THE INFLUENCE OF PURCHASING CONSTRAINTS AND UNCERTAIN DEMAND ON SELECTED ITEMS OF WORKING CAPITAL OF A LEADING SOUTH AFRICAN CABLE MANUFACTURER.

by

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LIST OF COMMONLY USED ABBREVIATIONS AND ACRONYMS

APO	-	Advanced planner and organizer
APS	-	Advanced planning and scheduling system
BOM	-	Bill of materials
CCE	-	Cash conversion efficiency
Cdf	-	Cumulative probability density function
CFR	-	Cost and freight
CIF	-	Cost, insurance and freight
CP	-	Constraint programming
DI	-	Days' other inventory kept excluding raw materials
DPO	-	Days' payables outstanding
DRM	-	Days' raw materials in stock
DSO	-	Days' sales outstanding
DWC	-	Days' working capital outstanding
EDI	-	Electronic data interchange
EOQ	-	Economic order quantity
ERP	-	Enterprise resource planning
EVA	-	Ethylenevinylacetate
EXW	-	Ex works
FCL	-	Full container load
FG	-	Finished goods
FOB	-	Free on board
ISO	-	International Standards Organisation
LCL	-	Less than container load
LP	-	Linear programming
MRP	-	Material requirements planning
Pdf	-	Probability density function
PE	-	Polyethylene
PVC	-	Polyvinyl chloride
SABS	-	South African Bureau of Standards
SAPCS	-	SAP Cable Solution
SCM	-	Supply chain management
TWCM	-	Total working capital^{SM} management
TCO	-	Total cost of ownership
WIP	-	Work-in-process

DEFINITIONS

Working capital:	In this research, the term "working capital" shall mean the net level or difference between current assets and current liabilities.
Supply chain:	Generally referred to as the all-encompassing activities associated with the flow and transformation of goods from the raw material stage, through to the end users, as well as the associated information flows.
SCM:	Generally referred to as the management activities relevant to a supply chain.
TWCM:	Holistic approach to working capital management incorporating all business processes and transactions involving customers, suppliers and products. As such it covers all three components of working capital management: the customer-to-cash^{SM} cycle, the purchase-to-pay^{SM} cycle and the forecast-to-fulfill ^{SM} cycle.

SUMMARY

This research examines the impact of purchasing constraints and demand variability on working capital balances. The working capital accounts considered are creditors, debtors and raw material inventories. Purchasing constraints and demand uncertainty are defined.

The supply chain of the South African cable industry, and one manufacturer in particular, and the challenges faced in the cable manufacturing process are discussed.

To quantify the influences, a comparison between working capital accounts in the case of economic order quantity and actual purchasing practices is performed.

A simulation model is developed to reproduce a larger sample of demand data, matching the cumulative probability density function of each cable type contained in the annual sales budget.

The results show, that the working capital accounts react differently to changes in purchasing conditions and variations in demand, the most sensitive being raw material inventories. The study quantifies the influence of purchasing constraints on each working capital value.

KEY WORDS

Cable industry, cable manufacturing, purchasing constraints, working capital, supply chain management, supply chain optimization, enterprise resource planning systems

CHAPTER 1: INTRODUCTION

CHAPTER 1 - INTRODUCTION

1. 1 OVERVIEW

Since the introduction and development of high-powered computer equipment in the 1970s, computational speed has increased by orders of magnitude, while the complexity of optimizing the supply chain has increased only a few times. Owing to this development, operational research methods and algorithms have found applications in this field. However, many of these methods are extremely specific and difficult to use, and only a few of them attempt to integrate all of the complexities of supply chain modelling and optimization.

Suppliers of large enterprise resource planning (ERP) Systems have also introduced new software modules, providing the capability of calculating complex scheduling problems, involving large quantities of data. Even with this wealth of optimizing programs and software, there is still a problem obtaining data to judge the effects of purchasing constraints and variable demand on companies' expected financial performance.

Working capital has been part of financial studies for more than 25 years. In the last five years in particular, working capital management has received more focused attention, as companies' possibilities of reducing costs and gaining other advantages have diminished in the global business environment. The cost differentials have decreased as more enterprises have access to the same resources. Hodge (1998:1) contends that increasing global competitiveness has continually eroded profits.

In addition, the weakening rand has contributed further to increasing capital asset prices, thus leaving limited possibilities for productivity improvements. South African cable companies are facing an extremely competitive environment, in which they still have to import many of their raw materials, some of which are fixed at international exchange prices or at least pegged against such price levels, leaving no advantage against imported finished goods. The success of South African cable companies therefore largely depends on the careful and optimized use of resources, given sufficient local and international demand. It is plausible that companies working in this environment need to focus specifically on their levels of working capital, which ties up funds for the particular business' conversion cycle. High levels of stock, either in raw materials, work in process or finished goods mean that cash, which could have been used more constructively, is simply not available. On the other hand, because of bad cash management, a company may forego advantageous opportunities. With this insight, many companies have embarked on optimizing their working capital positions, either by using self-written software, commercially available software to address specific areas of interest or sophisticated ERP systems (Eck 2003:47).

However, particularly in the complex cable manufacturing environment, not many systems have the ability to model the supply chain with all its constraints in its full entirety. Hence, the effects of late raw material deliveries, urgent production rescheduling or simply the lack of raw material on originally promised delivery dates and therefore on inventory levels and customer satisfaction as well as the associated accounts, can only be predicted through long, time-consuming processes, calculations and estimations. Even in modern ERP systems, such information is not readily available (Eck 2003:27-29).

The primary goal of this research is to identify the quantitative effects of constraints originating from international purchasing that is, the need to buy transport efficient container loads some months ahead of requirement dates (consolidated purchasing strategy), in an environment, which exhibits highly variable demand conditions, on selected items of working capital. This study will endeavour to promote insight into the impact of certain operational variables on working capital elements, which is necessary to efficiently manage working capital, particularly in the cable industry in South Africa.

1. 2 THE CABLE MANUFACTURING INDUSTRY IN SOUTH AFRICA

The industry sector of electric cable manufacturers excludes the communications cable industry and may best be described by the membership of the Association of Electric Cable Manufacturers of South Africa, which includes the following South African companies:

- African Cables Ltd
- Aberdare Cables (Pty) Ltd
- Malesela Taihan Electric Cables (Pty) Ltd
- Allcab Manufacturers cc
- Alvern Cables (Pty) Ltd
- Kewberg Cables & Braids (Pty) Ltd

The first three companies manufacture a wide spectrum of electric cables for low- and medium-voltage applications. The last three manufacturers, specialize in low-voltage cables and wires. African Cables is the only manufacturer in South Africa that engages in the production of high-voltage cables.

Although the above list does not represent a complete list of the cable and wire manufacturers in South Africa, it does depict the main suppliers who actively participate and compete in the South African economy. Owing to the recent political, economic and customs reforms, South Africa has become part of the global economy. Hence, the above companies are competing strongly against European and Asian cable manufacturers in supplying the South African market.

1.3 BACKGROUND ON AFRICAN CABLES LTD

The previous sections mentioned the main role players in the South African cable manufacturing market. Since this research deals specifically with the case of a single manufacturer, African Cables Ltd, a brief overview of its history will be given.

Donald Watson established African Cables Ltd in Vereeniging in December 1935. In May 1937, Anglo American became a major shareholder and African Cables was then listed as a public company. In 1938, the Cable Makers Association of Great Britain (BICC) took over the majority shareholding and the company gained the necessary know-how to become the major manufacturer of electric power cables in Africa. The late 1970s and early 1980s saw the establishment of improved manufacturing facilities, including the installation of machinery for the manufacture of high-voltage cable and a high-voltage test facility at Vereeniging. In 1983, African Cables Ltd launched the ZEROTOX cable, to promote safety in conditions of fire, with specific application in the mining industry. In 1986, the company diversified its activities with the acquisition of Power Installations – a company specialising in the installation and maintenance of oil-filled and XLPE cable installations.

In May 1987, Cullinan Holdings Ltd acquired the 35% BICC shareholdings and increased it to a 51% majority by February 1988. In July 1991, Afcab Holdings (Pty) Ltd, a company jointly owned by Reunert Limited and Siemens Limited, acquired the majority shareholding in African Cables from Cullinan Holdings Ltd. In September 1995, Afcab Holdings (Pty) Ltd acquired the entire shareholding in African Cables Ltd and the company was subsequently delisted. Late in 1998, Pirelli become a 50% stakeholder in African Cables through its acquisition of Siemens Power Cables. This share was sold to Reunert Ltd in the year 2004.

The company currently employs more than 500 people and is considered a leader in the South African cable industry. African Cables Ltd's commitment to the maintenance of documented procedures and instructions, in accordance with the requirements of the ISO 9000 to 9004 series of International Standards, and the effective implementation of the documented procedures and instructions in the quality system has culminated in the company acquiring ISO 9001:2000 accreditation through the South African Bureau of Standards (SABS). The quality of African Cables' products is a consequence of the quality delivered by all divisions of the company. African Cables is a market driven company that is committed to a policy of delivering complete customer satisfaction by creating solutions that make life easier and more productive for the end user.

1.4 PURCHASING CONSTRAINTS AND DEMAND UNCERTAINTY

This paragraph focuses on the identification of purchasing constraints and demand uncertainty in the cable manufacturing industry.

1.4.1 Purchasing constraints

1.4.1.1 Purchasing constraints in the cable industry

South African cable manufacturers, including African Cables Ltd, purchase raw materials both locally and from overseas suppliers. The different materials and quantities combined with the widely varying distances to the suppliers, pose unique challenges for purchasing departments. *Firstly*, the purchased materials are manufactured and packed in certain quantities, which cannot be subdivided into smaller portions. This precludes the acquisition of economic order quantities (EOQ), where these quantities are smaller or uneven multiples of such a packed or manufactured quantity. *Secondly*, the mode of transport causes certain constraints. In most instances, transport by sea or railroad is preferred. These transporters generally convey goods in standard size containers, which pack specific quantities of raw materials. These quantities normally differ significantly from economic order quantities. *Thirdly*, long distances cause certain obstacles. Lead-times tend to become increasingly uncertain, the longer the distance between manufacturer and supplier, making the order placement for a timely arrival of materials a difficult task. The purchasing departments therefore continuously engage in dangerous balancing acts to offset the unfavourable material quantities purchased and the uncertain arrival of materials with the requirement to keep inventory balances as low as possible.

1.4.1.2 Optimization of material supply with purchasing constraints

According to Hugo, Badenhorst-Weiss & Van Rooyen (2002:164), the provision of the right quantity of materials at the right time and the right price is one of the key tasks a purchasing department has to fulfil. This includes ensuring, that the inventory costs due to procurement of goods are kept to a minimum, the costs for the administration of goods purchased are kept as low as possible and production disruptions are avoided (Schoensleben 2000:154). To this end, many different optimization models and integrative systems (see 2) have been developed.

One of the better-known models is the EOQ model which attempts, on the basis of certain assumptions, to balance order costs and inventory holding cost, thus keeping overall purchasing costs to a minimum. A further development in the inventory management arena was the introduction of materials requirement planning (MRP) systems, which essentially entail a computer support system that attempts to synchronize the supply of material with the production schedule, in order to limit inventory to an absolute minimum (Hugo et al 2002:182-187). The basis for a successful MRP system implementation consists of reliable lead times for raw material supply, a stable master production schedule based on a reliable sales forecast and an assembly-type production environment, with known bills of material and structure. Any changes in those basic parameters may lead to erroneous results. It is clear that because of the uncertain raw material delivery and uncertain demand, MRP is not particularly suited to cable manufacturing.

The next development in the manufacturing resource planning (MRPII) system, which involved other business areas, especially financial and marketing management, provided more management information. However, the basic functioning of the MRP system did not change. The MRP system places orders automatically, which means that purchasing and supply chain management cannot take decisions independently in the course of normal events. This precludes, for example, taking advantage of attractive bulk purchases or changing supplier.

In addition, a major weakness of the MRP system is that it does not calculate lead times, but considers them as a given number. Furthermore, the MRPII does not contain an iterative process to consider production capacity constraints correctly. This also applies to large and complex logistics systems and ERP systems (Schoensleben 2000:319) such as SAP R/3, which use MRPII logic to compute material availability and material purchase quantity. However, to overcome the shortcomings of MRPII, SAP has included an advanced planner and optimizer (APO) into its suite (SAP Mill Products 1999:4-6). However, the SAP APO does not support certain SAP industry solution, such as the SAP cable solution (SAP CS). African Cables utilizes the SAP R/3 ERP system with the added on Cable Solution, an industry specific module supplied by SAP.

In the wake of advanced computer technology, new software termed “advanced planning and scheduling (APS) software” has made its debut on the market (Schoensleben 2000:152). This software attempts to optimize the material supply and production schedule, taking into consideration possible stock-outs and capacity constraints. African Cables is in the process of implementing an advanced planning and scheduling system, to overcome the shortcomings of MRPII, used by SAP R/3.

However, despite all efforts to optimize the material supply and inventory position, a firm may not always be able to purchase EOQ or MRP quantities. As already mentioned, South African cable manufacturers in particular, are required to procure materials from abroad (see 2 for a detailed description of the cable manufacturers’ supply base). This entails transportation of larger quantities by ship where transport costs constitute a major part of the material costs. In such instances, it is more important to optimize on transport cost and buy full container loads (FCL) instead of less than a container load (LCL) for which surcharges, and in many cases transshipments, are applicable. In addition, uncertainty in the already long lead times needs to be considered. Ships may arrive days later, or port congestion may prove an obstacle in off loading ships. Thus companies often keep safety stocks to cater for these eventualities. Inventories and associated costs rise with increasing purchase quantities and safety stocks (Schoensleben 2000:50). The purchasing of full container loads and keeping of safety stocks may therefore be regarded as constraints with which the purchasing and supply management have to deal.

1.4.1.3 Conclusion

In conclusion, the cable manufacturer operates under the following purchasing constraints: (1) uncertain delivery dates, (2) full container loads and not EOQs, (3) keeping of safety stocks, and (4) uncertain requirements.
According to Schoensleben (2000:154), the more exact information on the required inventory (demand) available to the manufacturer, the better the above problems can be solved - hence the importance of having more exact information about the demand for the firm's end products. The next section deals with uncertainty of demand.

1.4.2 Demand uncertainty

1.4.2.1 Demand uncertainty in the cable industry

The demand conditions for the South African cable manufacturer are extremely variable (see 2). The demand variations stem from long-term changes in preferences for different cable designs, but more importantly from unpredictable factors in the short term, such as breakdowns in mines and municipal networks, the lack of information on project requirements before and during the project life, and cable theft. Inaccurate market information in terms of demand as perceived by large wholesalers and their sporadic imports from overseas competitors, as the result of more favourable economic conditions, complicate forecasting demand.

1.4.2.2 Classification of demand

Demand can be classified into two categories, namely *deterministic* and *stochastic demand*. In the former, the demand level is known, whereas in the latter, the required amount is not known beforehand and must be forecast using stochastic methods (Schoensleben 2000:156). Hugo et al (2002:176) add a forecasting method by external indicators such as economic indicators – that is, the growth rate of the economy, labour conditions and expansions or contractions of supply. According to this classification, the demand for the South African cable manufacturer can be classified as stochastic because the exact demand is not known with any certainty.

Regarding the different demand categories, various methods must be employed in planning material requirements. Demand is also independent or dependent. *Independent demand*, which is created by the end customer, may be deterministic or stochastic, depending on the certainty with which this demand actually exists. *Dependent demand* is derived directly from the BOM of the independent items. The dependent demand items are the components needed to assemble the independent item.

In the case of deterministic demand, MRP techniques may be employed because the order quantities (or independent demand quantities) are known. Dependent demand can be derived from exploding bills of materials and order quantities and timing will be calculated directly by the MRP system. Since there is certainty in this case, safety stocks can be kept low.

In the case of stochastic independent demand, stochastic methods are needed to forecast the material requirements, such as the probabilistic models as described in section 2.6, taking into consideration the statistically calculated chance of being out of stock. However, these methods only lead to satisfactory results if the service level is high (Schoensleben 2000:158). For example, if the service level or the on-time delivery of components and materials is 95%, then the chance that 10 components, required for the assembly of one product, are available at the same time is only 60% (ie 0.95^10 = 0.599, according to the progression of tolerances). This is generally insufficient. Since the availability and the quantity of material required cannot be forecast with certainty, safety stocks need to be kept. The calculation of safety stocks is described in detail in chapter 2.

The demand experienced by the South African cable manufacturer, must be regarded as stochastic independent demand, as far as the finished cable items are concerned. As explained previously, the materials necessary to produce the cables, are dependent demand items specified on a BOM for the cable.

The above discussion shows that material requirement figures become increasingly inaccurate as demand forecasts become less reliable. Therefore the inventory position is rendered less optimal and more inventories are purchased and held, than absolutely necessary. This leads to increased investments in current assets and accounts payable, which are carried forward to the company’s balance sheet.

1.4.2.3 Conclusion

To summarize, the cable manufacturer operates under the following demand constraints: (1) uncertain cable requirement forecasts, if any, (2) uncertainty about specific cable items required, (3) uncertainty of cable safety stock requirements for certain customers and (4) uncertain material receipts.

1.5 THE INFLUENCE OF PURCHASING CONSTRAINTS AND DEMAND UNCERTAINTY ON WORKING CAPITAL

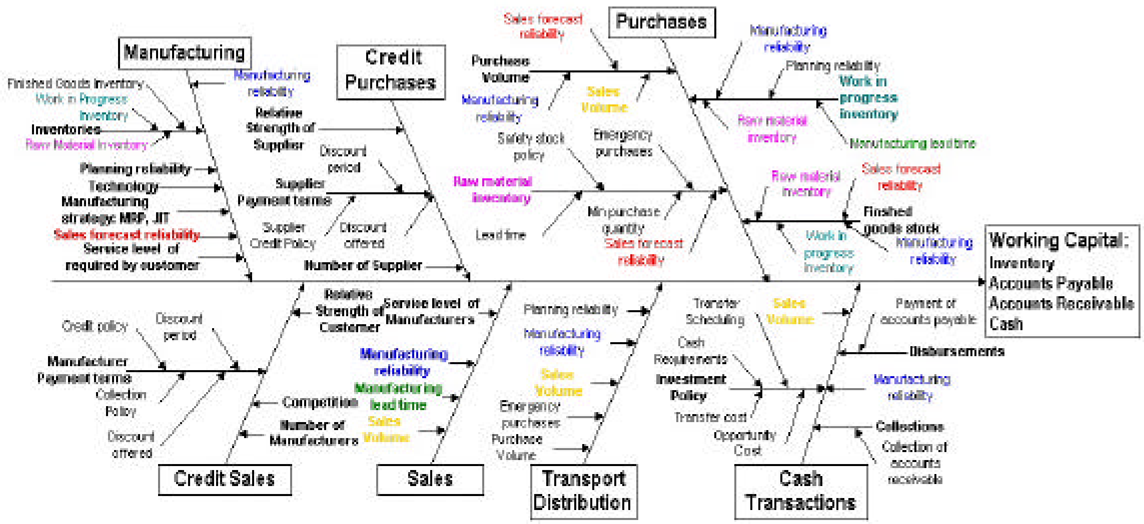
1.5.1 Definition of working capital

Working capital as defined by Brigham and Ehrhardt (2002:837-839), represents all current assets, whereas net working capital expresses the difference between current assets and current liabilities. Many authors share this view (see 3) and further reduce net working capital to accounts receivable and inventory, excluding cash, less current liabilities, excluding short-term debt. Cash and short-term debt form part of gross working capital. In this study the term “net working capital” will mean the net level or difference between current assets and current liabilities limited to inventory, trade debtors and trade creditors.

