addressing issues and resolving problems as well as limits of their authority.

		1	2	3	4	5	6	7	8	9	10	N/A
35)	Management designates who is responsible for committing your function to financial or contractual obligations through a formal delegation of authority.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
36)	Specific limits are established for certain types of transactions and delegations are clearly communicated and understood by employees within your function.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
37)	Job descriptions for your function's personnel include specific references to control related responsibilities.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
38)	Management accepts responsibility for information generated within your function and on reported results.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
39)	Managers in your function are appropriately empowered.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

FIGURE: 3.1

Coking Coal Receiving and Storage



6 METALLURGICAL COAL COMPONENTS:

TSH = 22%
GGL = 18%
BUR = 13%
WCP = 12%
BUL = 20%
RGB = 15%

FIGURE: 3.2

Coal Silos

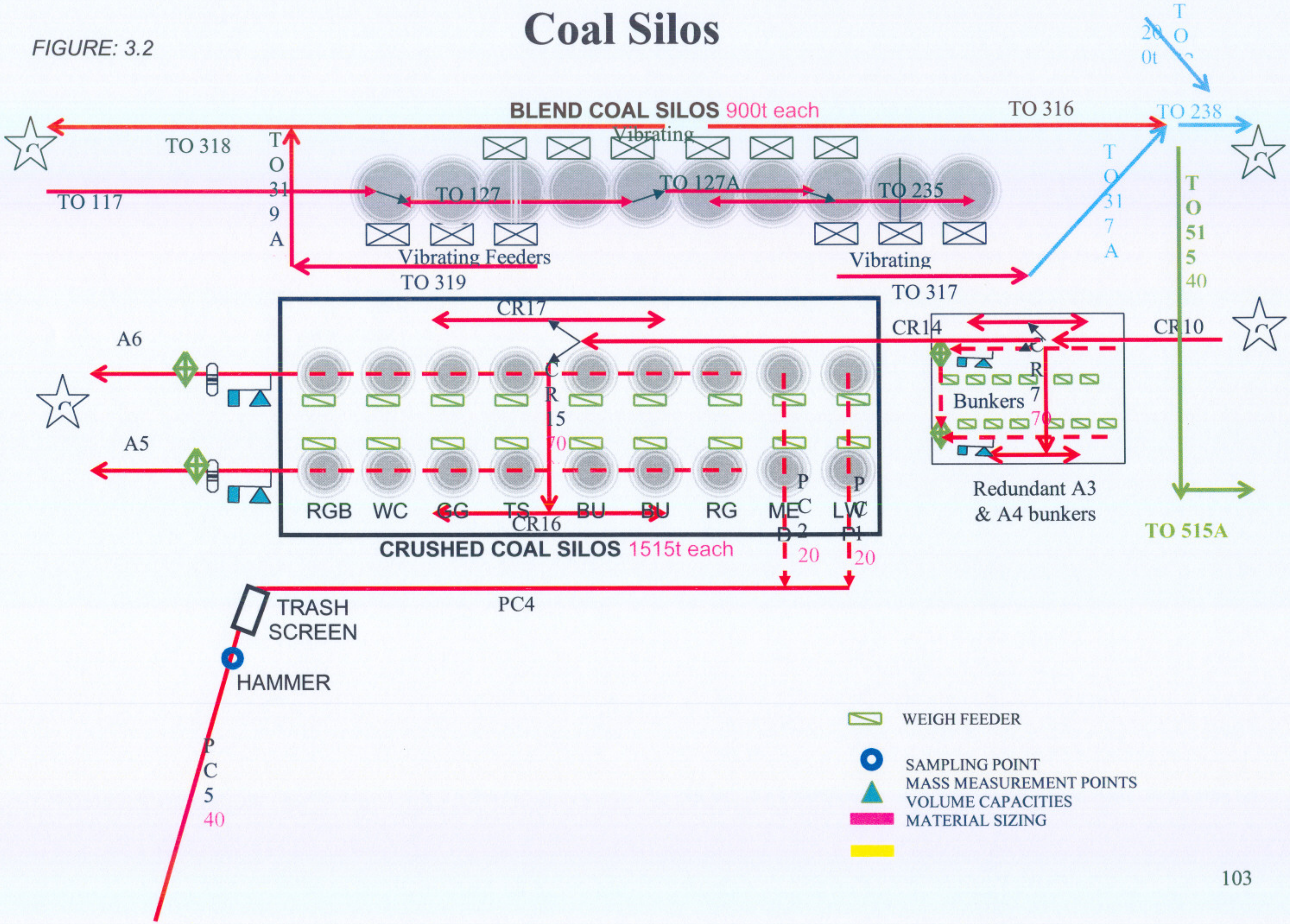


FIGURE: 3.3

Coal Conveyors to Coke Oven Batteries

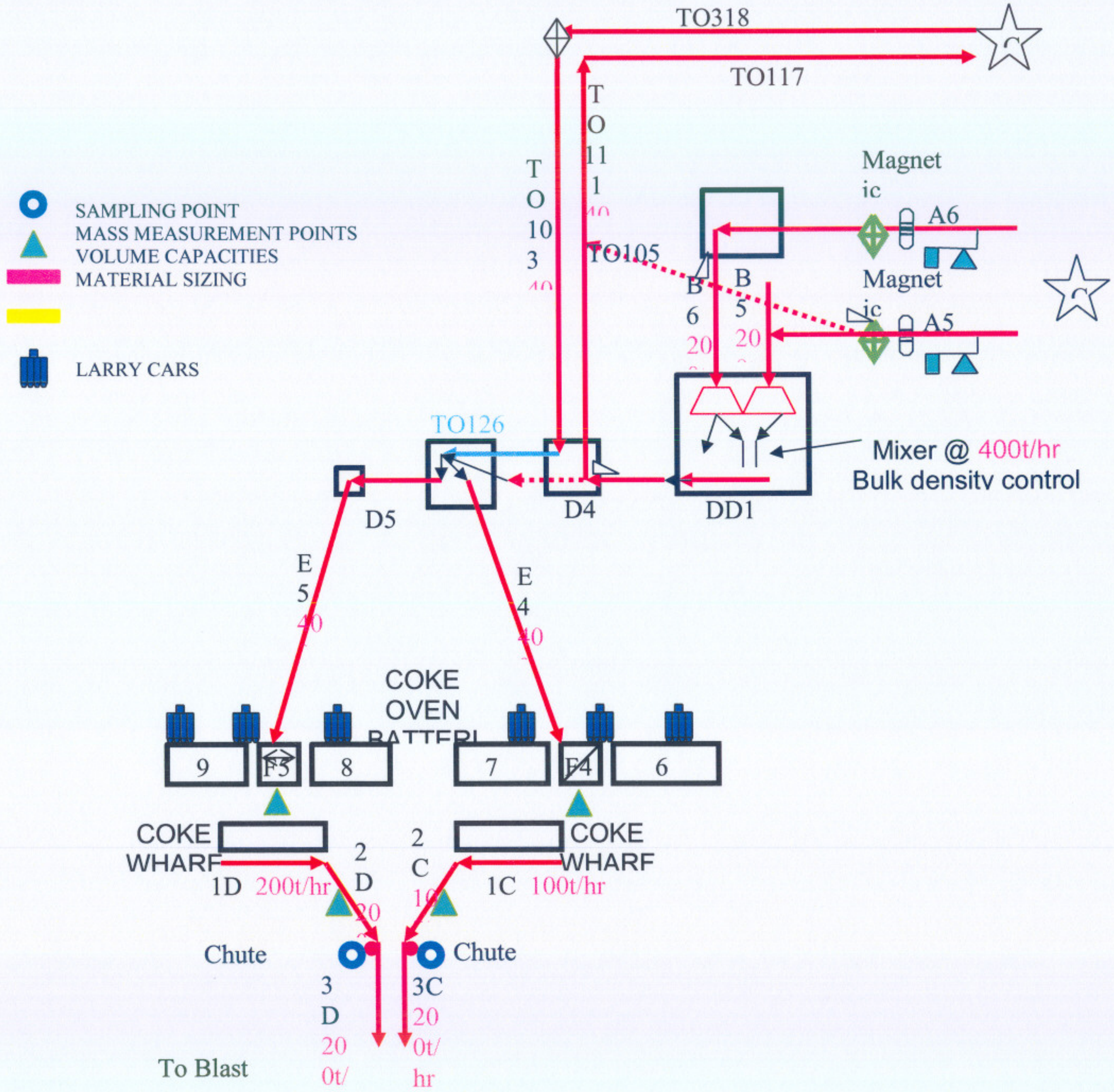


FIGURE 3.4: COKE PLANT ORGANIZATIONAL STRUCTURE

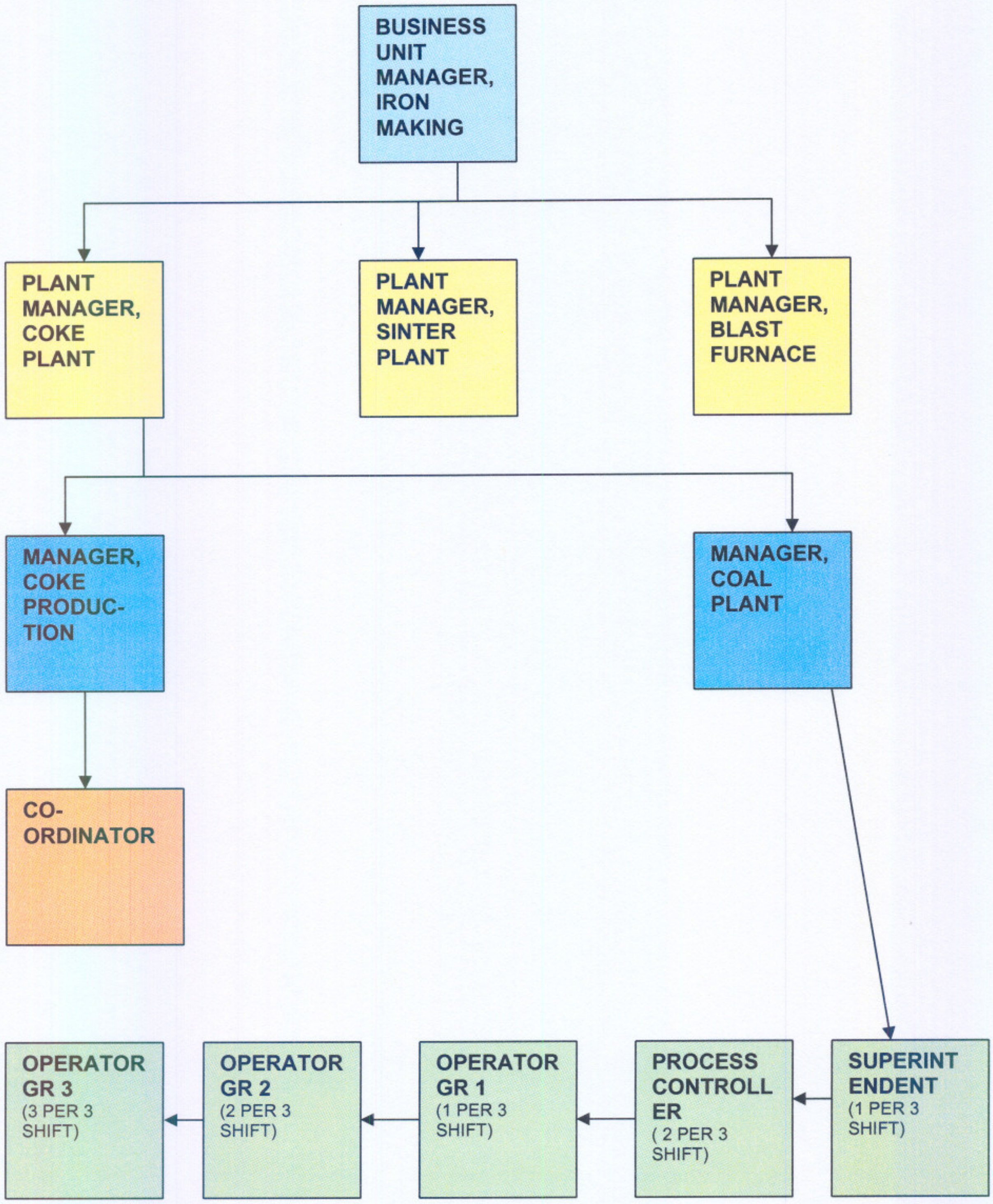
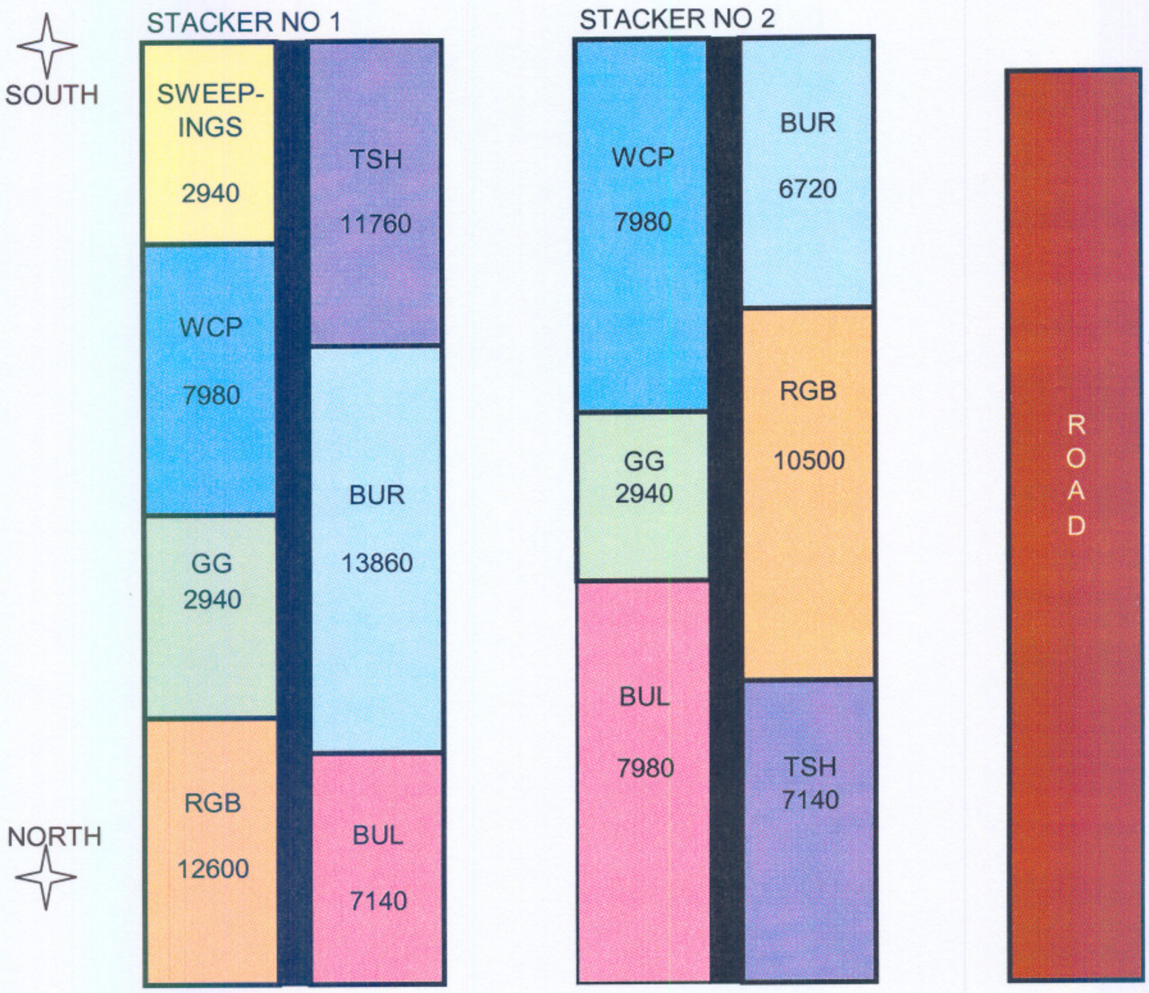