1.5.2 Specific parameters influencing working capital

Specific supply chain parameters, such as purchasing price, purchasing quantity, lead time and payment terms impact directly on working capital. The particular influences of supply chain parameters such as purchasing constraints and demand uncertainties on working capital are depicted in Figure 1.1.

Figure 1.1: Ishikawa diagram of working capital in the cable industry



Source: African Cables, (2004)

The figure summarizes the causes and effects of engaging in supply chain activities on working capital in the form of an Ishikawa diagram. Some items appear more than once in different root cause sections of the diagram, thus influencing working capital in more than one way. From the diagram it is obvious that purchases influence the working capital elements of inventory and accounts payable, whereas credit sales influence the working capital elements of accounts receivable and cash. However, the sales forecast reliability also has a direct effect on purchases. Manufacturing also impacts directly on inventory levels.

Although many of the parameters affect working capital in a direct or a direct but inverse manner, another important issue is uncertainty or reliability. The reliability of lead times is a concern. Manufacturing reliability or lead-time uncertainty, for example, influences work-in-process (WIP), finished goods (FG) levels, sales, cash transactions and inventories.

From an inventory perspective, it is supplier lead time uncertainty, which impacts on the availability of raw materials. Schoensleben (2000:41-42) refers to one of the transactional cost elements incurred by the buyer as cost of the lead time. This phenomenon relates to the fact that the buyer orders on the basis of requirement forecasts. The actual demand however, could be different from the requirement after the lapse of the lead time, particularly where lead times are particularly long.

Furthermore, the lack of information on the exact availability of materials and increased product and process complexity add to the transaction costs.

In conclusion, it is clear that many business decisions and internal and external influences, impact on working capital in the cable industry. This study will emphasize the impact of purchasing constraints and uncertainty of demand on the working capital elements of inventory, accounts payable and accounts receivable. Considering all the above intricacies, the question arises as to how cable manufacturers have been able to cope with this situation. This question will be discussed in more detail in the next section.

1.6 WORKING CAPITAL PERFORMANCE IN THE CABLE/ELECTRICAL MANUFACTURING INDUSTRY

The CFO Working Capital Management Conference Summary (2001:5) emphasizes that the viability of day-to-day business activity is based on daily changes in receivables, inventory and payables. Hence working capital must be recognized as the daily lifeblood of the business, and be managed accordingly. According to Kuhlemeyer (2001:3) and Brigham and Ehrhardt (2002:839-841), the management of working capital involves the administration of accounts payable and accounts receivable including the selection of an appropriate credit policy, cash and inventory. As outlined in Invest-Tech's White Paper on Working Capital (sa:2), each component of working capital has two dimensions - time and money. The faster money can be cycled in the business cycle, the more cash the business will generate. This means that, more funds will be available for financing other investments, or alternatively, borrowing requirements can be reduced.

In order to judge how well a company is doing - that is how well it collects its sales and pays its bills as well as manages inventory - several performance indicators, which are often used in economic benchmarks for an industry and companies alike, can be calculated. Eiteman, Stonehill and Moffett (2004:679-681) and Brigham and Ehrhardt (2002:841-843) recommend the computation of days' sales outstanding (DSO), days' payables outstanding (DPO), inventory turns, cash conversion cycle and days' working capital outstanding (DWC).

An additional ratio, described by Baccardax (2002:1), is the cash conversion efficiency (CCE), which is obtained by dividing cash flow from operations by sales. Baccardax (2002:1-7), CFO Staff (2002:1-2) and CFO Staff (2001:1-3) published a set of working capital indicators of some 750 companies that participated in a survey in order to illustrate its use as industry and company benchmarks. Included were the benchmarks of a few international cable manufacturers. In the same manner, working capital performance indicators were calculated for other international cable manufacturers from their annual reports, as well as for African Cables Ltd, in order to benchmark the management of working capital by African Cables Ltd.

Comparing the companies with one another, and with the published values, a large variation becomes apparent. Certainly, these variations must be interpreted from the viewpoint of the different business environment in which the companies operate. Basically, European, American and South African companies are evaluated, although a company like Pirelli operates in all of these countries.

Table 1.1: Historical working capital performance figures from survey

	REL - CFO MAGAZINES			
Working capital	Belden	General Cables	Pirelli	General Cables
Item	2001	2001	2002	2002
DSO	54	87	80	42
DPO	45	40	59	55
DWC	63	63	72	56
CCE	9	5	4	4
Inventory turns	5	5	5	4

Source: CFO Staff (2001:1-3; 2002:1-2), CFO EUROPE (2002:1-7)

Table 1. 2: Historical working capital performance figures from annual reports

	ANNUAL REPORTS							
Working capital	Draka		Pirelli		BICC		African Cables	
Item	2001	2000	2001	2000	1999	1998	2000	2001
DSO	70	73	80	87	84	52	66	60
DPO	27	33	59	65	63	32	32	26
DWC	109	103	71	82	98	83	99	89
CCE	5.9	7.3	N/A	N/A	4.9	6.4	N/A	N/A
Inventory turns	5.5	5.8	7.3	6.1	4.7	5.8	5.6	6.6

Source: Compiled from annual reports of companies (1999-2001)

In general, extremely favourable credit terms seem to be offered to customers by the cable industry, judging from the 70 to 87 days' sales outstanding, and it is noticeable that the DSOs for Draka, Pirelli and General Cable have improved, whereas those for BICC have increased. African Cables appears to have had a tighter control on Sales outstanding with 66 days in 2000, improving to 60 in 2002. Days' payable outstanding generally range from 40 to 63 days, except for Draka and African Cables, which operate at around 30 days. This indicates that their suppliers are unwilling to tender similar favourable credit terms to them. Inventory turns run between four and seven, which is indicative of long stock keeping periods.

From the above, one may conclude that working capital in the cable companies can be reduced by cutting down WIP and inventories, and stretching payments for as long as possible without prejudicing the companies' relationship with their suppliers. Since cable companies are still going concerns, it is obvious that this particular industry follows its own set of rules, within which such benchmark figures become more meaningful if they are considered over longer time periods and compared only within the industry, excluding the other branches of electrical and electronics businesses. Nonetheless, the indicators presented remain of critical importance because they are indicative of a business's wellbeing.

In this study, the impact of purchasing constraints and demand uncertainty on inventories, accounts payable and accounts receivable will be investigated with a view to gaining more insight into the dynamics of working capital management.

1.7 PROBLEM FORMULATION

1.7.1 Problem statement

The cable manufacturing process is complex in terms of the number of and types of processes. Considering that each cable has to undergo between five and 12 successive processes, each of the operations requires certain materials to be available at the right time to ensure the continuation of manufacturing.

As outlined earlier, material control for approximately 1 000 raw materials from about 100 suppliers is an overwhelming task that requires computerized support. In circumstances where materials must be imported and demand is uncertain, the MRPII computations can only provide guidelines on the times at which materials need to be purchased. One of the underlying assumptions of the MRP logic is a fixed master production schedule (MPS), which cannot be met when demand is uncertain. When materials are imported, supply lead times tend to be long. It may therefore happen that material was purchased for a production schedule, valid at the beginning of the supply lead time, but by the lapse of the lead time, this production schedule may have changed, requiring more or fewer quantities of the purchased material. Owing to the long supply lead time, the transport costs normally play a much more important role and optimal order quantities such as EOQs can no longer be purchased in many instances. The transport costs now dictate the acquisition of full container loads of material. Therefore, even with the widespread use of ERP systems using MRPII logic, the achievement of optimal inventory levels and other optimal working capital accounts remains difficult, in an environment that exhibits short-term demand changes as well as the necessity to source critical materials from abroad. Traditional methods such as reorder points and EOQs, incorporated into the ERP software, are used to assist this task. However as indicated in section 1.4, the use of MRP and EOQ in cable manufacturing is limited because of the circumstances in the cable industry in South Africa. The management of working capital is complicated by the complex interactions in the process flow of the cable manufacturing process as shown in figure 1.1 above.

With insight into the impact of the mentioned variables on working capital items, the question arises whether more realistic targets could improve the management of working capital, in the future.

This question, together with the abovementioned problems, will be investigated in this study with the following focus:

How do purchasing constraints and demand uncertainties impact on working capital in a South African cable manufacturer, compared with near optimal conditions?

1.7.2 Primary objective

The primary objective of this study is to determine the quantitative impact of purchasing constraints and demand uncertainties on the working capital elements of raw material inventories, accounts payable and accounts receivable in a cable manufacturer.

1.7.3 Secondary objectives

The secondary objectives of this study are

(1) to identify the purchasing constraints that influence working capital

(2) to identify demand uncertainties that influence working capital

(3) to determine working capital levels in the presence of purchasing constraints and demand uncertainty (calculated from the planned, actual and simulated demands, through exploding material requirements in an MRP method and computing the working capital values)

(4) to determine the differences in working capital levels between budgeted and actual conditions (by comparing the above working capital levels with working capital levels with EOQ [without purchasing constraints] and budgeted demand, calculated in the same manner as in (3))

(5) to determine average expected demand values (by simulating uncertain demand over multiple year periods, to arrive at average expected demand values, because single year actual demand figures do not provide certainty in terms of what demand, and ultimately, working capital values can be expected on average over a number of years)

(6) to determine projected working capital levels based on the simulated demand (and calculated in the same manner as in (3))

(7) to determine the difference in working capital levels between budgeted and simulated conditions (by comparing working capital levels under EOQ and budgeted demand with working capital levels under purchasing constraints and statistically simulated demand behaviour)

(8) to determine working capital benchmark ratios (as shown in tables 1.1 and 1.2 for working capital values as calculated for actual and simulated demand conditions, by converting working capital values into days' working capital, using actual WIP and FG values to augment the raw material inventory to comprehensive inventory values, and dividing by the actual cost of sales figures)

(9) to determine the quantitative difference between working capital benchmark ratios (by comparing benchmark ratios for (a) actual demand with purchasing constraints and actual demand without purchasing constraints, and (b) simulated demand with purchasing constraints and simulated demand without purchasing constraints)

1.7.4 Hypothesis

Based on the discussions above and in the previous sections, it appears logical to infer that increasing uncertainty in material supply and demand has an increasingly negative effect on working capital. The hypothesis of this study is therefore that purchasing constraints and variable demand have a statistically significant negative impact on working capital levels in terms of increasing average raw material inventory levels and accounts payable. Accounts receivable may either be reduced or increased.

1.8 RESEARCH METHODOLOGY

1.8.1 Research design

In order to achieve the objectives of this study, it is necessary to gather data and information from primary and secondary sources in an appropriate manner. Furthermore, the data and information are subject to an appropriate method of analysis.

The proposed research deals with the behaviour of certain variables and factors that influence one particular company in the cable industry. According to Tellis (1997:3), the research method applicable to single cases is known as the case study method and identified the following criteria that address the appropriateness of the case study method:

- case study specifically answers "how" and "why" questions.
- It is explanatory.
- It represents an empirical enquiry into a contemporary phenomenon in a real life context.
- The researcher has no control over the events.
- The internal validity of the case research findings is provided by a credible causal relationship between a predicted and an empirical pattern.
- External validity is achieved by clear specification of the applicable domain and research protocol.

The investigation of the behaviour of specific elements of working capital under variable demand and constrained purchasing conditions of a South African cable manufacturer certainly relates to a single case. The primary objective of this research is to determine the nature of the interaction. It is thus explanatory and answers the question "how", and in this case "to what degree" the variables influence one another. In addition, since the overall problem has as yet not been solved, it represents a contemporary phenomenon in a real-life context, and the researcher has no influence over the outcomes and the interaction between the variables.

The domain is clearly restricted to the domain of the cable manufacturer and is thus clearly specified. Exposing the causal relationship that exists between the variables and relating the findings back to the original hypothesis will achieve internal validation.

In conclusion, the proposed research matches the requirements and conditions for a case study method, which will be adopted.

1.8.2 Secondary research

To obtain insight into the dynamics of working capital and the factors that influence it, a literature study was conducted. The literature sources that were consulted were textbooks and journal articles. The Internet was used for searches relating to more contemporary information on the field of study of this research. Sources included areas such as supply chain management, purchasing management, operations research, financial and working capital management. The financial statements and reports of related companies were also used.

1.8.3 Empirical study

The empirical study involves gathering and analysing data and information relating to the company, African Cables Ltd. All primary data used in this research were extracted from African Cables' resident ERP system as well as the company's own financial reports and reports from affiliated or holding companies. The information was used to determine the impact of purchasing constraints and demand uncertainty on the working capital elements of inventories, accounts payable and accounts receivable.

Various sets of information are necessary to achieve the primary objective. Some of the information is available on the system or in records, while others have to be calculated and processed from available data for this study.

To determine the impact of purchasing constraints and uncertain demand on the working capital elements of raw material inventory, accounts payable and accounts receivable the following sets of data are necessary:

(1) *Working capital levels in the presence of purchasing constraints and uncertain demand.* This information will be calculated using the actual demand figures for a particular annual period as extracted from the ERP system and exploding the bills of materials for each cable type to obtain the raw material requirements. By applying actual manufacturing lead times to this calculation, to determine the availability of materials at the beginning of the manufacturing process, time-phased requirements are attained. These are used to calculate purchase proposals, taking into account actual minimum order quantities. In the second step, actual safety stock levels will also be considered. Both actual minimum order quantities and actual safety stocks are extracted from the ERP system.

Once the purchasing proposals have been computed, the remaining stock levels and monetary values, representing the inventory levels, can be calculated.
By using the time-phased purchase proposals, accounts payable values can be computed for both scenarios, with purchasing constraints and with purchasing constraints and safety stocks. The accounts receivable are derived using the initial demand figures and applying the current (as per ERP system) payment terms for end items.

(2) *Working capital levels without purchasing constraints and budgeted demand.* This information will be calculated using, firstly, the budgeted demand and secondly, actual demand figures. The explosion of material requirements follows in the same way as described above. To arrive at the purchasing proposals, the calculated EOQ quantities per material (as detailed in annexure 4) will be used, instead of the actual purchasing conditions. The inventory position is calculated as the difference between stock and purchases less requirements. These inventories will be multiplied by the price of the material (considering discounts) to arrive at the inventory values. Following the same principle as above, the accounts payable will be computed on the basis of the purchasing proposals. The accounts receivable will be calculated using the budgeted demand.

The quantification of the impact of the purchasing constraints on working capital items will be achieved by comparing the working capital levels based on budget demand and EOQ purchasing, with those derived from budget demand and actual purchasing conditions without safety stock, and with those derived from budget demand and actual purchasing conditions including safety stocks. The result will show the influence of constraints relating to minimum order quantities in the first instance, and a further impact by introducing safety stocks in addition to the minimum order quantities.

(2) *Working capital values under purchasing constraints and statistically simulated demand.* The actual demand as extracted from the ERP system, represents only one full annual period of demand. In addition, this demand is uncertain and the working capital values derived from this one period can only be indicative of changes for this period. In order to attain more reliable or expected data for decision making, the demand needs to be simulated. As further detailed in chapter 4, Monte Carlo simulation techniques will be employed, especially Monte Carlo sampling from known discrete cumulative frequency distribution functions. The simulation will be run over a period of 246 weeks or five years. Since the maximum width, that an Excel sheet can currently cater for is limited to 256 columns, 246 weeks represents the maximum logical sample that can be accommodated. Because the required number of rows during these calculations exceeds 256, no advantage could be added by transposing the rows and columns of the worksheet. The cumulative probability density functions for each cable will be calculated on the basis of the probability of each demand occurring in each of four intervals. The average demand of each interval will be used as a representative demand for the specific range of demands covered by the specific interval. Based on random number allocation to the intervals, random samples with average demand for a particular interval will be chosen. This will be repeated 246 times for each cable type. The simulated demand figures will be used instead of the actual demand figures for calculations as in (1) above, to arrive at inventory values, accounts payable and accounts receivable under purchasing constraints with and without safety stocks.

The monthly averages of the derived five-year working capital figures will then be used to compute the benchmark ratios to assess the impact of purchasing constraints and uncertain demand on working capital values and ratios. These values will also be compared with the working capital values and ratios as obtained from the annual values.

1.8.4 Delimitation of research

The prevailing research will concentrate on working capital items that can be calculated and forecasted with a degree of confidence. The study was therefore conducted within the following limitations:

- Cash, will not be included because it is currently managed on a daily basis and largely influenced by unforeseen expenditure such as maintenance and major repair.

- Finished goods stock will not be included because most orders are made for a particular customer and delivered on time. Approximately 75% of African Cables Ltd's production is for existing customer orders for finished products. Consequently low levels of FG are kept for orders.

- WIP will not be included, because it depends on the exact progress status of each individual cable during the manufacturing period. This would require a finite capacity scheduling programme which is not available.

- Accounts payable will be considered only in terms of the South African rand, ignoring international payment transfer conditions and exchange rate variations, since all material prices are converted to local currency and kept as such in the ERP system, including transport, clearing and other costs.

- In order to arrive at meaningful sets of benchmark ratios, the working capital figures derived from the calculations performed in this research will be augmented with actual WIP, FG and other stock figures. As outlined above these additional inventories will not form part of the calculations of this work but taken from African Cables Ltd's ERP system.

1.9 CONCLUSION

This chapter outlined the need for companies to try to reduce their working capital investments in order to free up capital for better use. Many different approaches have been adopted to optimise the parameters leading to the increased working capital investment. The parameters, which are more operational than financial, are generally found in the supply chain activities of the companies. The principal areas are inventory management, purchasing and sales because these activities relate directly to a company's levels of working capital. Specifically, the individual parameters are inventory value, investment in accounts payable and accounts receivable. Although individual optimisation attempts were made at the outset, it was soon found that a more integrative approach such as supply chain management and total working capital management are required as explained in chapters 2 and 3. This research project endeavours to show the degree of influence of purchasing constraints and demand uncertainty on the working capital levels of African Cables Ltd, a leading South African cable manufacturer.

CHAPTER 2: SUPPLY CHAIN MANAGEMENT IN A CABLE MANUFACTURER

CHAPTER 2: SUPPLY CHAIN MANAGEMENT IN A CABLE MANUFACTURER

2.1 INTRODUCTION

Supply chains in the cable industry are complex and a multitude of factors in the various stages of the supply chain influence the working capital of the end producer. This chapter starts with a discussion of supply chain and supply chain management. The specific supply chain of a cable manufacturer will then be explained to provide insight into the factors that influence working capital from the original source to the final consumer. The various elements of the cable supply chain, including material supply, the transformation process and the customer will be outlined.

2.2 SUPPLY CHAIN MANAGEMENT

2.2.1 The concept of the supply chain

According to Ganeshan and Harrison (1995:1-6), a supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. A supply chain exists in retail, service and manufacturing organizations, although the complexity of the chain may vary noticeably from industry to industry and from one firm to the next. This view is widely shared by other authors such as Lambert (2001:4), who describes the supply chain network as the sum of all the firms participating in such a chain, from the raw materials to the ultimate consumer. According to Dong (2001:1-2), a supply chain may also be defined as a system of suppliers, manufacturers, distributors, retailers and customers, in which materials flow downstream from suppliers to customers and information flows in both directions. Angerhofer and Angelides (2000:343) define the supply chain as a system whose constituent parts include material suppliers, production facilities, distribution services and customers linked together via the feed-forward flow of materials and the feedback flow of information. This definition limits the supply chain concept to materials only.

The Supply Chain Resource Consortium (2003:1) defines a supply chain as encompassing all activities associated with the flow and transformation of goods from the raw material stage, through to the end users, as well as the associated information flows. Material and information flow both up and down the supply chain. The supply chain includes new product development, system management, operations and assembly, purchasing, production scheduling, order processing, inventory management, transportation, warehousing and customer service. Supply chains are essentially a series of linked suppliers and customers. Every customer is, in turn, a supplier to the next downstream organization until a finished product reaches the ultimate customer.

The above perspectives on the concept, illustrate the interdependence or cooperation between vertically linked organizations in which information flows in both directions are vitally important.

2.2.2 The supply chain of a cable manufacturer

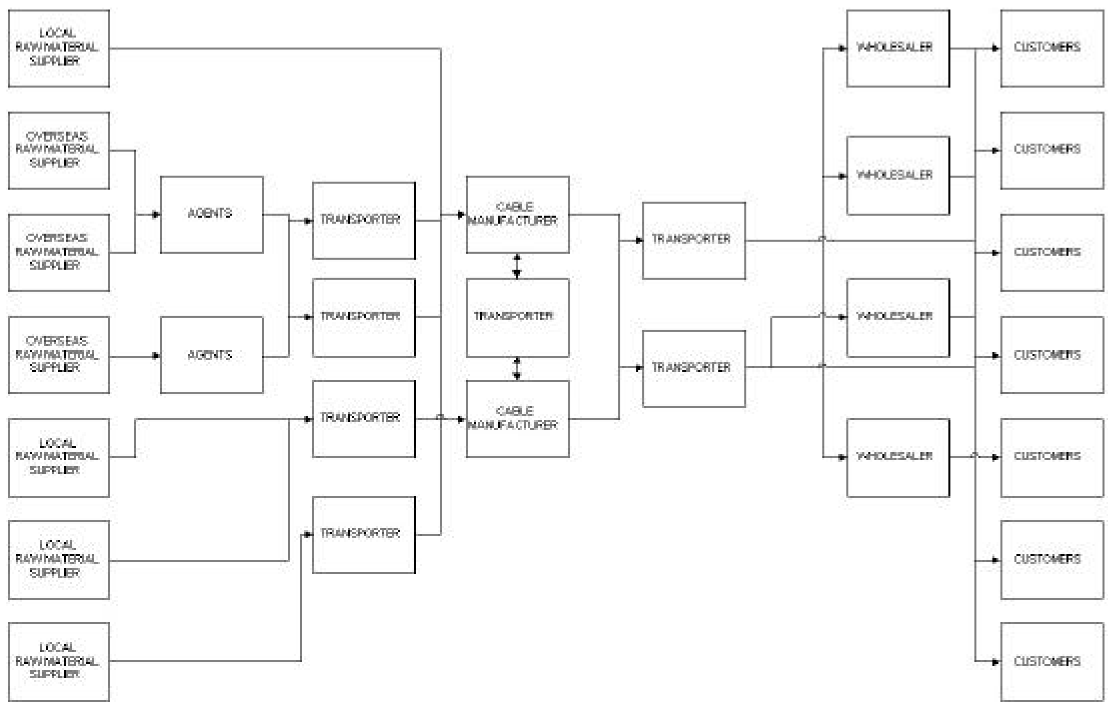
Figure 2.1 depicts the complex supply chain of the South African cable industry. One should note, that the raw material suppliers, or second-tier and third-tier suppliers are either local or international, whereas the latter are mostly represented by agents operating locally (second-tier and first-tier suppliers). The agents take orders from the cable manufacturer and communicate them directly to the overseas supplier (the principal). Agents also handle quality issues and returns, and in some instances arrange for shipments through forwarders. In the case of international purchases, an international shipping line will transport the materials. The specific transport arrangements depend on the particular Inco-terms of the purchase. Regarding EXW and FOB, the cable manufacturer is responsible for transport, whereas for CFR and CIF, the supplier will arrange for transport using appropriate forwarders. Once on South African territory and in the case of local purchases, the goods are distributed to the manufacturers by local transporters arranged either by the agent, supplier or cable manufacturer.

The manufacturers convert the raw materials into semifinished and finished goods and distribute them to the customer directly (first- and second-tier customers) or through wholesalers, which are typically first-tier customers. Occasionally manufacturers purchase finished goods from each other to fulfil urgent requirements.

The finished goods must be distributed to the customers. A cable manufacturer has the option of maintaining its own fleet of trucks or outsourcing this activity. African Cables Ltd has opted to outsource the transport activity to a local transport company. Sometimes customers insist on collecting their cables by means of their own transport.

The wholesalers cater specifically for the general consumer market, but also compete with the cable manufacturers for end customers. Although the larger customers, such as municipalities and mining houses, enter into contracts with cable manufacturers, the wholesalers generally cater for any customer requiring cables and purchase on their forecast, as they perceive their future demand. Hence, sometimes the same customer purchases from wholesalers and cable manufacturers.

Figure 2. 1: The supply chain of the South African cable manufacturer



Source: African Cables Ltd's procurement and sales information (2004)

2.2.3 The concept of supply chain management

The second issue requiring elucidation is supply chain management. With due consideration of the management principles as discussed by Hugo et al (2002:3-5), it follows that supply chain management must deal with planning and organizing the whole supply chain as well as providing the necessary resources and leadership. It also involves taking appropriate action in cases of deviation in such a way that the outcome of the whole is greater than the sum total of the outcomes of the individual areas covered by the supply chain. This approach is based on the fact that the individual areas of the supply chain represent a system of open subsystems that require integration. Angerhofer and Angelides (2000:343) define supply chain management as a process-oriented, integrated approach to procuring, producing and delivering products and services to customers. Integrated supply chain management covers the management of material, information and fund flows. According to Lambert (2001:2), supply chain management is the integration of key business processes from the end user through the original suppliers which provides products, services and information that add value for customers and stakeholders.

The Supply Chain Resource Consortium (2003:1) defines SCM as the integration of these activities through improved supply chain relationships to achieve a sustainable competitive advantage. According to Hugo et al (2002:28), supply chain management is the systems approach for managing the entire flow of information, materials and services from raw material suppliers through factories and warehouses to the end customer.

All of the definitions embrace the requirement of integration of the processes from original supplier to end users and include the management of information flow. Angerhofer and Angelides (2000:343) also include the flow of funds.

The phenomenon of increased efficiency due to integration is commonly referred to as *synergy*, and can be included to possibly enhance the definition. In addition, one should bear in mind that the definitions mention only vertical information flow. However, there may be a horizontal flow between supply chains.
It is obvious that adding value is an important component of the supply chain management concept. Eliminating the duplication of asset utilization, and reducing cycle times by streamlining processes can add value.

2.2.4 Supply chain management best practices

Although one of the principal purposes of SCM is to minimize the use of working capital throughout the whole supply chain, working capital is still required for the operation of the whole supply chain. To this end, companies have embarked on developing best practices, - activities suited to their particular operation - to reduce working capital. Fitzgerald (2002:1-2) points out that companies have attempted to focus as much as possible on core competencies, while outsourcing other work to outside firms. Technology has provided new tools to extract maximum value from supply. The Internet is particular deemed to have increased value for all entities in the supply chain. Other factors that affect the implementation of best practices in procurement include cooperative supplier relations, a culture of continuous improvement, the cross-functional approach and a sound understanding of cost drivers. Critically important to best practices in procurement is the development of systems and methodologies to measure performance. Shapiro (2004:1-2) adds that the exploration of transactional data is vitally important to enhance the knowledge, required to make the necessary business decisions.

In general, best practices are found in the areas of supplier relation, cost management and the use of key performance indicators (Fitzgerald, 2002:5-7). Hugo, Badenhorst-Weiss and Van Biljon (2004:11) extend this list by including flexible organizations, organizational relationships, coordination in the supply chain, improved communications, outsourcing of noncore competencies, cycle time reduction, JIT management and TQM and continuous improvement.

The South African cable industry, and African Cables Ltd in particular, have also been affected by these developments. African Cables Ltd is specifically concerned with exploring possibilities for cost reduction. One of the obvious areas to examine is the reduction of physical waste, including the waste of time, as mentioned in the previous section.

The waste produced in the cable industry consists of all of the materials used in the manufacturing process. However, many materials can be recycled and re-used. Examples of this activity are metals, which are purchased by specialized scrap dealers, and resold to companies specializing in purifying the materials. Another example is the recycling of PVC compound. PVC compound scrap commonly originates at the extrusion lines where it is applied as insulation as well as inner and outer sheathing. The scrap is collected and regranulated for inner sheathing purposes only, where the governing specifications allow this practice. Other materials, such as cross-linked polyethylene cannot be recycled for re-use as cable material.

African Cables Ltd further reduces cost, by employing EDI to effect payments, order transmittal to the supplier directly out of the ERP system, and bar-coding to track material movements in an effort to provide real-time information.

Cross-functional teams are employed in African Cables Ltd to enhance the process of cable and process design and material development. This process has not yet reached the level of cross-organizational teams. Owing to the fact that cable designs and material characteristics are laid down by SABS specifications, this task has been standardized. The benefit of cross-organizational teams in this sphere has become questionable.

Outsourcing noncore competencies has been successfully implemented in African Cables Ltd. In particular, services such as transportation of finished goods, the battening (closing) of customer drums, steel-wire rewinding operations and the reclaiming of scrap have effectively been outsourced to outside contractors.

JIT management is generally not applicable to African Cables Ltd operation. The basic assumption of JIT is that this philosophy is based on a fixed MPS. However, as shown in chapter 1, the demand for the firm's end products is highly variable, and a fixed MPS can thus not be maintained.

In order to establish the operational capabilities for a momentarily given demand, African Cables Ltd is in the process of improving its coordination in the supply chain by implementing an APS system. Based on the operational possibilities, the exact delivery times of finished product and raw material requirements may be computed more accurately, leading to improved resource utilization and more reliable data passed on to suppliers and customers.

As yet, cycle times are not fully measured at African Cables Ltd. Although manufacturing lead times are monitored, they do not provide any conclusive evidence of the reliability of the manufacturing period of the different products.

African Cables Ltd has engaged in discussions with suppliers to improve relationships with them. However, many purchases are conducted on an arm's length basis, or business awarded by tender. Few longer-term contracts are in place.

African Cables Ltd specifically forges relationships with key customers, ensuring the on-time delivery of high-quality products. It also attempts to improve visibility of product use by these customers, by assisting in the implementation of vendor managed consignment stocks and common ERP platforms.

African Cables is a quality-driven company as detailed in 1.3. It thus fully embraces the concepts of total quality management and continuous improvement.

The above discussion shows that African Cables Ltd has recognized the importance of SCM best practices, and although some are fully implemented, others are in the state of development and not yet fully utilized.

As indicated above, many SCM best practices may improve the efficiency of an organization and in the cable industry in particular. The impact of purchasing constraints and demand uncertainties may be reduced by better utilization of SCM practices. In the process, working capital levels may be optimized throughout the SC.

2.3 MATERIAL SUPPLY

2.3.1 Introduction

This study focuses on purchasing constraints and demand uncertainties and the way they impact on levels of working capital in a cable manufacturer's supply chain. The materials used in the manufacturing process, especially the origin of the materials and their supply lead time and price, impact directly on the purchasing conditions and constraints.

On the supply side of a cable manufacturer's supply chain, the starting point is the identification and acceptance of suppliers of raw materials. The sourcing mechanism, which includes the evaluation of materials and suppliers, as well as the conditions under which the materials may be obtained, comprises quality, price, discounts, payment conditions and delivery conditions. Purchasing in cable manufacturing is complicated, because many materials have to be sourced overseas, and a variety of materials and many suppliers are involved.

The following sections provide a brief overview of the diversity of the types of materials required to manufacture African Cables' range of products and their relevant purchasing conditions.

2.3.2 Materials used in the cable industry

The materials used in the general cable industry may be classified into the following six groups:

(1) Metals (or conducting materials)
(2) Semi- and non-conducting materials
(3) Binding materials
(4) Packing materials
(5) Processing materials
(6) Additives

The possible material combinations and their applications will be briefly outlined in the ensuing sections (Heinhold 1990:11-47).

(1) *Metals.* Conducting metallic materials mainly comprise electrolytic copper, aluminium, aluminium alloy, galvanized steel, lead and lead alloy. Copper and aluminium are the main constituents of cable conductors, whereas aluminium alloy serves the dual purpose of conductor material and carrier element. The lead and lead alloy perform moisture and corrosion barrier functions when applied over insulated conductors (cores). Galvanized steel applied either in the form of steel wires or as tape, is used for mechanical protection.

(2) *Semi- and non-conducting materials.* This group of materials includes paper and impregnating oils, on the one hand, and polymeric compounds on the other. Papers usually consist of pure sodium cellulose paper for insulating purposes or, when combined with carbon black during the manufacturing process, for semi-conducting purposes. The second part of this material group comprises a wide range of unmixed polymers as well as of polymer compounds which, in turn, consist of a large variety of ingredients, such as polymers, mineral fillers, plasticizers, processing aids, anti-oxidants and cross-linking agents. Depending on their electrical properties, such polymers or compounds are applied as insulations and inner and/or outer protective sheaths.

(3) *Binding materials.* Binding materials include paper, polymeric materials and copper tapes. During the manufacturing processes, it may become necessary to bind individual elements together in order to avoid losing a certain shape or dimension, to separate incompatible layers from each other, or even introduce special characteristics into the cable assembly. Paper with a thickness of typically 100 to 200 µm or polymeric materials with a thickness range of 25 to 200 µm generally find their application in binding and separation tapes. Copper and polymeric tapes containing water-swellable substances provide special functionality.

(4) *Packing materials.* The finished cables are generally packed onto specially designed wooden drums, with the exception of very small cables and wires, which may be packed into cardboard boxes and/or shrink-wrapped. Some manufacturers use returnable steel drums. Packing materials also include nails, battens and steel or plastic straps to close the wooden drums, pallets, boxes, etc.

(5) *Processing materials*. This class of material spans a wide variety of materials, ranging from process oils and mineral powders to polymeric processing aids.

(6) *Additives.* Additives form a vital part of the manufacturing process, especially the processes, that apply the polymeric compounds. The additives themselves consist of a polymeric base and an addition of organic or inorganic pigments and other substances that are difficult to apply. The prebatching, carried out by specialized manufacturers, serves the purpose of applying colours and special substances more easily to specific cable components, without the cable producer having to acquire such specialized equipment for several machines.

The above explanation reveals the multiplicity of materials required for the cable manufacturing process. In total, a number of 1 000 materials is not uncommon. If one adds maintenance items, this number may increase to several thousands, making material control a daunting task.

2.3.3 Supply base

The cable manufacturing process requires many different materials to achieve the desired cable properties. The purchasing function therefore has to locate suppliers who will provide the materials at the required quality, time and price. Cable manufacturers have to deal with many suppliers. African Cables Ltd, for example, deals with approximately 100 (mainly local) material suppliers. South African cable manufacturers are also faced with the problem of a large number of the cable materials not being available locally.

An ABC analysis of African Cables' current supply base and its origin are attached as annexure 3. It is clear from annexure 3 that the A category suppliers (the top 8 items which form 74.47% of total spending) consist of Palabora Copper Mining, Billiton, Springbok Box (Pty) Ltd, Fry's Metals (Pty) Ltd, Cape Gate (Pty) Ltd, Dow Chemicals Division, Borealis A/S and Sasol Polymers (Vinyl Division), of which five suppliers are local, and the products of three suppliers are sourced internationally. The B category consists of 22 suppliers which form 21.41% of total spent and 94.88% together with the A suppliers. Eight suppliers deliver from overseas locations. The last 5.12% of the total spent consists of 87 suppliers, 11 of which are located outside the African continent.
Altogether, 15.9% of the total spent is paid out to overseas suppliers. The materials imported range from metals such as copper and aluminium billets to insulating and sheathing compounds for HVXLPE and MVXLPE cables to highly specialized tapes and assemblies.

All of the above materials, both local and international, except for the assemblies and packaging materials, will be considered in the empirical study.

2.3.4 Purchasing conditions of a South African cable manufacturer

The following factors impact on the purchasing of requirements of cable manufacturing in South Africa:

(1) number of suppliers
(2) type and variety of materials
(3) Inco-terms
(4) Lead times
(5) payment terms

(1) Number of suppliers. A variety of materials needs to be procured from a large number of suppliers, because many of them specialize only in certain commodities. Some important raw materials for cable manufacturing are sourced outside South Africa. In addition, bearing in mind that a company normally requires more than one supplier to ensure an uninterrupted supply, at least locally, a total of 100 suppliers is not uncommon.

(2) Type and variety of Materials. A large variety of materials needs to be sourced in the power cable industry. Owing to the number of options, in terms of the types of materials permitted by the relevant cable specifications for each manufacturing process, a fairly large number of materials is required to produce compliant cables. These numbers comprise several hundred types of raw materials, and with the inclusion of packing and maintenance materials, can easily increase to several thousand items.

(3) Inco-terms. The way in which risk is handled during the purchasing activity as well as the duties that the buyer and seller are expected to perform are basically laid down by the Inco-terms of the International Chamber of Commerce (ICC). (ICC 2000:3-120; Hugo et al 2002:204). These range from mostly ex works or named place (EXW) for local supplies, to free on board (FOB), cost, insurance and freight (CIF) and cost and freight (CFR) in the case of international purchases. The Inco-terms impact directly on the cable manufacturer, because in certain instances, (eg in the EXW case), the manufacturer has the additional burden of arranging for clearing and transport. The costs incurred by transporting and clearing the goods add to the material price.

(4) Lead times. The lead time, known as the time that elapses from the order placement to the receipt of material comprises two main components. Firstly, the supplier's manufacturing time (when it is made to order, particularly with custom-made items), and secondly, the actual shipping or transport time.

Materials purchased locally are subject to a total lead time between one day and two weeks, whereas international deliveries are constrained, because they require approximately six to 12 weeks. Often, local and international suppliers are prepared to keep consignment stock at the manufacturer's premises or close to his or her premises, providing zero lead time.

(5) Payment terms. These terms regulate the conditions of payment, particularly when payment is required and whether any discounts are offered for early payment. The local suppliers generally demand payment 30 days net after receipt of order, although special discounts may be arranged. The international community allows more favourable terms, such as 60 to 90 days net.

2.3.5 The role of supply-side intermediaries

The main intermediaries that fulfil a key role in the purchasing cycle of African Cables Ltd are agents.

According to Neff (2003:1), agents are the most common form of intermediaries, and handle virtually all aspects of international commerce, from sales to shipping, finance, advertising and regulatory matters. The relationship between the principal and agent may vary. Agents are covered by common law in South Africa. The relationship is usually based on an agreement between principal and agent, wherein the agent acts on behalf of principal and binds him or her to agreements negotiated. The agent does not act on his or her own authority and the principal therefore generally dictates the terms the agent will offer.

Agents are used in the South African cable industry mainly to handle orders, communicate with the overseas principal and, depending on the type of purchase agreement and the embedded Inco-terms, arrange shipment. Agents also typically handle complaints and returns to the supplier (reverse logistics requirements). This relieves the cable manufacturer of the burden of having to deal with the overseas suppliers and all the complications involved. As outlined in section 2.2.2, the responsibility for the shipment and the incurred costs depends on the type of purchasing agreement concluded between the cable manufacturer and the supplier. Another important reason for the use of agents is that some agents also keep consignment stock on their principal’s (overseas suppliers) behalf, and the latter will always remain the owners of the stock. The agent or the cable manufacturer, depending on the location of the warehouse, may carry the stockholding cost. The main goal is to provide buffer inventories to make up for long lead times.

2.4 THE TRANSFORMATION PROCESS

2.4.1 Introduction

In cable manufacturing a wide range of cables such as low-, medium- and high-voltage cables are manufactured. African Cables Ltd manufactures mainly medium- and low-voltage cables for the general consumer market, the mining industry and municipalities. The cable manufacturing process is complex because of the variety of raw materials required.