FIGURE 3.5: COAL STOCKYARD AREA



COAL	STOCKPILE TONS
SWEEPINGS	2940
WCP	15960
GG	5880
RGB	23100
TSH	18900
BUR	20580
BUL	15120
TOTAL	102480

DIMENSIONS OF STOCKYARD:

From North to South = 775m

From West to East = 150m

TABLE 3.2 **COKE OVENS PLANNING, STOCK & DEMAND - SEPTEMBER 2005**

	Sep-05 1	Sep-05 2	Sep-05 3	Sep-05 4	Sep-05 5	Sep-05 6	Sep-05 7	Sep-05 8	Sep-05 9	Sep-05 10	Sep-05 11	Sep-05 12	Sep-05 13	Sep-05 14	Sep-05 15
Wharf Coke Demand	3429	3429	3429	3429	3429	3429	1737	2640	3429	3429	3429	3429	3429	3429	3429
Wharf Coke Supply	3854	3792	3854	3792	3854	3792	3668	3792	3854	3792	3854	3792	3854	3668	3854
Diff	425	363	425	363	425	363	239	363	425	363	425	363	425	239	425
Total Stock	37178	36315	35493	34630	33808	32945	33814	33740	32918	32055	31233	30370	29548	28685	29110
Limit	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000
Total warf+Import Stock	37178	36315	35493	34630	33808	32945	33814	33740	32918	32055	31233	30370	29548	28685	29110
Market Sup	595	586	595	586	595	586	595	586	595	586	595	586	595	586	595
Market Sell	595	586	595	586	595	586	595	586	595	586	595	586	595	586	595
Batt 3/4 Market	1119	1100	1119	1100	1119	1100	1119	1100	1119	1100	1119	1100	1119	989	0

	Sep-05 16	Sep-05 17	Sep-05 18	Sep-05 19	Sep-05 20	Sep-05 21	Sep-05 22	Sep-05 23	Sep-05 24	Sep-05 25	Sep-05 26	Sep-05 27	Sep-05 28	Sep-05 29	Sep-05 30	Total	
Wharf Coke Demand	3429	3429	3429	3429	3429	3429	3429	3429	3429	3429	3429	3429	3429	3429	3429	100389	1
Wharf Coke Supply	3792	3854	3792	3854	3792	3668	3792	3854	3792	3854	3792	3854	3668	3854	3792	114070	2
Diff	363	425	363	425	363	239	363	425	363	425	363	425	239	425	363	11200	3
Total Stock	29473	29897	30260	30685	31048	31288	31651	32076	32439	32864	33227	33651	33891	34316	34679	34679	4
Limit	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000		5
Total warf+Import Stock	29473	29897	30260	30685	31048	31288	31651	32076	32439	32864	33227	33651	33891	34316	34679		9
																	10
Market Sup	586	595	586	595	586	595	586	595	586	595	586	595	586	595	586	17723	11
Market Sell	586	595	586	595	586	595	586	595	586	595	586	595	586	595	586	17723	12
Batt 3/4 Market	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15425	