The cable manufacturing process may comprise as many as 10 individual processes, each of which may require a number of specific raw materials. Because processes vary in speed, depending on the product design, the correct allocation of capacity, process time, lead times and the timely receipt of materials become vital considerations. The number of alternative materials, product mix, set up and changeover procedures and physical operations design influences the complexity of the manufacturing process.

The sections below outline the inherent complexity of the cable manufacturing process.

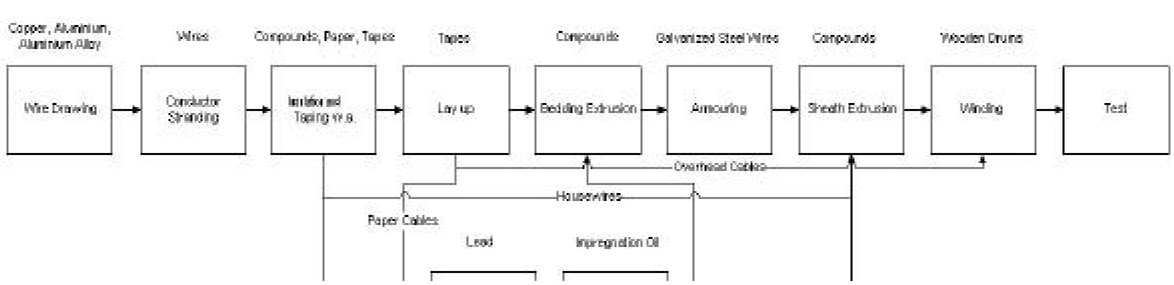
2.4.2 Manufacturing processes and operations requirements

The manufacturing processes applicable to the cable industry are as follows (Heinhold 1990:11-47):

- Wire drawing
- Conductor stranding
- Insulation extrusion
- Laying up
- Impregnation
- Lead extrusion
- Bedding or inner sheath extrusion
- Armouring
- Outer sheath extrusion
- Winding
- Test

The above is a list of processes most commonly encountered in cable manufacturing. However, not all cables have to be subjected to all of the processes. In the simplest of cables, only three processes are required, whereas some of the larger cables may need to complete each of these processes. The flow diagram for the basic manufacturing process and the type of material consumed in each step is depicted in figure 2.2.

Figure 2.2: Cable manufacturing process flow diagram



Source: African Cables, Planning Data (2004)

The manufacturing process starts with wire drawing. The process generally uses a 7.9 mm diameter copper rod as input. Drawing the rod requires it to be pulled through a series of dies, the orifices of which are gradually reduced in diameter, producing a wire of between 1.5 and 4 mm in diameter. Occasionally, thinner wires are required, which necessitates a second wire-drawing process. Owing to the work hardening of the copper during the process, the wires undergo electric annealing to the level specified. The conductor-stranding process collects a certain number of wires, arranging them into layers and applying a helical twist to each layer, in the opposite direction to the previous layer.

The insulation process follows the manufacture of the conductor. In the case of paper cables, the insulation consists of paper – hence the need for a paper lapping process. All polymeric cables have an insulation of polymer or polymer compound, which is normally applied by means of extrusion.

Following the insulation process, the insulated conductors or cores need to be twisted together helically. This is referred to as *laying up*. The laid-up cable assembly is then moved to impregnation in the case of paper cables, where the paper insulation is subjected to hot impregnating compound under vacuum. This process provides the necessary electrical and physical properties. Following the impregnation cycle, a lead sheath is applied by means of extrusion. This lead sheath protects the cable from ingress of moisture as well as from corrosion.

In the case of polymeric cables, as well as the lead-sheathed paper cable, an inner sheath of plastic compound is applied to protect the cable from subsequent armouring. As before, the layer of compound is applied by means of extrusion. The armouring process applies a number of galvanized steel wires of a specified size over the bedding, in a helical manner, to prevent the loosening of the wire layer. Finally, an outer protective sheath of mainly polymer or compound is extruded over the wire layer.

All processes thus far have been performed on bulk drums. Hence in the next operation, the cable has to be wound into the individual customer specified lengths. Electrical testing of the final cables may be carried out before or after winding, in order to prove the electrical integrity of the finished product.

Owing to the aforementioned number and diversity of processes involved in the manufacture of electric cables, a process-oriented operations layout is commonly found. Specialised cables or cable types utilising an individual set of machinery, have been manufactured in separate or near cell type manufacturing arrangements. In many instances, a combination of process layout and product layout is employed to achieve some optimum operations design.

2.5 THE MARKET OF A CABLE MANUFACTURER IN SOUTH AFRICA

2.5.1 Demand conditions

Schonberger and Knod (2001:80) contend that demand is the lifeblood of an enterprise. It is the primary drive behind all supply chain activities. In order to satisfy customer demand, it needs to be properly understood and forecast as accurately as possible. However, even with the best forecast, there are always some customers who appear and place new orders or cancel orders unexpectedly, causing more or less disorder in prepared plans and schedules.

The demand for energy cables in South Africa is both diverse and variable, depending on the market sector and geographical areas. Two of the more important sources of demand for cables are the mining industry and municipalities. The demand from these markets is uncertain and strongly correlated to the gold price levels and, inter alia, government spending policies. The demand for cable used in the private industry relies on general expansionary project activities, such as municipal expansions and maintenance activities.

The South African cable market is served by a number of large distributors (wholesalers) who have specific views on market requirements and tend to forecast and place orders on that basis. In addition to the distributors' forecast, the cable manufacturing companies' own marketing departments have to decide on market requirements. The inaccuracies of both forecasts add to the already volatile market conditions.

In addition, customers in different regions do not necessarily have a common preference for a particular cable design, given a specific set of circumstances. Also, preferences for certain cables and cable designs may change over time. A current market share profile for the South African energy cable market per product type is contained in annexure 1, and elaborated on in annexure 2.

Besides the longer-term variation in demand as discussed above, there are short-term variations, which also have to be accommodated. One of the causes of short-term demand is cable theft.[1] Other causes of short-term demand are break-downs on mines, in particular those producing gold and platinum, or municipal networks, resulting in emergency situations.

Market research in the cable industry has not been very successful in forecasting these demand variations because of unforeseen, sometimes irrational causes of demand. For example, cable types ordered sometimes depend on personal preference. Future demand from the customer's point of view may or may not exist and their final materialization will depend on, inter alia, overall economic conditions. In emergencies, such as lost or broken cables, local cable manufacturers are required to react swiftly, in order to restore electricity supply to prevent huge discomfort or losses for industry, commerce and the public. Such swift reaction often leads to disruptions in the manufacturer's process, which basically boils down to accommodating unplanned demand with high priority. However, higher inventory levels are undesirable because the exact type of cable required is not known prior to the event.

2.5.2 CUSTOMER GROUPS

The electric cable manufacturers' and specifically African Cables' supply chain consists of several key participants - consumers, competitors, intermediaries, transporters and suppliers. Suppliers, supply-side intermediaries, transporters and competitors have already been discussed. This section focuses on the consumers and consumer-side intermediaries with which African Cables Ltd deals.

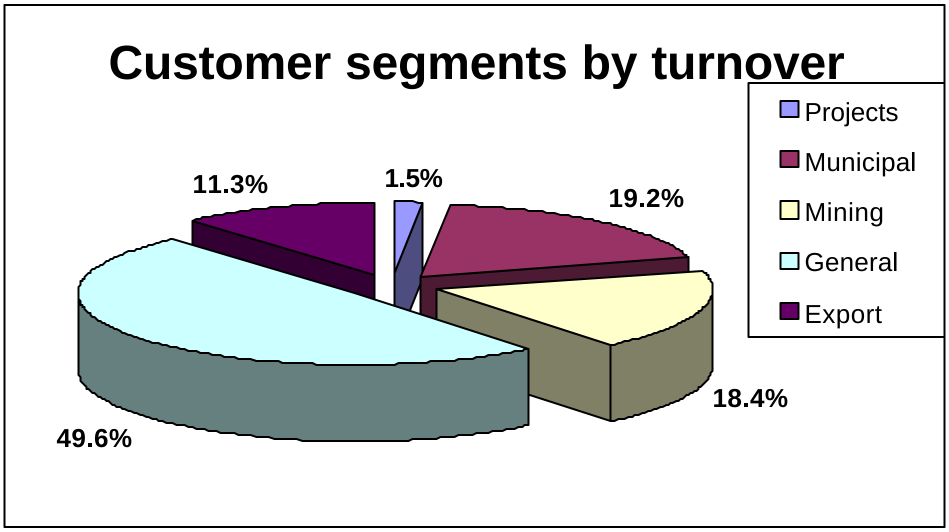
The consumers may be divided into several groups, depending on their location, say, national or international, and the type of industry. Approximately 90% of African Cables Ltd's products are sold locally. The market has been divided into the following customer groups:

- general market (ie wholesale companies and contractors)
- the mining industry
- municipalities
- projects
- export

The approximate market share of each customer group is shown in figure 2.3.

Figure 2.3: Customer segments by turnover

[1] Theft of cables containing nonferrous metallic conductors has become a major problem in South Africa. Major institutions such as Eskom, Transnet and Telkom lose an estimated R300 million in revenue annually (Van Den Berg (2002:1),.



Source: African Cables, Marketing Data (2003)

From figure 2.3 it is clear that the primary local segment is the general market, generating 49.6% of turnover, the municipal and mining markets generating 19.2 and 18.4% of turnover respectively, and 11.3% of production being exported. Projects form a tiny segment, currently contributing only 1.5% to turnover.

The requirements for cables vary widely between the different customer segments. Municipalities typically purchase on annual contracts, small ranges of cables types, which suit their particular needs and standards, whereas the mining industry requires a somewhat wider range of cables, in widely varying quantities, but at short notice. The general first-tier customer market consists mainly of intermediaries such as wholesale companies and contractors. Their aim is to satisfy the needs of various industries such as the general consumer market, municipalities and mining houses (second-tier customers). Hence the requirements are largely variable regarding quantity, type and time. Projects are unique, planned months ahead, and generally cover a larger variety of cable types in small quantities.

To satisfy the different customer segments' requirements, African Cables specifically maintains a database with approximately 3 000 different cable designs, and each cable can be offered with a different colour outer sheath and different cable markings. To further appreciate the complexity of the electrical cable market, customers require African Cables to manufacture between 150 and 200 different designs, on average, every month. Special design requirements for projects are not uncommon.

2.6 SUPPLY CHAIN PROBLEMS ENCOUNTERED BY THE CABLE MANUFACTURERS

As shown in the previous sections, the business environment of the South African cable manufacturer is extremely complex. Owing to the changing nature of the demand, cables are not produced to be kept in stock as finished goods. They are therefore generally manufactured to order. A large variety of cables and subvariation must be manufactured on time and with the required characteristics to satisfy and retain customers. The problem of purchasing the correct amount and types of raw materials and keeping inventory as optimal as possible therefore poses a huge challenge for the cable manufacturer.

The processes used to produce the cables were detailed in section 2.3.2. Each process requires time which, in turn, depends on the size and type of cable and the type of material consumed in the particular process. Although planning and scheduling are carried out, any change of this plan, say a delay in materials or any sudden change in the manufacturing programme, will lead to inefficiencies. Such inefficiencies can be recognized in excess inventory in terms of raw materials as well as WIP and FG, and therefore in an additional investment in working capital.

The main influencing parameters in terms of material delays are supply uncertainties. These stem primarily from the variability in lead times as well as the necessity of purchasing in large lots versus EOQ quantities in an attempt to limit transport expenses in the case of imports where materials are transported by sea vessel for periods of four to six weeks. These are known as purchasing constraints.

On the demand side, problems originate from the uncertainties in the required cable types. Ordering patterns in the market as previously outlined may change over time, which requires different or alternative products to be manufactured than initially budgeted for. In addition, unplanned orders may need to be accepted in emergencies, particularly energy supplying cables which, in many instances, entail deliberated expediting of specific orders, altering the expected or forecast demand and in reciprocation a change in the forecasted demand for materials.

2.7 CONCLUSION

This chapter explained the supply chain of the South African cable manufacturer, and African Cables Ltd’s supply chain in particular. The discussion focused especially on the material supply, the transformation process and the customer.

It was shown that there are complex interactions between the individual organizations constituting the supply chain, as well as between the different levels of the supply chain. Complexity was all too evident in the diversity of the materials and the processing required manufacturing the finished goods.

Of equal importance was the fact that uncertainty in the execution of supply chain activities inhibits full integration of the supply chain. Supply chain best practices were illustrated and African Cables Ltd’s position in terms of the application of the best practices indicated.

African Cables Ltd's customer base was divided into five distinct segments based on the turnover realised from each segment. The general market, municipal and mining markets make up 87.2% of total turnover.

Finally, specific attention was paid to the supply chain problems encountered by the cable manufacturers. It was pointed out that because of the uncertainties in supply and demand, additional stocks need to be kept. Also, owing to long shipping times nonoptimal (non EOQ) quantities of raw materials need to be purchased. These discussions showed, that safety stocks and the uncertainties in supply and demand must be considered as constraints, which have explicit quantitative impacts on the selected elements of working capital.

Since the focus of this research is, to quantify the impacts of purchasing constraints and demand uncertainty on elements of working capital, the following chapter will define working capital and explain in detail how the individual working capital accounts considered in this research will be affected by changes in demand and purchasing constraints.

CHAPTER 3: WORKING CAPITAL AND THE INFLUENCE OF PURCHASING CONSTRAINTS AND UNCERTAIN DEMAND

CHAPTER 3: WORKING CAPITAL IN THE CABLE MANUFACTURER

3.1 INTRODUCTION

As mentioned earlier, this research study focuses on the impact of purchasing constraints and demand uncertainty on working capital. This chapter explains the concept of working capital, the interaction between elements thereof and the factors that influence these elements.

3.2 DEFINITION AND ELEMENTS

Kuhlemeyer (2001:3) and Brigham and Ehrhardt (2002:837-839) define working capital as two concepts, namely as *gross working capital*, representing all current assets, and as *net working capital*, which is the difference between current assets and current liabilities. This view is shared by Walsh (2003:120-124), Atrill (2002:329-330) and Ross, Westerfield, Jordan and Firer (2003:506-507). According to the multinational view, Eiteman et al (2004:681) limit net working capital to current assets including accounts receivable and inventory, excluding cash, less current liabilities, excluding short-term debt. These authors view cash and short-term debt as part of gross working capital. Cash and short-term debt do not react spontaneously to the general business activities and are thus excluded.

The Office of Water Services (OFWAT 2002:7) in the UK, includes all trade creditors and debtors, stock and other accruals and prepayments, brought into calculation against profit, into the definition of working capital. Emery, Finnerty & Stowe (2004:679) mention, in particular, short-term securities, short-term borrowings and taxes payable into current assets and current liabilities respectively.

It is clear that the components of working capital, which are included in the balance sheet, comprise accounts receivable, accounts payable, cash and inventories. As indicated in section 1.9.4 of this study, the term “net working capital” will, for the purpose of this study, mean the net level or difference between current assets and current liabilities limited to inventory, trade debtors and trade creditors.

Accounts receivable consist mainly of debtors and receivables from associated and subsidiary companies. However, receivables besides trade debtors are not directly influenced by the above-mentioned supply chain parameters such as purchasing constraints and demand uncertainty in the short term and, for the purpose of this research, will be ignored. Accounts receivable form an integral part of a company's strategy to optimize sales. Every business would certainly prefer cash sales, but competitive forces coerce enterprises into offering credit arrangements to their customers. However, carrying receivables imposes costs, in terms of having to finance the outstanding balances, as well as possible bad debts. The proper design and management of a credit policy and outstanding balances are therefore of paramount importance to ensure sufficient liquidity in the company.

Accounts payable comprise creditors, accrued wages, tax liabilities and short-term portions of long-term loans and other short-term debt (Emery et al 2004:679). The main issue of accounts payable is the payment of creditors (suppliers) for credit purchases of materials. Purchasing decisions or demand uncertainties do not influence the other elements such as taxes and wages. They must, however, be considered when evaluating overall cash requirements.

Cash may consist of actual cash as well as near cash equivalents, which can be converted into cash in a short timespan.

Inventories comprise raw material stock, work-in-progress stock and finished goods, as well as processing and packaging materials and maintenance spares.

As mentioned in section 1.9.4, cash is highly variable and subject to other expenditure besides purchasing costs, such as investment in capital assets and emergency repairs, and will therefore not form part of this research study.

In addition, finished goods and work-in-progress will not be considered because it is assumed that customers will take their goods as planned and no orders will be made to stock (in real terms, less than 25% of all orders is manufactured to stock at African Cables Ltd).

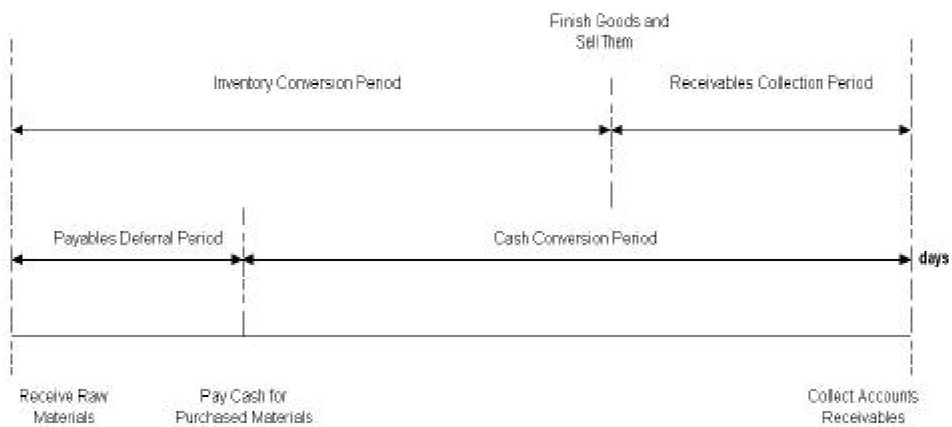
3.3 PRINCIPLES OF WORKING CAPITAL MANAGEMENT

Each component of working capital influences the liquidity position of the company in a certain way. Inventories must be purchased in order to carry on the business activities as planned. These purchases cause cash outflow and also give rise to accounts payable where such purchases are on credit. In the case of accounts payable, the cash outflow is extended for a while. In order to maintain sufficient liquidity and to be able to afford purchases, enterprises need to collect their accounts receivable efficiently. Accounts receivable are typically created by credit sales in order to augment the sales volume. However, too much credit tends to lead to high levels of bad debt. Hence the advancement of credit requires strict control.

Because of the impact of working capital items on the viability of the business (as outlined above), obviously these items need to be managed. Ross et al (2003:506-507) define working capital management as the management of short-term finance and thus the analysis of decisions that affect current assets and current liabilities. Brigham and Ehrhardt (2002:837-839) consider working capital management as the setting of working capital policy and applying this policy in day-to-day operations.

The concept of the so-called "cash cycle" is often used in the management of the working capital and thus the liquidity of the organization. The cash cycle can be defined as the time that funds are out of the hands of the company. In total, it is the time spent manufacturing the product plus the time until the customer pays, less the time the company is allowed to pay later for its purchases. This is represented graphically in figure 3.1:

Figure 3. 1: Conversion cycle of a manufacturing enterprise

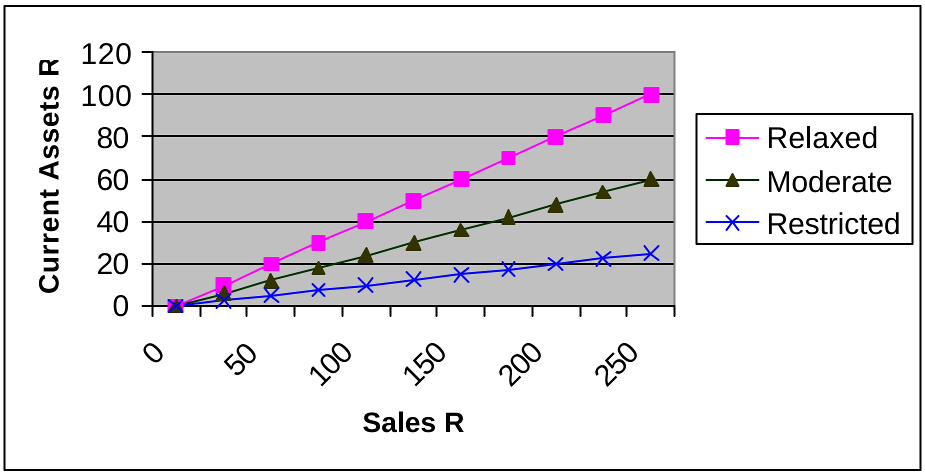


Source: Brigham & Ehrhardt (2002:844)

Given this cash conversion cycle, a company needs to finance the manufacturing costs for this period. Hence, it should be in the best interest of the firm to shorten this cycle as much as possible because it also curtails the need for external interest-bearing finance.

The policy guidelines on managing working capital thus need to answer the following two questions: (1) What is the appropriate level of working capital? (2) How should it be financed? Brigham and Ehrhardt (2002:840) and Kuhlemeyer (2001:5) define three different current asset policies, namely relaxed, moderate and restrictive policies. These policies differ in the amount of current assets that should be carried to support different levels of sales. Figure 3.2 illustrates this relationship graphically.

Figure 3.2: Current asset policies



Source: Brigham & Ehrhardt (2002:840)

The "relaxed" line with the steepest slope indicates that relatively large amounts of inventories and high levels of accounts receivable are held. Conversely, the restricted policy requires a minimum of cash and inventories as well as a lower level of accounts receivable. A moderate approach lies somewhere between the two previous policies.

The main determining factor for the correct choice is uncertainty. If all sales, lead times, costs and payments were known with any certainty, a firm could hold minimum levels of current assets. However, this picture changes as sales, lead times, etc, become more uncertain, and cash and inventories are based on forecast sales, expected lead times and expected costs. To cover the uncertainties, further safety stocks and safety funds are required. This means that a restrictive policy under conditions of uncertainty will lead to a high risk of losing sales and running out of stock and cash. (From the previous discussion one can infer that circumstances in the cable industry are not appropriate for a restricted working capital policy. The relaxed policy is more appropriate because of constraints and uncertainties).

In terms of the conversion cycle, a restricted policy would reduce inventory and the collection period, thus reducing the total cash conversion cycle. An appropriate level of working capital must be found in order to reduce the cash conversion cycle, taking into account the level of risk created by this policy.

Working capital, like all capital, costs money. Hence reducing working capital will yield permanent savings in capital cost. However, freeing up any funds through better collection and reduced inventory will add the same amount to cash flow.

Brigham and Ehrhardt (2002:845-846) discuss the "zero working capital" concept, the achievement of which, in the view of the proponents of this concept, generates cash and speeds up operations. Faster turnaround in operations leads to improved business relations and new business opportunities.

Mintz (2000:1-4) found that financial management endeavour to keep as little cash as possible. Similarly, limiting the other components of working capital, as desired by financial management, is achievable by moving inventory more rapidly through the company, receiving payments on time and paying bills as late as possible. However, Myers (2000:1-4) and Fink (2001:1-2) call into question the assumptions underlying the theory of minimizing working capital, specifically in times of economic downturns.

Hodge (1998:1-3) emphasizes the numerous factors that lead to working capital levels. The major determinants of inventory levels are facility configuration, internal materials and in-process flows. The actual flow of orders and billing, as well as dispute resolution, largely impact on the level of receivables, and also hold true for payables.

3.4 TOTAL WORKING CAPITAL MANAGEMENT℠

3.4.1 Introduction

The previous sections concentrated mainly on working capital management from a financial perspective. Although the question regarding which level of working capital should be considered appropriate was answered in terms of three distinct policies, little has been said about how to arrive at these figures indicating the individual policies; nor has any attempt been made to identify the parameters that influence the working capital levels for the different policies and to what extent they do so.

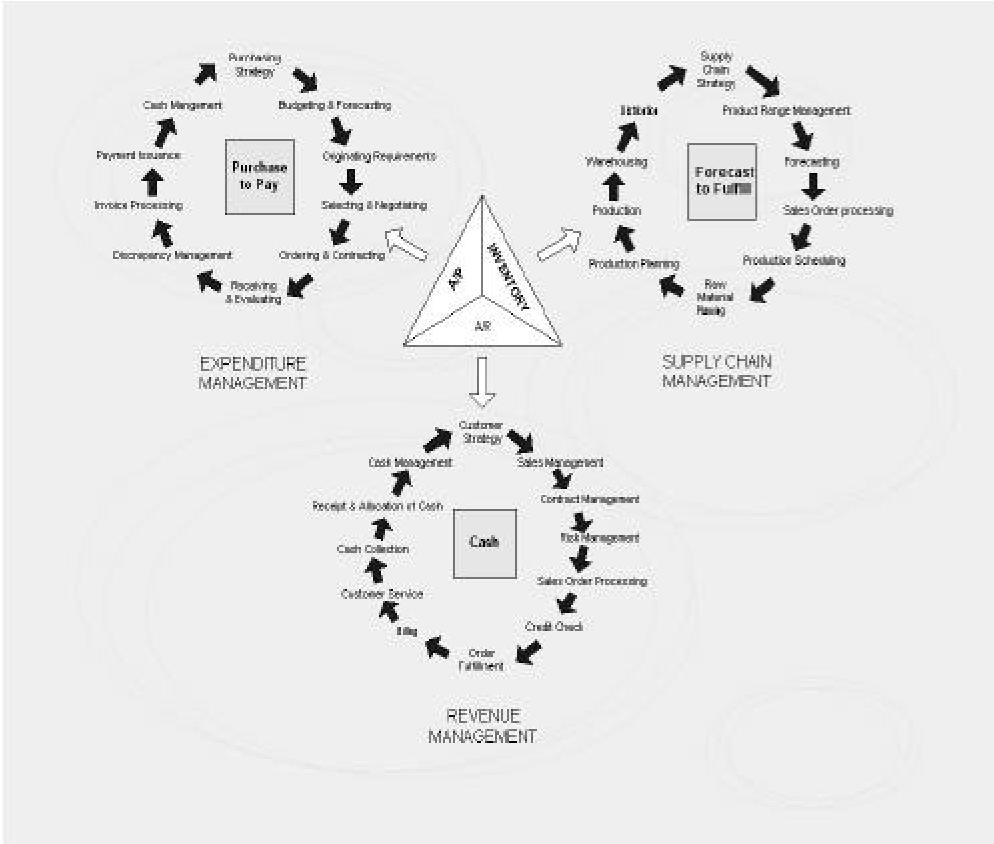
In this regard, the REL Consultancy Group (2002:1) has done extensive research and published its results. The main finding was that a Fortune 500 company, operating in a highly competitive industry, generated a 21.4% improvement in cash from operations. This improvement was mainly attributed to reductions in working capital requirements rather than increased sales or higher profit margins. Furthermore, in their analysis of income statements and balance sheets of the largest public corporations in USA and Europe, the REL Consultancy Group (2002:1) indicated that on average, these firms tie up 20% to 30% more cash in working capital than necessary. The worst-performing companies suffer from excessive receivables, superfluous inventories, lack of purchasing clout, high operating expenses, and in extreme cases, insufficient cash to meet day-to-day corporate obligations or strategic initiatives. In addition, there are enormous discrepancies from one company to the next, even in the same industry. Each year the excess investment in working capital translates into the forfeiture of billions of dollars in cash flow and profits and suboptimal returns to shareholders. Money recaptured from working capital can be used more effectively elsewhere – for research and development, acquisitions, debt reduction or raising the dividend.

According to the REL Consultancy Group (2002:1), many business leaders view working capital management too narrowly, mostly as an accounting exercise pursued by the treasury department. In this view, short term and artificial fixes to working capital are too often the norm. Companies temporarily delay payments to suppliers, or haphazardly push customers on collections. While these efforts may reduce working capital over the short-term, improvements soon disappear as suppliers adjust their pricing accordingly and customers become alienated.

Of course the wiser solution to the reduction of working capital levels is to attack the problem by adopting a holistic approach known as total working capital management[SM][2] (TWCM). The REL Consultancy Group (2002:1) contend that TWCM is far more than a number game. It transcends the accounting definition of working capital – current assets minus current liabilities – to incorporate all business processes and transactions involving customers, suppliers and products. As such it covers all three components of working capital management: the customer-to-cash[SM] cycle, the purchase-to-pay[SM] cycle and the forecast-to-fulfill [SM] cycle as shown in figure 3.3.

Figure 3.3: Total working capital management variables

[2] Service marked (SM)



Source: REL Consultancy Group (2002:2).

Embracing all three components of working capital management, TWCM recognizes that the drivers of working capital performance are more often operational than financial. Considering the example of a company having trouble collecting its receivables, the problem could be that the collection personnel are ineffective. Other issues may be that the company is providing its customer with faulty products, causing them to withhold payments, the sales force may have been promising extended payments and not sharing this information with the collection department, or the deliveries were late thus causing an automatic extension of payments on account of fixed payment terms, (ie end of month terms etc).

By extending its reach to the suppliers, the shop floor, the loading deck and the sales process, TWCM extends its benefits beyond the balance sheet and income statement. TWCM companies operate at a greater velocity than their competitors. They produce fewer errors, less waste and rework and happier customers and suppliers. As a consequence, TWCM companies generate more sales, enjoy better profit margins, and ultimately, deliver improved shareholder values.

In order to implement TWCM, companies must find the relevant levers in the three component areas of working capital. The three components will be discussed in the sections below.

3.4.2 Purchase-to-pay cycle

As illustrated in figure 3.3, the purchase-to-pay cycle includes all elements, starting with the purchasing strategy right through the payment for goods - in short, the cycle that deals with accounts payable.

The significance of accounts payable is the fact that they represent a short-term loan from the suppliers, which can be used to offset other working capital costs, (ie inventory costs). In order to maximize the effect of this short-term loan, companies usually hold invoices until the last possible moment or even past the due date. However, the REL Consultancy Group (2002:7) points out that arbitrarily holding invoices past the due date is not a long-term solution to inflated levels of working capital. Suppliers will notice and inevitably reflect the increased costs they are being asked to absorb in their pricing and service. The correct fulfilment of the individual tasks from budgeting, requirements generation, selecting and negotiating, ordering and contracting, receiving and evaluating, managing discrepancies, invoice processing, issuing payment, and finally, managing cash, is of utmost importance for the successful completion of the cycle. These activities are reflected in the general procurement procedures or procurement cycle as outlined in Hugo et al (2002:15-26). The purchasing activities have to be executed in such a way that the lowest cost of ownership will result. This means that, besides the delivery time, the size of the shipment, the method of transport and the value of the products also require careful consideration (Hugo et al 2002:503). Depending on the value of the product, the quantity of the product consumed and the cost of transport, procurement must decide when to order and how much inventory to keep. For example, if an organization requires a product in bulk, it would make sense to purchase it in large quantities using low cost transport. If, however, an expensive item is required, this could be purchased on demand and it would even pay to use a premium transport, to avoid holding stock of this item. This ability to determine when, where and what quantity of a product to purchase, serves to substantially reduce operational variance.

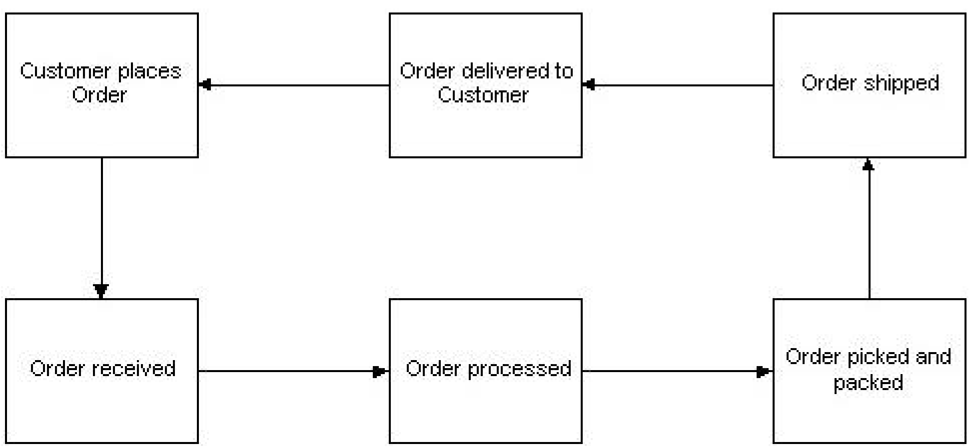
However, Coyle, Bardi and Langley (2003:90) state that order performance cycles, which are closely related to purchase-to-pay cycles, are subject to variance and therefore uncertainty. In particular, order processing, order selection and delivery may vary in terms of their execution times, thus creating uncertainty in delivery dates. Variations in the execution times of these elements also add to the overall uncertainty of the purchase-to-pay-cycle process. In addition, thus far it has been assumed that the required quantities can be forecast accurately. If this is not the case, one of the objectives, which could assist in the reduction of operational variance, namely the ability to determine the quantity to be purchased, can no longer be met. The consequence of this phenomenon is the fact that additional stocks must be held to support operations or, in the case of insufficient stocks, rush deliveries must be made at high premium transport arrangements. It is thus imperative that the purchasing task should not be performed in isolation but integrated with the other two functions, as discussed below.

3.4.3 Forecast-to-fulfil cycle

As illustrated in figure 3.3, the forecast-to-fulfil cycle includes all elements of supply chain management. These include, in particular, the supply chain management strategy, product range management, forecasting, sales order processing, production planning and scheduling, raw material planning, production, warehousing, and finally, distribution.

The important outcome of managing this cycle is inventory. As REL the Consultancy Group (2002:7) states, although forecasting inventory demand will always be an inexact science, it does not need to be done haphazardly. Technology has made it possible to jointly consider information from the entire company, and not only from one section. It is therefore also possible to balance mutually conflicting objectives that may influence total inventory costs, customer service, operating cost and the product range. This is particularly important when considering faster-moving goods, where product obsolescence can negatively impact on the supply chain. This forecast-to-fulfil cycle is closely related to the customer order cycle as detailed by Stock and Lambert (2001:148) and depicted below.

Figure 3.4: Customer order cycle



Source: Stock & Lambert (2001:148)

These cycle activities integrate two conflicting tasks. On the one hand, marketing try to please the customer under all circumstances and maintain a broad product spectrum, while on the other manufacturing endeavour to ensure long production runs in order to keep operating cost per unit to a minimum by sustaining economies of scale. In order to achieve a balance between the two opposing responsibilities, traditionally, inventory has been employed to act as a buffer. This means that inventory is built in anticipation of future sales.

Inventories are accumulated on the basis of forecast requirements. However, forecast quantities become doubtful when the uncertainty of customer requirements increases (Hartmut & Hebsaker 2003:4-5). Similarly, inventories will increase because of aggregation of production or shipments, or when variation in manufacturing occurs. These aggregations and variations delay or advance the availability of semifinished or finished goods in the plant or to the customer. It is clear therefore that the accuracy of forecasting, production scheduling and distribution requirements planning directly influences the working capital required.

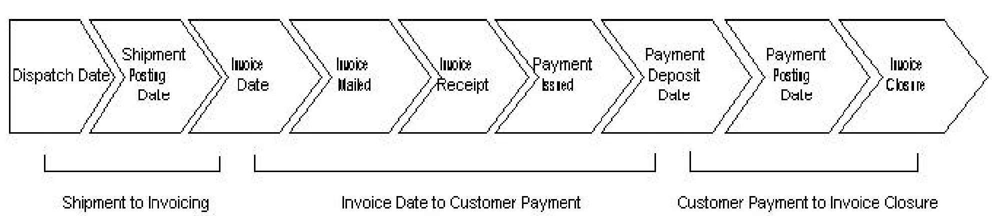
3.4.4 Customer-to-cash cycle

This cycle deals mainly with sales management starting with the customer strategy, sales, risk and contract management, sales-order processing, credit checks, order fulfilment, billing, customer service and cash collection, and ending with cash management.

The main risk in this cycle, according to the REL Consultancy Group (2002:8), is the tying up of suppliers' cash in credit sales, thereby creating high levels of accounts receivable, leading to the accumulation of aged debt, and ultimately, write-offs.
Traditionally, from a logistics point of view, the emphasis was on credit check and invoicing as part of the customer order cycle (Stock & Lambert, 2001:150). In contrast, the customer-to-cash cycle, as depicted in figure 3.3, is more focused on the actual sales, risk management and cash collection activities.

According to Hodge (1998:6), measurement of the efficiency of the customer-to-cash cycle, compared with the order fulfilment cycle in figure 3.5, should not be measured in terms of high-level financial data (ie the DSO), but by directly tracking the activities of the cycle itself. In order to monitor the order fulfilment cycle, he further suggests breaking down this cycle into three major components.
These are: (1) shipment to invoicing, (2) invoice date to customer payment, and (3) customer payment to invoice closure. The individual components are shown in figure 3.5 below.

Figure 3.5: Individual components of the order fulfilment cycle



Source: Hodge (1998:6)

Delays in the total cycle occur as a result of specific problems encountered with particular components or activities. The most common concerns in each component are as follows:

- *Shipment to invoicing.* The first delay generally occurs at shipment and can be eliminated by implementing correct procedures at the plant. The second delay arises with invoicing. The payment cycle normally begins on the invoice date. Hodge (1998:6) highlights that significant delays can be encountered from the time the product is legally available to be invoiced to the time it is actually invoiced. Such delays have a marked impact on working capital.

- *Invoice date to customer payment.* Delays in this area are determined by the company's credit terms and collection policies. Collecting outstanding payments from customers can be a sensitive issue. However, a professional sales force in conjunction with correct information on each customer's payment performance can influence receivables payment positively.

- *Customer payment to invoice closure.* This part of the cycle has to deal with the efficient resolution of pricing and invoice inaccuracies as well as disputes. This additional work, required to be performed in clearing the exceptions, again impacts on the firm's receivables account level.

3.5 WORKING CAPITAL AND SUPPLY CHAIN OPTIMIZATION

3.5.1 Introduction

In an attempt to reduce the cost of the supply chain, companies have been using optimization models in the areas of sourcing, manufacturing, transportation, warehousing and customer service management for over 30 years (Eck 2003:35; Shapiro 2002:1). Such models, which may form part of other stand-alone solutions, endeavour to provide local optima or optimization by integrating some of the above areas. The fact-based decision making and optimization accomplished by these models, have helped many companies to produce plans that afford the opportunity of significantly reducing the supply chain cost and improving the working capital situation.

What is needed are sound and scientifically based inventory replenishment models which incorporate statistical and operations research techniques, to analyze the richness of data and deduce the required patterns, trends, variability and dynamics of customer demand (Lee 2002:1-2). These scientific techniques enable organizations to balance various costs – inventory, transportation, handling warehousing and other direct and indirect labour – while simultaneously rendering optimal services to customers. Such a balancing act requires timely and accurate data, coupled with appropriate analytical techniques (Lee 2002:1-2).

In the wake of faster and growing computer technology, more sophisticated modelling and optimization have become possible and available (Eck 2003:35-36). According to Ganeshan and Harrison (1995:1-3), such models are huge and require a considerable amount of data. Often owing to the enormity of data requirements and the broad scope of decisions, these models provide approximate solutions to the problems they describe.