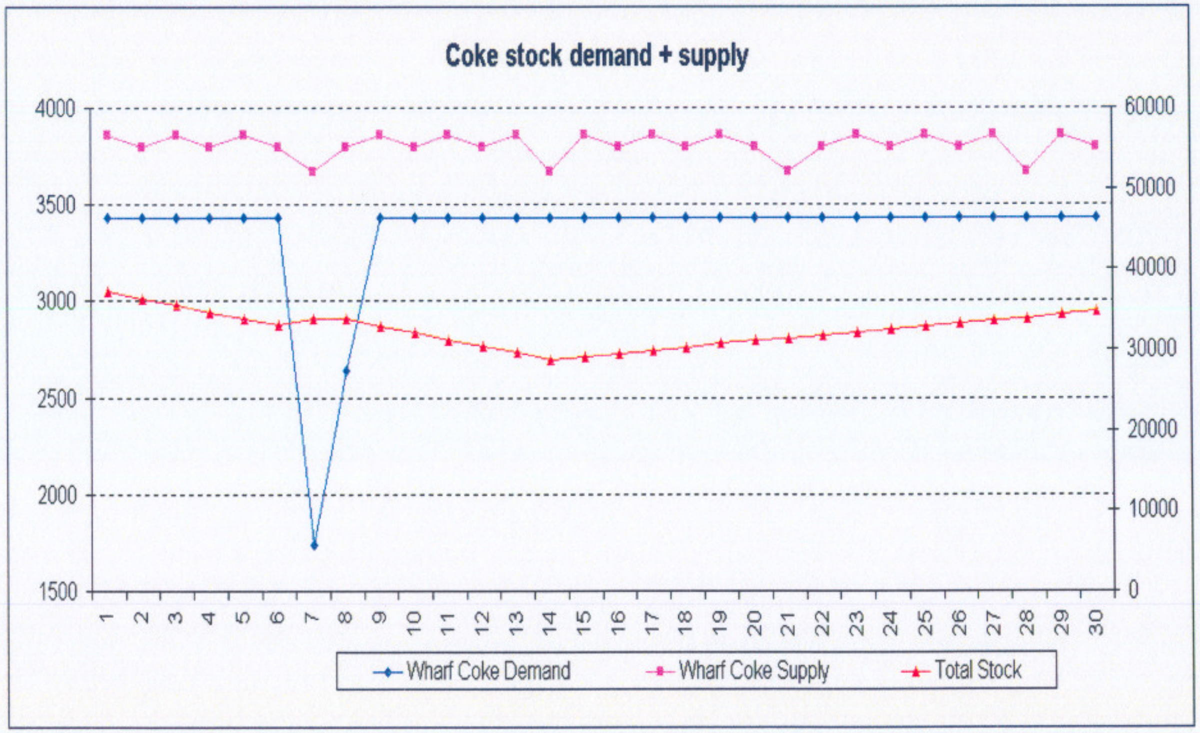


TABLE 3.3: PRODUCTION PLANNING AND INVENTORY CONTROL SEPT 05

Blend	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu
	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep	12-Sep	13-Sep	14-Sep	15-Sep
GGL	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
TSH	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
BUR	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
RGE	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
BULLI	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
WCP	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
CLR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DROS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Blend	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri
	16-Sep	17-Sep	18-Sep	19-Sep	20-Sep	21-Sep	22-Sep	23-Sep	24-Sep	25-Sep	26-Sep	27-Sep	28-Sep	29-Sep	30-Sep
GGL	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0
TSH	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
BUR	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
RGE	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
BULLI	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
WCP	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
CLR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DROS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Consumptions

	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep	12-Sep	13-Sep	14-Sep	15-Sep
GGL	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9
TSH	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4
BUR	831.8	831.8	831.8	831.8	831.8	831.8	831.8	831.8	831.8	831.8	831.8	831.8	831.8	831.8	831.8
RGE	931.6	931.6	931.6	931.6	931.6	931.6	931.6	931.6	931.6	931.6	931.6	931.6	931.6	931.6	931.6
BULLI	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8
WCP	697.0	697.0	697.0	697.0	697.0	697.0	697.0	697.0	697.0	697.0	697.0	697.0	697.0	697.0	697.0
CLR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DROS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	6061	6061	6061	6061	6061	6061	6061	6061	6061	6061	6061	6061	6061	6061	6061