Following the development of optimization from operational research methods, through MRPI/II programs and ERP packages to advanced planning and scheduling (APS) software, the aim of the next section is to provide a historical overview of the available models.

3.5.2 Historical optimization methods

3.5.2.1 Introduction

As stated previously, many authors report that businesses have recognized the need to free up cash from working capital. The complexity of the market environment, in which cable manufacturers operate, has led to the quest for computerized assistance in accomplishing a reduction in working capital levels. Also, pressures on organizations to change internally to embrace new strategies, such as SCM, in order to survive in an increasingly competitive market, add to the complexity and require computerized optimization models. The possibility of optimization is greater with the increase in computer availability and processor speed. Over time the models have become larger and more complex. The process has moved from the easy models, such as the EOQ model, through MRP and MRPII programs to APS systems, and the all-encompassing ERP systems.

Of particular importance to this study are the EOQ model and MRP logic. Both, EOQ and MRP will be used in this study to calculate and to quantify the impact of purchasing constraints and demand uncertainty on elements of working capital. The EOQ model will be used to calculate optimal purchasing quantities, whereas MRP will be employed to compute the timing of the purchases.

In view of the importance of these models and programs, a brief overview of the development of optimization models will be given.

3.5.2.2 Traditional models

a *Inventory models*:

According to Winston (1994:869–938), inventory models are divided into two categories, namely deterministic and probabilistic models. The main difference between the two model categories is the assumption that demand in the deterministic approach is known exactly for each period under consideration, whereas in the probabilistic method, demand is modelled in terms of discrete probabilities or as a random variable with a particular probability density function.

The best known *deterministic models* include the following:

Economic order quantity model (EOQ) :

$$EOQ = \sqrt{\frac{2KD}{IC}}$$

K = order cost, D = demand, C = unit cost

I = annual inventory-carrying cost rate

This model minimizes overall cost as a trade-off between ordering and holding cost. This model is also applicable when quantity discounts are involved, as well as in a situation where goods are manufactured instead of purchased.

The model can be adapted to accommodate in-house production. Material is therefore not received at a particular point in time, but trickles in from a production line. This modification is called the economic manufacturing model (EMQ):

$$EMQ = \sqrt{\frac{2KD}{h(1-D/P)}}$$

r = production rate, D = demand, K = order cost

h = holding cost, P = production rate.

In the deterministic situation, the EOQ is calculated as above, and the reorder point in the simplest sense equals lead time times EOQ.

In contrast, the *probabilistic models* essentially are EOQ models with uncertain demand. In these cases, the reorder point is computed using the variation of demand and the expected level of demand during lead time as well as the probability of a stock-out during lead time and the expected shortage cost in the back ordered case or the cost of the loss of orders in the lost orders case. The continuous inventory review policy, namely the (r,q) policy was derived from the probabilistic EOQ model. Here, it is assumed that every time the inventory level reaches the reorder point level r, an order is placed for q items - hence the terminology (r,q) policy (Winston 1994:912-920). Shapiro (2002:2-5) explains, that the (r, q) re-order policy, calculates safety stock to be equal to the re-order point, less the expected demand during lead time, assuming that demand is normally distributed.

Other models based on probabilistic assumptions are those that use the service level method (SLM) to determine safety stock levels (Winston 1994:921-929). The reorder points are determined as previously, using a certain probability of a

stock-out occurring. The service level is defined as the expected fraction of all demand being met on time in the case of the SLM_1 model, and the expected number of cycles per year during which shortages occur for the SLM_2 model. Specifying appropriate numbers for the service levels, the required reorder point can be determined using tables of the normal distribution as well as the normal loss function (SLM_1). Using the SLM_2 method, which follows a procedure similar to the SLM_1 method, a safety stock level and a reorder point can be computed that satisfies a certain stock-out requirement.
The reorder point with SLM_1 is defined as:

$$NL\left(\frac{r - E(X)}{\boldsymbol{s}_x}\right) = \frac{q(1 - SLM_1)}{\boldsymbol{s}_x};$$

where:

NL = normal loss function
r = reorder point
E(X) = mean of normally distributed demand
$ó_x$ = standard deviation of demand
SLM_1 = service level

The reorder point in SLM_2 is defined as:

$$P\left(\frac{X - E(X)}{\boldsymbol{s}_x} \geq \frac{r - E(X)}{\boldsymbol{s}_x}\right) = \frac{s_0 q}{E(D)};$$

where:

P = Probability of stock out occurring
s_0 = average of cycles per year that will experience a stock-out (SLM_2)
E(D) = annual demand
E(X) = average demand during lead time
$ó_x$ = standard deviation of demand during lead time

b Accounts payable and receivable:

These accounts occur during the normal course of business because materials are purchased and finished goods sold. Therefore optimization in terms of a model is not applicable in these cases. However, these items require particularly careful management because they influence the business's daily cash flows and thus its very survival (Ross et al. 2003:513).

EOQ models are not used at African Cables Ltd. The method used involves an MRPII logic being incorporated into an ERP system, which determines the reorder point and order quantities, and attempts to minimize stockholding by creating planned receipts only for the amount of material absolutely necessary. MRPII does not consider EOQ.

3.5.2.3 Development to new computerized advanced planning systems

In retrospection, the traditional optimization models were generally restricted in their application to specific performance areas of the supply chain or different departments of a firm. For example, inventory models were mainly used in the materials sourcing environment, whereas cash management models featured in the financial arena. Each of these departments had its own, in many cases, conflicting goals, with the result, that the firm did not have a single integrated plan available, according to which the entire operation could be optimized (Ganeshan & Harrison 1995:1-3). The pursuit of more all-encompassing supply chain optimization models led to the early development of the MRPII software, which further developed into ERP systems embracing all enterprise resources.

At the same time, linear programming (LP) was widely used to solve scheduling, inventory, capacity and distribution problems. With the aid of LP, advanced algorithms were created to deal with a wide variety of problems, not only in the above-mentioned environments, but also in the financial world. Shapiro (1973:37–46) described an algorithm to compute optimal inventory and credit granting strategies under inflation and devaluation, while Merville and Tavis (1973:47–59) developed a chance-constraint programming approach to model optimal working capital policies, Atkins and Yong (1977:71-74) commented on the opportunity cost in the evaluation of investment in accounts receivable. Stone and Hill (1980:35-43) depicted LP mechanisms of cash transfer scheduling for efficient cash concentration. Moshe and Levy (1983:42-48) elaborated on the use of LP in the management of accounts receivable in conditions of inflation.

However, as much as the usefulness of such models was propagated, in some authors' opinion there were doubts about their usefulness. For example, Daellenbach (1974:607-626) argued that cash management optimization models cannot offer any improvements over simple decision rules commonly practised by treasurers in all cases.

All the examples described above and in the previous sections emanate from different areas of the business and require some form of optimization. Furthermore, because the variables of the various problems interact and influence one another, an integrated optimization of problems for the entire business would be more appropriate.

According to Benton (1999:1-5), companies have made considerable investments in MRP and ERP systems in the attempt to increase ROI through information integration, thus optimizing inventories and associated costs. However, the implementation of these systems, which are still static, has led to mixed results (Kalakota, Stallaert & Whinston 1996: 2).

Shapiro (1973:37–46) emphasizes that supply chain models must include aggregate descriptions of how the supply chain works, providing a minimum total cost of meeting demand for a given period, subject to customer constraints. Such SCM and optimization systems employ new technology, comprising complex algorithms that solve increasingly comprehensive problems, as well as faster computers and processors. The advanced planning and scheduling (APS) software only gained wider acceptance during the late 1990s and according to Lustig (1999:1-9), industry experts believe that it is the next phase in the evolution of manufacturing systems. These systems still incorporate techniques, such as LP to solve many planning and capacity-related problems, as well as, newer techniques such as, constraint programming (CP), genetic algorithms (GA), theory of constraints (TOC) and other heuristics to deal with the optimization of activities under constrained resources in a real-time scheduling environment.

Although APS systems have been designed to easily integrate with ERP systems, some still require a batch-oriented mode of operation, that is, a daily or weekly up- and down-load of masses of data from one system to the other (African Cables Ltd. 2004). Only few systems offer a fully integrated package enabling a real-time view of effects of demand fluctuations and lead-time uncertainties on overall inventory requirements (Eck 2003:59-62).

African Cables Ltd currently uses SAP, an all-encompassing ERP system, which employs MRPII logic to compute material requirements. It also has the capability of basic forward and backward scheduling, without any closed-loop finite capacity scheduling algorithms. This means that material requirements are calculated on the basis of fixed material lead times. No consideration is given to the fact that certain work centres may be overloaded and not be able to perform the required work when MRPII computes that this work should be done.

Furthermore, the current setup of the ERP system does not allow for a comparison of working capital management performance based on existing purchasing practices and purchasing practices that could be considered as optimal, or any other benchmark. Working capital management performance can only be evaluated after the fact – that is, after a time period has elapsed and all data relating to purchasing practices and working capital values have been recorded. A simulation of working capital performance with different sets of purchasing and demand data or a prediction of the working capital performance for the current time period is not possible. It is therefore necessary to conduct an empirical study, to establish the real quantitative impact of current purchasing constraints and demand uncertainty on selected elements of working capital when compared with optimal purchasing conditions and budgeted demand. The quantitative impacts determined in this study will enable the managers who control working capital to focus on improvement strategies and set realistic targets for the different elements of working capital.

This study focuses on African Cables Ltd, which operates in an environment, that does not allow for easy optimization of its supply chain. In particular, the effects of substituting EOQ purchasing practices for pure freight optimization, owing to large distance sourcing, under conditions of variable demand on the firm's working capital, form a vital part of the study.

3.6 WORKING CAPITAL IN THE CABLE SUPPLY CHAIN

3.6.1 Introduction

The problems in the cable supply chain, as identified in section 2.7, involve mainly purchasing constraints and demand uncertainties. Owing to unavailability, certain materials need to be imported. Hence, purchasing constraints consist of lead-time uncertainties, because of the long shipping periods of import requirements. In addition, shipment consolidation necessities arise, because the transport costs associated with imports are extremely high and impact significantly on the price of material. As previously explained, demand uncertainties stem from forecasting uncertainties, changing ordering patterns in the market and unplanned demand. Similarly, deliberate expediting of specific customer orders as a result of emergencies experienced by the customer alters the forecast material requirements.

The impact and consequences of such purchasing constraints and demand uncertainties on the selected items of working capital as experienced by cable manufacturers in South Africa (personal interview with Operations Manager, De Villiers, at African Cables, 01.09.2004) will be briefly discussed in the ensuing sections.

3.6.2 The influence of purchasing constraints and uncertain demand on inventories

Purchasing constraints in cable manufacturing are caused mainly by the importation of raw materials. As previously indicated, in cable manufacturing in South Africa certain materials have to be imported. This increases transport costs. It might be more advantageous to buy larger consignments, leading to a trade-off between import costs and inventory-holding cost. In such cases, safety stocks are normally kept to ensure that sufficient material is available during the lead time as well as during an unforeseen increase in the lead time. A higher investment in raw material inventories is therefore an obvious consequence.

Work-in-process (WIP) and finished goods inventories would normally not be influenced by a higher raw material stock level because the production schedule is fixed. However, lower raw material inventory levels can lead to stock-out situations, which influence WIP and finished goods, depending on where in the chain of processes the unavailable material is required. If the material was required in the early stages, WIP will deplete if the stock-out duration is longer than the time until the existing stock is consumed in the production process, and finished goods (FG) will eventually also be reduced. If the material is required during the later stages, say, closer to the end of the process chain, (also assuming longer term stock-out), then WIP will increase until operations at the input processes cease, whereas FG will drop, assuming a continuous sales pattern.

Another factor leading to increases in FG, is the possible change over from manufacturing one product, which will be stopped because of a material shortage, to manufacturing another, which does not experience the same constraint imposed by the shortage, (eg. where only local raw materials are used).

Changing demand in terms of product design, would typically not influence inventories, if the demand changes are known to the purchasing function long enough in advance. This notice period must take into consideration the lead times of all the processes remaining to completion and the lead times of the materials consumed during these processes. The time period from announcement of the requirement of a material to the purchasing function, to the actual date of consumption should be longer than the sum of material plus manufacturing lead times. Short-term changes may have a greater impact on inventories. If a product is required outside the normal production scheduling and all attempts are being made to satisfy this demand, then this may lead to additional purchases and increased WIP.

Similarly, changing product designs may incorporate different bills of materials (BOMs), thus requiring more or less of certain materials - hence changing inventory levels. If, for example, in the short term, products are demanded which require more materials than normal, inventories will run low, and the firm may run out of a particular commodity, necessitating additional purchases, which in the case of imports may involve considerably higher transport prices.

A certain demand can change FG stock levels, depending on whether or not the required products are available from inventory. If the particular FG for which the demand developed is not available in FG it will be produced and delivered to order, leaving stock levels unchanged. If the particular FG is available in stock, no production will take place, WIP will remain constant and FG levels will drop.

3.6.3 The influences of purchasing constraints and uncertain demand on accounts payable

Any successful business must manage its money or funds carefully. Recurring payables need to be handled, vendor invoices matched to purchase orders and cheques produced. In order to perform the payables function accurately, detailed information on all open accounts must be kept. This allows payments to be scheduled so that the enterprise can take advantage of prompt payment discounts. Accurate information on payments due, enables the organization to forecast some of its cash requirements in exact time periods. However, in order to minimize investment in working capital, certainly some accounts payable should only be paid at the last possible moment in order, to take full advantage of holding cash or near cash instruments, without damaging credit relationships with suppliers.

The management of cash is closely related to the treatment of payables. Obviously, cash in itself is kept to pay accounts of purchasing transactions and speculative and cautionary purchases. The main aim, however, is to have as little cash as possible on hand, thus necessitating the transfer to interest-bearing near cash equivalents or accounts.

Purchasing decisions have a direct effect on accounts payable and cash levels, and the effects of constraints will therefore pervade cash and payables. The purchase of larger quantities because of consolidated shipment requirements causes higher levels of payables, whereas emergency purchases may lead to a higher cash outflow because of increased transport costs.

The influences of uncertain demand are more indirect in the case of accounts payable. A reduction in demand will only lead to lower payables and cash requirements after the reduced demand is known to the purchasing function. An increase in demand will work in the opposite direction. A change in the demand for several of the organization’s products can either reduce or increase cash requirements and payables. The direction is subject to the actual material quantities required and the prices of the replacement materials. Of further importance is the point in time when the altered material requirements occur. If these occur during the supply lead time, emergency purchases may be necessary, whereas a requirement prior to that period can be ordered via the normal ordering process, whereby the quantity levels determine the direction of change.

3.6.4 The influence of purchasing constraints and uncertain demand on accounts receivable

Cash flow can be significantly enhanced if outstanding amounts owing are collected faster, or may be drastically reduced if they are not properly controlled (Invest-Tech Limited 2003:2-4). Debtors require close management to ensure timeous payment by customers and prompt processing of invoices and pricing data.

Receivables are influenced indirectly by raw material shortages. Raw material shortages will lead to decreased WIP and FG stock. As FG stock levels decline, sales and hence, receivables, will also decrease.

The primary influence in accounts receivable will be experienced from the direct fluctuation in sales. Sales may fluctuate as a result of changing demand patterns in terms of quantity and product design. The sales quantities obviously have a direct proportional effect on receivables, whereas product mix changes may either increase or decrease sales, or cause sales to remain unchanged.

3.7 CONCLUSION

It is clear from the discussion in this chapter that purchasing constraints and demand uncertainty directly and indirectly influence the elements of working capital. The question is, how significant the impact is in selected elements of working caused by purchasing constraints and demand uncertainties. In the next chapter the impact of the purchasing constraints and uncertain demand on selected working capital elements in a cable manufacturer will be empirically determined.

CHAPTER 4: RESEARCH METHODOLOGY

CHAPTER 4: RESEARCH METHODOLOGY

4.1 INTRODUCTION

The primary objective of this research, as outlined in chapter 1, is to find an answer to the question on how purchasing constraints and demand uncertainties impact on working capital. This is of paramount importance to cable manufacturers in South Africa, because they have to import a large portion of their materials (purchasing constraints), and the demand for their finished product is uncertain.

4.2 PROBLEM STATEMENT

Purchasing constraints of (1) uncertain delivery dates, (2) full container loads and not EOQs, and (3) keeping of safety stocks, coupled with the uncertainties of demand, namely (1) uncertain cable requirement forecasts, if any, (2) uncertainty about specific cable items required, and (3) uncertainty of cable safety stock requirements for certain customers, influence the individual elements of working capital.

With specific insight into the qualitative impact of these constraints on inventory, accounts payable and accounts receivable, as detailed in chapters 2 and 3, managers controlling working capital require a quantitative statement of the effect on these specific elements of working capital, in order to improve the management thereof and to set realistic targets.

Hence the question to be investigated in this study is:

How do purchasing constraints and demand uncertainties impact on working capital in a South African cable manufacturer, when compared with near optimal conditions?

4.3 EMPIRICAL RESEARCH

4.3.1 Introduction

The empirical study will be conducted in one of the main cable manufacturers in South Africa, namely African Cables Ltd. This company manufactures a wide range of power cables mainly for the South African market with a small portion of exports. The demand for these final products and the conditions under which raw materials are purchased, are the main objectives of this study. This study will concentrate in particular on exposing the significant impact of purchasing constraints and uncertain demand on the working capital position of African Cables Ltd.

4.3.2 Primary objective

The primary objective of this study is therefore to determine the quantitative impact of purchasing constraints and demand uncertainties on working capital elements of raw material inventories, accounts payable and accounts receivable in a cable manufacturer. From chapters 2 and 3 it is clear that purchasing constraints will influence raw material stocks and accounts payable and demand uncertainties will influence raw material inventories and accounts receivable. The secondary objectives will be formulated around these variables.

4.3.3 Secondary objectives

In order to determine the impact of constraints and uncertainties on the working capital elements of raw material stock, accounts payable and receivable, the following secondary objectives were formulated and the way in which each will be pursued, fully described:

(1) to identify the purchasing constraints that influence working capital

(2) to identify demand uncertainties that influence working capital

(3) to determine working capital levels in the actual conditions in the presence of purchasing constraints (as currently set in the ERP system) and demand uncertainty (calculated from the budgeted and actual demands, through exploding material requirements in an MRP method and computing the working capital values)

(4) to determine the differences in working capital levels between the actual conditions in (3) and optimum (budgeted) conditions (by comparing the above working capital levels with working capital levels with EOQ [without purchasing constraints] and budgeted [fixed] demand, calculated in the same manner as in (3))

(5) to determine average expected demand values (by simulating uncertain demand over multiple year periods, to arrive at average expected demand values, because single year actual demand figures do not provide certainty in terms of what demand, and ultimately, working capital values can be expected on average over a number of years)

(6) to determine projected working capital levels (based on the simulated demand and calculated through exploding material requirements in an MRP method and computing the working capital values as in (3))

(7) to determine the difference in working capital levels between budgeted and simulated demand conditions (by comparing working capital levels under EOQ and budgeted demand with working capital levels under purchasing constraints and statistically simulated demand behaviour)

(8) to determine working capital benchmark ratios (as shown in tables 1.1 and 1.2 for working capital values as calculated for actual and simulated demand conditions, by converting working capital values into days' working capital, using actual WIP and FG values to augment the raw material inventory to comprehensive inventory values, and dividing by the actual cost of sales figures).

(9) to determine the quantitative difference between working capital benchmark ratios (by comparing benchmark ratios for (a) actual demand with purchasing constraints and actual demand without purchasing constraints, and (b) simulated demand with purchasing constraints and simulated demand without purchasing constraints [EOQ]).