	16-Sep	17-Sep	18-Sep	19-Sep	20-Sep	21-Sep	22-Sep	23-Sep	24-Sep	25-Sep	26-Sep	27-Sep	28-Sep	29-Sep	30-Sep	Total
GGL	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	1048.9	31466.3
TSH	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	1335.4	40061.1
BUR	831.8	831.8	831.8	831.8	831.8	831.8	831.8	831.8	831.8	831.8	831.8	831.8	831.8	831.8	831.8	24955.4
RGE	931.6	931.6	931.6	931.6	931.6	931.6	931.6	931.6	931.6	931.6	931.6	931.6	931.6	931.6	931.6	27947.7
BULLI	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	1215.8	36474.0
WCP	697.0	697.0	697.0	697.0	697.0	697.0	697.0	697.0	697.0	697.0	697.0	697.0	697.0	697.0	697.0	20910.8
CLR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DROS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	6061	6061	6061	6061	6061	6061	6061	6061	6061	6061	6061	6061	6061	6061	6061	181815.3

	01-Sep	02-Sep	03-Sep	04-Sep	05-Sep	06-Sep	07-Sep	08-Sep	09-Sep	10-Sep	11-Sep	12-Sep	13-Sep	14-Sep	15-Sep
R/ton	836.91	836.91	836.91	836.91	836.91	836.91	836.91	836.91	836.91	836.91	836.91	836.91	836.91	836.91	836.91
%Ash	12.71	12.71	12.71	12.71	12.71	12.71	12.71	12.71	12.71	12.71	12.71	12.71	12.71	12.71	12.71
%F	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032
%S	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
CSR	61.35	61.35	61.35	61.35	61.35	61.35	61.35	61.35	61.35	61.35	61.35	61.35	61.35	61.35	61.35
M40	69.00	69.00	69.00	69.00	69.00	69.00	69.00	69.00	69.00	69.00	69.00	69.00	69.00	69.00	69.00
VM	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81
Yield	74.11	74.11	74.11	74.11	74.11	74.11	74.11	74.11	74.11	74.11	74.11	74.11	74.11	74.11	74.11

	16-Sep	17-Sep	18-Sep	19-Sep	20-Sep	21-Sep	22-Sep	23-Sep	24-Sep	25-Sep	26-Sep	27-Sep	28-Sep	29-Sep	30-Sep
R/ton	836.91	836.91	836.91	836.91	836.91	836.91	836.91	836.91	836.91	836.91	836.91	836.91	836.91	836.91	836.91
%Ash	12.71	12.71	12.71	12.71	12.71	12.71	12.71	12.71	12.71	12.71	12.71	12.71	12.71	12.71	12.71
%F	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032	0.032
%S	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
CSR	61.35	61.35	61.35	61.35	61.35	61.35	61.35	61.35	61.35	61.35	61.35	61.35	61.35	61.35	61.35
M40	69.00	69.00	69.00	69.00	69.00	69.00	69.00	69.00	69.00	69.00	69.00	69.00	69.00	69.00	69.00
VM	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81	26.81
Yield	74.11	74.11	74.11	74.11	74.11	74.11	74.11	74.11	74.11	74.11	74.11	74.11	74.11	74.11	74.11

PLANNED TRAINS FOR SEPTEMBER 2005

	WEEK36	WEEK 37	WEEK 38	WEEK 39	TOTAAL	REC.	CONS.	DIFF.
GGL	2.0	2.0	2.0	2.0	8.0	31360	0	31360
TSH	5.0	5.0	4.0	5.0	19.0	41800	0	41800
BUR	3.0	0.0	0.0	6.0	9.0	39600	0	39600
RGB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BULLI	0.0	0.0	0.0	0.0	0.0	0	36474	-36474