The impact of the purchasing constraints on working capital items will be quantified by comparing the working capital levels based on budget demand and EOQ purchasing with those derived from budget demand and actual purchasing conditions without safety stock, and with those derived from budget demand and actual purchasing conditions including safety stocks. The result will show the influence of constraints relating to minimum order quantities in the first instance, and a further impact by introducing safety stocks in addition to the minimum order quantities.

In the next step, the demand will be simulated to attain greater reliability in the calculated working capital values and benchmark figures. As further detailed, Monte Carlo sampling from the calculated discrete cumulative frequency distribution function of each cable type, will be employed. Based on random number allocation, random samples with average demand for particular discrete intervals will be chosen. This will be repeated 246 times for each cable type. The resulting demand will be treated in the same way, as described above, to obtain inventory values, accounts payable and accounts receivable under purchasing constraints with and without safety stocks. The averages of the derived working capital figures will then be used to compute the benchmark ratios to assess the impact of purchasing constraints and uncertain demand on working capital values and ratios. These values will also be compared with the capital values and ratios as obtained from the annual values.

4.4 RESEARCH DESIGN

4.4.1 Introduction

Once the problem and objectives have been carefully defined, the researcher needs to establish the plan that will outline the investigation to be carried out. The research design indicates the steps that will be taken and in what sequence they occur. There are two main types of research, namely exploratory and conclusive research. Conclusive research may be subdivided into descriptive and causal research. Both, conclusive and exploratory research may rely on one or two data collection techniques, which constitute primary research through observation or direct communication, and secondary research, through a literature review (Joppe sa:Research Design, Data Collection, and Selection of Subjects).
Research methods can also be classified as qualitative and quantitative research methods (Myers, 2004:2). These methods will be explained in more detail in the section below.

4.4.2 Research methods

4.4.2.1 Conclusive research method (Joppe sa:Research Design, Data Collection, and Selection of Subjects)

As the term suggests, conclusive research is meant to provide information that can be used to draw conclusions or make decisions. It also tends to be quantitative - in other words it is in the form of numbers that can be quantified and summarized. It relies on both secondary data, particularly existing databases that are analyzed to shed light on a problem, and primary research, or data specifically gathered for the study.

Descriptive research or statistical research provides data on the *population or universe* being studied. But it can only describe the “who”, “what”, “when”, "where" and "how" of a situation, not what actually caused it. Hence, descriptive research is used when the objective is to provide a systematic description that is as factual and accurate as possible. It details the number of times something occurs and lends itself to statistical calculations such as determining the average number of occurrences or central tendencies. The two most commonly types of descriptive research designs are o*bservation* and s*urveys.*

If the objective is to determine what variable may be causing a certain behaviour – that is, whether there is a cause-and-effect relationship between *variables* - causal research must be undertaken. To determine causality, it is necessary to hold constant the variable that is assumed to cause the change in the other variable(s), and then measure the changes in the other variable(s). This type of research is extremely complex and the researcher can never be completely certain that there are not other factors influencing the causal relationship, especially when dealing with people's attitudes and motivations. Two research methods can be used to explore the cause-and-effect relationship between variables, namely *Experimentation* and *Simulation*

4.4.2.2 Exploratory research method (Joppe sa:Research Design, Data Collection, and Selection of Subjects)

As the term suggests, *exploratory research* is often conducted because a problem has not yet been clearly defined, or its real scope is as yet unclear. Exploratory research helps determine the best research design, data collection method and selection of subjects, and sometimes even concludes that the problem does not exist.

Exploratory research may be quite informal, relying on secondary research such as reviewing available literature and/or data, or approaches such as informal discussions with consumers, employees, management or competitors, and more formal approaches through in-depth interviews, focus groups, projective methods, case studies or pilot studies.

Generally, the results of exploratory research are not that useful for decision making, but they can provide significant insight into a given situation. However, the results of qualitative research can provide some indication of the "why", "how" and "when" of something occurring.

4.4.2.3 Qualitative research method

Qualitative research methods were developed in the social sciences to enable researchers to study social and cultural phenomena. Examples of qualitative methods are action research, case study research and ethnography. Qualitative data sources include observation and participant observation (fieldwork), interviews and questionnaires, documents and the researcher's impressions and reactions.

4.4.2.4 Quantitative research method

Quantitative research methods were originally developed in the natural sciences to study natural phenomena. Examples of quantitative methods which are also generally accepted in the social sciences include survey methods, laboratory experiments, formal methods (eg Econometrics) and numerical methods such as mathematical modelling.

4.4.2.5 Case study research method

The term “case study” has many meanings. It can be used to describe a unit of analysis (eg a case study of a particular organization) or a research method. Myers (2004:6) defines the case study method as an empirical inquiry that investigates a contemporary phenomenon in its real-life context, especially when the boundaries between the phenomenon and context are not clearly defined.

4.4.3 Research design chosen for this study

The research work presented in this study must specifically answer the question of how purchasing constraints and demand uncertainties impact on elements of working capital. Using the above definitions of research methods, it is clear that the question of “how” will be answered by employing a conclusive descriptive method. In addition, this study will use data from existing databases to establish the causality between constraints, uncertainties and working capital variables. This research will therefore also contain a quantitative element.

Clearly, the investigation of the behaviour of specific elements of working capital under variable demand and constrained purchasing conditions of a South African cable manufacturer do relate to a single case. The primary objective of this research is to determine the nature of the interaction and it is thus explanatory and answers the question of “how” (and in this case “to what degree”), the variables influence each other. In addition, since the overall problem has as yet not been solved, it represents a contemporary phenomenon in a real-life context, and the researcher has no influence over the outcomes and the interaction between the variables.

The domain is clearly restricted to that of the cable manufacturer and is thus clearly specified. This study will therefore adopt a case study method.

4.5 MEASURING INSTRUMENTS

4.5.1 Introduction

Each of the research methods discussed above uses one or more techniques for collecting empirical data. These techniques range from interviews, observational techniques such as participant observation, experiment observation through to archival research. They may also comprise case studies and mathematical models such as simulations and sampling methods. A brief overview will be provided in the ensuing sections.

4.5.2 Observation

Observation is a primary method of collecting data by human, mechanical, electrical or electronic means. The researcher may or may not have direct contact or communication with the people whose behaviour is recorded. Observation may be part of qualitative as well as quantitative research techniques. These techniques range from participant observation, obtrusive or unobtrusive observation, to structured and direct or indirect observation. Indirect observation, for example, relates to observation of behaviour or data after the fact (recorded behaviour or data).

The budget demand data and annual actual demand data used in this study, will be observed indirectly, by querying an existing database containing prerecorded values.

4.5.3 Sampling

The procedure in which a few subjects are chosen from the universe to be studied in such a way that the sample can be used to estimate the same characteristics in the total is referred to as sampling. Sampling in this particular sense will not be used in this study. The data will be sampled by using a mathematical simulation method as outlined in the next section.

4.5.4 Monte Carlo simulation and sampling

4.5.4.1 Introduction

In the empirical study, a simulation model will be used to determine the average expected demand (secondary objective (5)) over a multiyear period. The sampling method to be simulated is based on the probability of occurrence in the underlying actual annual demand pattern for each cable type considered. The cable types, which are included in this study and in the calculations, are African Cables Ltd's product range, namely electrical power cables as detailed in annexure 2.

4.5.4.2 General application of Monte Carlo simulation

Monte Carlo (MC) methods are stochastic techniques – in other words, they are based on the use of random numbers and probability statistics to investigate problems. MC methods can be used in everything from economics to nuclear physics to regulating the flow of traffic. However, the way in which they are applied varies widely from field to field.

Monte Carlo simulation is advantageous because it is a "brute force” approach that is able to solve problems for which no other solutions exist or for which other solutions are too complex. The only requirement is that the system must be described by probability density functions (pdf's). We will assume that the behaviour of a system can be described by pdf's and that the pdf's are known. Then the Monte Carlo sampling simulation can proceed by random sampling from the pdf's. Many simulations are then performed (multiple trials) and the desired result is taken as an average over the number of observations (which may be a single observation or perhaps millions of observations). In many practical applications, one can predict the statistical error (the “variance”) in this average result.

4.5.4.3 Specific application of Monte Carlo Simulation in this study

As mentioned previously, demand in the electric power cable market has been termed highly diverse and variable. Since the contributing factors that cause the variance cannot be forecast, the companies operating in this market must consider their demand pattern as quasistochastic. In order to arrive at meaningful expected values for working capital, the longer periods with a known pattern of demand are required. Owing to the fact that only one year’s demand is available, other periods must be forecast using a sampling model, assuming that the frequency of occurrence of a particular length of cable is given by the demand distribution of the actual demand (see annexure 6). The Monte Carlo simulation (MCS) method lends itself to model statistically distributed demand by sampling from a given probability distribution function.

The output of the simulation will provide us with a set of demand figures for a five-year period (secondary objective (5)). As outlined above, the demand figures derived from the ERP system represent only one occurrence of uncertain demand. With due consideration of the uncertainty, the multiple sampling will used to arrive at demand figures that can be expected on average over a longer period. Generally speaking, Monte Carlo sampling can produce thousands of values providing increasingly more accurate results as the number of samples increases. However this study was limited to 246 samples, which is more accurate than only 12 samples for one year.
The simulated demand values will be used to determine the working capital values of inventory, accounts payable and accounts receivable (secondary objective (6)). The working capital values derived from this calculation will be compared with the working capital values attained from the budget conditions, in order to exhibit the difference between them (secondary objective (7)). These values will also be used to calculate the benchmark ratios for the working capital elements of raw material inventory, accounts payable and receivable (secondary objectives (8) and (9)). It is therefore imperative for this simulation to be carried out to arrive at statistically significant results as required by the primary objective and the hypothesis of this study.

4.6 STATISTICAL EVALUATION OF DATA

4.6.1 Origin of data

The primary objective of this study is the quantification of the impact of purchasing constraints and uncertain demand on the working capital elements of raw material inventory, accounts payable and receivable, and to prove that there is a statistically significant difference between the working capital values derived from the different data sets representing conditions of various purchasing constraints and uncertain demand. It is therefore of paramount importance to ensure reliable and consistent data. The data used in this study either stem from actual ERP data or have been calculated. The data calculated from the annual demand values in particular, exhibit distinct sloping-up and sloping-down effects at the beginning and at the end of the period respectively. This phenomenon can be ascribed to the fact that payables are incurred before the time the demand actually starts, whereas receivables are still collected after the end of the annual demand period.

4.6.2 Statistical tests

From section 4.3.1 it is clear that the annual demand data can be said to be discontinuous at the beginning and at the end and do not represent an ongoing business operation in these areas. Since there is no overlap in demand data from the previous year and to the next year relative to the annual demand period considered, the calculated working capital data will increase from zero at the beginning and decrease to zero at the end. Values from the sloping-up and sloping-down area of the curve require further investigation, because they appear suspect. Statistical analysis is therefore required to ensure the necessary quality and validity of data.

4.6.2.1 Tests for outliers

Firstly, all monthly values used for the final calculation will be inspected for outliers. According to Fallon and Spada (1997:1-8), outliers are observations that appear to be inconsistent with the remainder of the collected data. These data must be subjected to further study. Four common outlier tests for normal distributions are Rosner's test, Dixon's test, Grubb's test and the box plot rule, which are based on hypothesis testing. For the data presented in this study, which typically deal with a small sample size of 12 to 13, the Dixon's test, which can be used when the sample size is between 3 and 25 observations, will be employed.

The data are ranked in ascending order, then based on the sample size, and a tau statistic for the highest or lowest value is computed. The tau statistic is compared with a critical value at a chosen alpha. If the tau statistic is less then the critical value, then the conclusion is that no outliers are present. The tau statistic is calculated as follows:

Observations	Highest value suspect	Lowest value suspect
3 to 7	$\tau = \frac{x_n - x_{n-1}}{x_n - x_1}$	$\tau = \frac{x_2 - x_1}{x_n - x_1}$
8 to 10	$\tau = \frac{x_n - x_{n-1}}{x_n - x_2}$	$\tau = \frac{x_2 - x_1}{x_{n-1} - x_1}$
11 to 13	$\tau = \frac{x_n - x_{n-2}}{x_n - x_2}$	$\tau = \frac{x_3 - x_1}{x_{n-1} - x_1}$
14 to 20-30	$\tau = \frac{x_n - x_{n-2}}{x_n - x_3}$	$\tau = \frac{x_3 - x_1}{x_{n-2} - x_1}$

The critical values can be obtained from commonly used statistical tables (Seely sa:15-23). The tables containing the actual data only show the reduced data set, without any outliers.

The data originating from the simulation will be tested using Rosner's test, because the sample size is larger than 25. To apply Rosner's test, one firstly needs to determine an upper limit r_0 on the number of outliers (r_0 <= 10), and then arrange the r_0 extreme values from most extreme to least extreme. Rosner's test statistic is then based on the sample mean and sample variance. The following example will elucidate the application of Rosner's test. The following steps are required:

- STEP 1: Suppose X_1, X_2, . . . , X_n represent the ordered data points. By inspection, the maximum number of possible outliers, r_0 must be identified.

- STEP 2: The sample mean $\bar{x}$, and the sample standard deviation, s, must be computed using all the data leading to values $\bar{x}^{(0)}$ and $\bar{s}^{(0)}$, respectively. The observation farthest away from $\bar{x}^{(0)}$ must be determined and labelled $y^{(0)}$. Observation $y^{(0)}$ must be deleted from the data and the sample mean computed and labelled $\bar{x}^{(1)}$, and the sample standard deviation, labeled $s^{(1)}$. Then the observation farthest away from $\bar{x}^{(1)}$ must be determined and labelled $y^{(1)}$. Observation $y^{(1)}$ must be deleted and $\bar{x}^{(1)}$ and $s^{(1)}$ computed. This process must be continued until r_0 extreme values have been eliminated.

  To summarize, after the above process, the analyst should have

  $\left[\bar{X}^{(0)}, s^{(0)}, y^{(0)}\right]; \left[\bar{X}^{(1)}, s^{(1)}, y^{(1)}\right];...;\left[\bar{X}^{(r_0-1)}, s^{(r_0-1)}, y^{(r_0-1)}\right]$ where

  $\bar{X}^{(i)} = \frac{1}{n-i}\sum_{j=1}^{n-i} x_j$; $s^{(i)} = \left[\frac{1}{n-i}\sum_{j=1}^{n-i}\left(x_j - \bar{x}^{(i)}\right)^2\right]^{1/2}$; and $y^{(i)}$ is the farthest value from $\bar{x}^{(i)}$.

(The above formulae for $\bar{x}^{(i)}$ and $s^{(i)}$ assume that the data have been renumbered after each observation has been deleted.)

- STEP 3: In order to test if there are 'r' outliers in the data,

  $R_r = \dfrac{\left| y^{(r-1)} - \bar{x}^{(r-1)} \right|}{s^{(r-1)}}$ must be computed and compared to ë$_r$ in as per the tables given in EPA QA/G-9.

  If R_r ë$_r$, conclude that there are r outliers. A test must be done to establish if there are r_0 outliers (compare R_{r0-1} to ë$_{r0-1}$). If not, a test must be done to determine if there are r_0 - 1 outliers. If not, a test must be done to determine if there are r_0 - 2 outliers. The process must be continued, until one has determined that there are a certain number of outliers or that there are no outliers at all.

4.6.2.2 Tests for differences in sample means

In order to achieve the objective of this study, namely to prove that there is a significant difference between the working capital values, calculated for the different conditions and shown in tables 5.1, 5.3 and 5.6, sample averages need to be statistically compared with one another.

In general statistics, hypothesis testing of the difference between two means is applied. According to Wyllys (2003:2), the student t-test must be applied for cases where the sample size is less than or equal to 30. Since this research deals mainly with smaller sample sizes, in particular, where monthly values are concerned, this test will be used to detect significant differences between means. The sample averages of the calculation reflected in tables 4.1 to 4.6 therefore constitute means from two different populations. In a statistical sense, this comprises a comparison between two means μ_1 and μ_2 having standard deviations s_1 and s_2. As outlined by Wyllys (2003: 2), the null hypothesis is that there is no difference between means μ_1 and μ_2, i.e. $\mu_1 = \mu_2$, or the samples were drawn from two populations with the same mean. The t-score can thus be calculated as follows using the sample standard deviations s_1 and s_2:

$$t = \hat{X}_1 - \hat{X}_2 / s_p \sqrt{(1/N_1 + 1/N_2)}$$

$$s_p^2 = \frac{\left((N_1 - 1)s_1^2 + (N_2 - 1)s_2^2\right)}{\left((N_1 - 1) + (N_2 - 1)\right)}$$

where:

N_1,N_2 = sample sizes of means $\hat{X}_1$ *and* $\hat{X}_2$

s_1,s_2= Sample standard deviations of means $\hat{X}_1$ *and* $\hat{X}_2$

s_p = pooled estimate of standard deviation
s_p^2 = pooled estimate of population variance

In this study, both cases of a smaller sample mean or larger sample mean than the other are important. Therefore, the test involves exploring both tails of the normal distribution. Since most researchers settle on a 5% significance (Hopkins 2003:2) the null hypothesis will be accepted if the calculated t-score lies within the tabled t-values of –2.06 to +2.06 for 24 degrees of freedom (StatSoft, 2003:3-4).

4.6.2.3 Tests for differences in variances

Furthermore, the averages calculated and reflected in tables 5.1, 4.3 and 4.6 may be similar. In this instance, a test for differences in means as detailed above may no longer suffice. In order to prove that the averages originate from two different populations, and therefore differ significantly, it is necessary to test for significant differences in their variances. Statistics offers the F-test, which is most commonly used in the comparison of variances. The F-test is designed to test whether two population variances are equal. It does this by comparing the ratio of two variances. Thus, if the variances are equal, the ratio of the variances will be 1. If the null hypothesis is true, then the F test-statistic can be derived from the following formula:

$$F = \frac{s_1^2}{s_2^2}$$

This ratio of sample variances will be the test statistic used. If the null hypothesis is false, then the null hypothesis that the ratio was equal to 1 and the assumption that they were equal, will be rejected. There are several different F tables. Each one has a different level of significance. Firstly, the correct level of significance must be found, and then the numerator degrees of freedom and the denominator degrees of freedom must be looked up to find the critical value. The F tables give level of significance for right-tail tests only. This is because the F distribution is not symmetric, and there are no negative values. The left critical values are avoided altogether.

4.7 CONCLUSION

In order to achieve the primary objective of this research, namely to find an answer to the question of how purchasing constraints and demand uncertainties impact on working capital and to provide managers who control working capital with a quantitative statement of the impact on these specific elements of working capital, an appropriate research design is required to ensure the correctness of the results derived from the research. The validity of the research results depends on the validity of the input data into the research. To ensure valid results, the input data must be statistically interrogated using the different methods as described above.

As explained above, the most appropriate research strategy for this research is the case study method, using quantitative measuring instruments such as sampling and simulation techniques, as well as the necessary methods of statistical analysis. The purpose of the research is to explain and quantify the impact of purchasing constraints and demand uncertainty on selected elements of working capital. This impact can be explained by the chosen research design. However, generalization about the South African cable industry is not possible in terms of the quantitative impact on selected working capital accounts.

CHAPTER 5: RESEARCH RESULTS

CHAPTER 5: RESEARCH RESULTS

5.1 INTRODUCTION

The empirical study was conducted to investigate the quantitative impact of purchasing constraints and uncertain demand on the elements of working capital of inventory, accounts payable and accounts receivable. In sections 5.4.2 to 5.4.6, the influence of purchasing constraints and demand uncertainty on inventory levels will be determined. Sections 5.5 and 5.6 will deal with the influence on accounts payable and on accounts receivable respectively. Using a Monte Carlo simulation of expected demand over a five-year period one can calculate the expected working capital values as shown in section 5.7.

5.2 ECONOMIC ORDER QUANTITIES FOR RAW MATERIALS

5.2.1 Introduction

According to Hugo et al (2002:165-182), the EOQ denotes an order quantity, which represents the minimum cost associated with the order in terms of carrying cost, acquisition cost and the cost of the material itself. Keeping the actual material cost constant, the EOQ corresponds to an offset between the order cost and holding cost of the material. The reason for this relationship becomes clear on closer inspection of the individual cost elements. As the order quantity increases, holding cost will also rise. Conversely, the acquisition cost decreases with increasing order quantity. Thus a minimum of total cost can be found because the resulting total cost curve represents a parabola with a local minimum point. However, in order to be able to apply the EOQ formula as shown in chapter 1, both holding cost and order cost need to be known. EOQ calculations are used in a purchasing situation with no constraints. In this study, EOQ will be used to compute working capital values in instances where no purchasing constraints will be present, thus contributing to the achievement of the secondary objectives (5) and (7).

The sections below show the calculation of the individual cost elements, ordering costs and holding costs, as well as the final computation of the economic order quantities for all raw materials required in the manufacture of the real and expected demand of African Cables' products.

5.2.2 Ordering cost

In general, the ordering or acquisition cost relates to the cost of generating and processing a purchase order, along with the related paperwork. The following cost elements can be identified as being responsible for this type of cost:

- wages and operating cost required for purchasing, material planning, receiving inspection, stores and accounts payable management.
- the cost of requirements, such as specifications, drawings and stationary
- the cost of services such as computer time, fax, telephone and postage.

When considering these cost elements, it becomes obvious that their behaviour and magnitude do not depend on the size and quantity of material ordered. A buyer would typically spend a similar amount of time in handling an order and dealing with the respective supplier, regardless of whether one kilogram or one ton of material was purchased. Hence, on a per unit quantity measure, the acquisition cost will normally decrease.

In the case of African Cables Ltd, the ordering cost can be calculated as follows:

Number of orders placed per annum

Raw materials	1 942
Drum Orders	966
Maintenance	1 525
Sundry	6 083
Total	10 516

The total annual cost associated with order handling as derived from African Cable Ltd's annual cost report is R512 189.

Ordering Cost = 512 189 / 10 516 = 48.71 rand per order

5.2.3 Holding cost

The holding or carrying cost of material in store can mainly be associated with the opportunity cost of capital. Thus the higher the interest rates, the higher the material cost will be. However, according to Hugo et al (2002: 169-170) the following five major elements make up inventory-holding cost.

(1) the opportunity cost of invested funds.
(2) the insurance cost for assets
(3) property taxes
(4) the storage cost including the depreciation of storage facilities
(5) obsolescence and deterioration

In general these costs are directly related to material quantity and increase with the rising material quantity to be stored.

The figures for African Cables Ltd are as follows:

Total purchases per annum:		R349 041 524
Property taxes:		R254 000
Area of stores:	10 821.58 m²	
Total Afcab area:	132 900.00 m²	
Apportioned property taxes:		R20 682
Insurance:		R915 716
Stock adjustments (Slow moving & spoilt):		R344 334
Cost of operating stores incl. depreciation:		R1 534 927
Total cost:		R2 815 659

The holding costs are therefore R2 815 659/R349 041 524
= 0.81% of spent

Prime Rate (Current)	11.50%
Total Cost	0.81%
Holding Cost	12.31%

5.2.4 Economic order quantities

The EOQ can now be calculated using the inventory-carrying cost and ordering cost as determined in the previous sections together with the annual demand figures for each material as derived from the annual budgeted demand for end items as per annexure 5. The results of the calculation, using the formula provided in section 2.5.2.2, are shown in annexure 4.

However, having calculated the EOQs for each material, cognizance must be taken of the assumptions underlying the calculation. As detailed in Hugo et al (2002:178), the assumption revolves around the certainty of forecasting material demand, consistency of purchasing and transport prices as well as unlimited availability of capital and materials. Subject to these limiting factors, the EOQ model is applicable in this situation because reference is made to a reference (budget) demand, on the one hand, and the actual demand is considered in retrospection, on the other. Hence there is certainty about all of the above factors.

5.3 BUDGET AND ACTUAL DEMAND

5.3.1 Introduction

Demand has been shown to be variable and almost impossible to forecast. Nevertheless, an enterprise needs to engage in business planning to be able to anticipate turnover levels, associated spending and profits. Such a business plan will enable the firm to define precisely its business and identify goals for the future period. Because it provides specific and organized information about the company and how it will repay borrowed money, a sound business plan informs sales personnel, suppliers and stakeholders about the company's operations and goals. Important business issues hinge on it, - for example outside funding, supplier credit, management of operation and finances, promotion and marketing of the business, and the achievement of goals and objectives.

In general, in the so-called "budgeting process", each function or department sets out requirements for funds and bases its plan on an expected level of business. The whole organization plans according to the sales and the material requirements budgets. These budgets will determine the general business activities and working capital levels after the extraction of an acceptable MPS for the firm's demand.

However, the actual demand experienced by a firm, in this case African Cables Ltd, may differ largely from the forecast demand. The origins of the differences were discussed in chapter 1.

A change in requirements for the end product will inevitably influence the requirements for raw material. The determining factors are the BOMs of the end items. In order to appreciate the effects of changes in the demand, it is necessary to analyse the actual demand compared with the forecast (budgeted) demand. The section below will deal with both types of demand, namely actual and budgeted demand.

5.3.2 Sales budget

The African Cables Ltd sales budget is generally prepared from historical figures, with a few exceptions, where the customer's intentions are clear and almost committed. A typical annual budget is shown in annexure 5.
This budget incorporates demand figures for all product groups as shown in annexures 1 and 2, with the exception of rubber cables, which are no longer manufactured on-site at African Cables Ltd. The budget has been prepared taking the previous year's sale figures into consideration, and inflating these, in order to meet the required growth targets. The production mix is therefore standard.

5.3.3 Actual Demand

The actual demand for African Cables Ltd's finished products is reflected in the actual production that occurs during an annual period of production. In essence, it is equal to the invoiced sales, although a finished product is occasionally purchased from competitors or wholesalers, in order to overcome short-lived demand peaks. Generally, in the cable industry, customers accept as normal lead times from order to delivery of six to eight weeks. Economic conditions may, however, extend these lead times to 16 to 20 weeks.

An example of one year of real demand is shown in annexure 6. Compared with annexure 5, the anticipated demand, huge differences are evident. The actual variability of the real demand versus budget is discussed in the ensuing section.

5.3.4 Demand variability

Demand variability can be expressed in several ways. In simple terms, it is the amount of cable in terms of length and weight that is under- or overestimated in the budget. In the case of African Cables Ltd, 18 880 km were forecast and 17 697 km were really produced on actual demand, - an overestimation of 6.3% in terms of length. In terms of weight, a demand for 22 553 tons was anticipated and 20 523 tons actually manufactured on actual demand, - an overestimate of 9%. Owing to the fact that the difference in weight is larger than the difference in length of the cables actually manufactured, one may conclude that the average cable weight per cable length manufactured, was smaller than anticipated.

Another means of expressing the deviation between expectation and actual demand is the accuracy with which the actual cable item demand can be forecast.
In African Cables Ltd's case, the budget contained 354 end items, whereas 457 different cables were requested. This implies a match of only 77.5%. The demand for items not budgeted for can influence the set-up times in the production process. Its influence may be reflected in the shortage of actual demand

(production) in comparison with budgeted demand (production). The demand for nonbudget items thus has an impact on available capacity and lead time.

However, in arriving at a meaningful variability analysis that can be used for calculation and modelling processes, the general concept of variance, standard deviation and coefficient of variation as detailed in Winston (1994:622-626) can be employed.

Accordingly, the standard deviation and variance are calculated as follows:

$$\mathrm{var}(X) = \sum_{k=1}^{k} (X_k - \overline{X})^2$$ var(X) = variance of variable X

$$s = \sqrt{\mathrm{var}(X)}$$ ó = standard deviation

$$CV = \frac{s}{\overline{X}} * 100\%$$ CV = coefficient of variation

$\overline{X}$ = arithmetic mean of variable X

The above formulae basically denote that the variance is the square of the difference of the actual value and an expected value. The standard deviation is expressed as the square of the sum of all the squares of the differences.
The CV provides a percentage measure of the actual spread relative to the calculated mean and can be used to compare the variability of different data series.
However, to be able to use the budget as the expected average, it is necessary for the cables and quantities not contained in the plan, but actually manufactured, to be converted into the budget mix and expressed in terms of the cable quantities of the expected mix. In the researcher's own experience, a common way of converting cable quantities of different size and length is to calculate the product of area of the conductor and the number of cores and the length, resulting in a square millimetre*metre quantity which can then be apportioned according to the square millimetre*metre quantity of each cable contained in the budget.

The following example explains this calculation:

It is assumed that the budget consists of two cables, that is, F4CC4016111–100 km (4-core 16 mm² PVC cable) and F4CC4185111 - 50 km (4-core 185 mm² PVC cable), and the cable produced but not contained in the budget was an F4CC4050111-10 km (4-core 50 mm² PVC cable). The calculation would be as follows:

Cable	Length m	mm²m	% of total

F4CC4016111	100 000	6 400 000	14.75
F4CC4185111	50 000	37 000 000	85.25
		43 400 000	100.00

The apportionment of the manufactured cable, which was not budgeted for, would be as follows:

Cable	Length m	mm²m
F4CC4050111	10 000	2 000 000

Allocation of nonbudgeted material for product 1:

2 000 000 mm²m * 14.75% = 295 000 / 4 / 16 = 4 609 m

Allocation of nonbudgeted material for product 2:

2 000 000 mm²m * 85.25% = 1 705 000 / 4 / 185 = 2 304 m

The quantities calculated in this manner must be added to the actual manufactured quantity of cables contained in the budget.

Once this computation has been performed for all products manufactured but not contained in the plan, the actual variances and standard deviations for all cables can be computed for all cables of the budget mix, with due consideration of the actual produced quantities on a monthly basis. Note that the variance is calculated using the difference between quantity produced after allocations and the monthly average of the annual budget (annual budget divided by 12).
Annexure 7 indicates the calculated figures using the above mix adjustment and allocation method. As indicated in annexure 7, the coefficients of variation vary between 44 and 3 618%. If the actual demand was normally distributed, then percentage figures of not more than 12.5% should be expected. This confirms that the demand experienced by African Cables Ltd is highly variable.

In order to determine working capital values with actual demand and with and without purchasing constraints, (to satisfy secondary objectives (3) and (4)), the recalculated end item quantities can now be exploded into raw material requirements, which will be dealt with in the next section.

5.4. MONTHLY MATERIAL REQUIREMENTS AND STOCK LEVELS

5.4.1 Introduction

In this section, in order to achieve the relevant part of secondary objectives (3) and (4) the method used to determine monthly material requirements and inventory values will be explained. The following information is needed to calculate inventory values and the differences between the inventory values derived from the different purchasing and demand conditions:

(1) manufacturing periods per product group
(2) calculated monthly material requirements
(3) monthly raw material stock levels for the budget, with and without purchasing constraints
(4) monthly raw material stock levels for actual demand, with and without purchasing constraints

5.4.2 Manufacturing periods per product group

In order to calculate the material requirements per cable for each period, the typical manufacturing lead times for the different products must be taken into consideration. To produce realistic material requirements, in line with real manufacturing conditions, lead times must reflect a manufacturing situation in which the plant is loaded to capacity. Finite capacity and loading to capacity are therefore assumed. Under such conditions, the manufacturing lead times per product are as follows:

Paper and XLPE MV products	-	4 weeks
XLPE ST products	-	5 weeks
XLPE LV, PVC Mains, Bells, ABC Zerotox Mains, OHSC products	-	3 weeks
Housewire products	-	2 weeks
Overhead conductor products	-	1 week

Using these lead times, the actual time-phased material requirements can be calculated.

5.4.3 Calculated monthly material requirements

Exploding the BOM of each product, and moving the required material quantities to earlier dates, in accordance with the time given by the manufacturing lead time, enables one to calculate the material requirements for every week and at month-ends. This procedure ensures that material is available at the beginning of the manufacturing period for each product. Although, strictly speaking, some of the materials are only required in subsequent processes, in practice, materials are generally available at the start of manufacturing. This is particularly true of high-value and imported materials. Thus the impact of applying this procedure is minimal. In order to further minimize the implied error, monthly demand as per annexures 5 and 6 has been broken down into weekly requirements, thus achieving nearly continuous manufacturing and supply conditions. Separate graphs were developed for the budgeted demand and the actual demand situation.

5.4.4 Monthly raw material stock levels for budget demand

Table 5.1 below contains information on section 5.4.4 (budget demand) and section 5.4.5 (actual demand).

The raw material requirements for budget demand, determined according to the method described above, are depicted graphically in annexure 21.

To illustrate the relevant results in more detail, two of the most consumed commodities have been exemplified, namely PVC polymer and copper rod (see annexure 18). As shown in the graphs in annexures 21 and 18, the inventory curves follow the theoretical curves as shown in commonly cited textbooks. Table 5.1 below shows the actual calculated values. In terms of total stocks, a differentiation was made between weekly stock values and monthly stock values. The latter would typically be considered in current financial statements. The left-hand side of table 5.1 summarises the monthly results. The averages and absolute minima and maxima do not require further elucidation. The calculated average of the raw material stock value was found to be approximately R129 000 for monthly values and R128 500 for weekly values, which initially indicates good agreement.

Table 5. 1: Raw material stock values at month-ends

Raw material stock values at month-ends (rands)						
Month	Demand type					
	Budget			Actual		
	With EOQ	with real purchasing quantities and no safety stocks	with real purchasing quantities and safety stocks	with EOQ	with real purchasing quantities and no safety stocks	with real purchasing quantities and safety stocks
0	124 965	----	17 056 594	137 233	----	17 806 512
1	127 949	5 265 100	16 642 358	132 302	6 224 353	17 079 509
2	136 978	4 696 466	16 560 709	127 631	4 068 414	16 423 391
3	140 787	5 890 132	16 943 671	119 753	4 567 600	16 656 688
4	115 968	4 925 104	16 263 994	116 025	5 340 507	17 007 387
5	110 717	4 295 200	15 850 912	124 564	4 205 417	15 995 352
6	119 376	4 529 695	17 152 354	124 299	5 510 420	16 580 186
7	120 974	4 885 240	16 325 567	128 258	5 709 699	16 761 862
8	144 538	5 006 261	15 454 308	120 960	5 031 971	16 467 806
9	141 125	5 293 743	16 493 283	120 205	4 621 931	16 228 147
10	136 227	4 750 214	16 531 048	110 887	4 085 288	16 249 430
11	122 788	4 805 180	16 632 513	133 713	4 620 668	16 146 265
12	137 279	4 861 474	16 731 534	----	5 377 908	16 377 907

Average	129 205	4 933 651	16 510 680	124 653	4 947 015	16 598 496
Std dev	10 910	409 489	467 953	7 641	694 069	484 078
No of samples	13	12	13	12	12	13
Weekly avg	128 407	5 040 364	16 433 795	131 049	5 013 620	16 436 680
Std dev	11 584	602 443	476 257	11 791	700 140	436 441
No of samples	52	52	52	52	52	52
Abs min	105 251	3 765 652	15 305 463	110 242	3 955 634	15 752 058
Abs max	156 073	8 170 327	18 253 416	157 762	8 418 796	18 497 124

Source: Compiled from calculations in annexures 18 and 21.

5.4.5 Monthly raw material stock levels for actual demand

The raw material requirements for the actual demand, determined by means of the same method as outlined in section 4.5.3.4 for budget demand, are presented graphically in annexures 22 and 23. In order to show the contribution of holding safety inventory to the stock values the two graphs differentiate between actual purchasing conditions inclusive of safety stocks (annexure 22) and actual purchasing conditions excluding safety stocks (annexure 23). The three data sets, namely (1) budget demand with actual purchasing conditions and no safety stocks, (2) actual demand with actual purchasing conditions and no safety stocks, and (3) actual demand with EOQ, showed one outlier each, which were eliminated.

To illustrate the relevant results in more detail, PVC polymer and copper rod are again shown separately (see annexure 19 – for purchasing conditions with safety stocks, and annexure 20 – for purchasing conditions excluding safety stocks). As shown in the graphs in annexures 19 and 20, the inventory curves also follow a sawtooth pattern, although not as perfectly as in the case of budget and EOQ. Most importantly, as indicated on the bottom right-hand side of table 5.1, the averages for weekly and monthly inventory values differ widely. Furthermore, the calculated average for total stock in the case of actual purchases including safety stock was found to be approximately R16 598 496 for monthly values and R16 436 680 for weekly values, whereas the values of total stock in the case of actual purchases excluding safety stock were found to be approximately R5 148 836 for monthly values and R5 013 620 for weekly values. For comparison purposes, the model was rerun with actual demand figures, but in accordance with EOQ purchasing conditions. The respective figures for monthly and weekly inventory levels were found to be R126 749 and R131 049. These figures agree satisfactorily with the values found for budget and EOQ conditions.

The difference between weekly and monthly figures shows that the choice of month end closure dates or the weeks in which the months end will influence the level of the raw material stock values. In addition, even if the average raw material stock values differ only marginally, more severe differences could be experienced between individual months.

5.4.6 Comparison of inventory values

To formulate a clear and unambiguous statement about the relationship between the calculated inventory value averages, statistical hypothesis testing, as outlined in section 4.5, must be employed.

In order to test the individual contributions of purchasing constraints and uncertain demand, the respective means will be compared with the mean obtained under optimal EOQ purchasing conditions and budget demand. The following table summarizes the results:

Table 5. 2: Summary of statistical test results for stock levels

Budget with EOQ	**Compared to**		
$\hat{X}_1$ = 129205 s_1 = 10910 N_1 = 13	Budget with real purchasing conditions, no safety stocks	Budget with real purchasing conditions	Real demand with real purchasing conditions
$\hat{X}_2$	4 933 651	16 510 680	16 598 496
s_2	409 489	467 953	484 078
N_2	12	13	13
t-score	-42.4	-126	-123
Decision	Reject H_0	Reject H_0	Reject H_0
Budget with real purchasing conditions	**Compared to real demand with real purchasing conditions**		
t-score	-0.47		
Decision	Accept H_0		

Source: Table 5.1

5.4.7 Conclusion

The above values show that there is a significant difference between the stock level obtained from *optimum purchasing conditions* and those achieved with real purchasing conditions, with and without safety stocks. However, the difference between stock levels that originate from real purchasing conditions in the cases of actual and *budget demand* is insignificant. The variances as indicated by the F-test at a 5% significance level, also stem from the same population. In fact, one may therefore conclude that the difference in the previous values is caused solely by the real purchasing conditions and mainly influenced by the decision whether or not to carry safety inventory.

The *uncertain demand* can be said to have no effect on the inventory levels, as long as the uncertain material requirements are known long enough in advance for materials to be purchased within their actual lead-time parameters. Should this not be the case, the scenarios as shown in annexures 24 and 25 may arise.

The graphs detail the situation, in which material requirements are purchased against the initial budget either by EOQ or actual parameters and consumed as if they had been purchased for actual demand. The graphs show, in the best-case scenario, that material will be out of stock after approximately seven weeks in the case of actual purchasing conditions, and after three weeks in the case of EOQ purchasing practice. It is clear that in the first case, large-quantity purchases and safety stocks keep the material requirements satisfied for a longer period.

The influence of purchasing constraints and demand uncertainty on inventory levels were determined in sections 5.4.1 to 5.4.6. In section 5.5, the influence of purchasing constraints and uncertain demand on accounts payable will be determined.

5.5 ACCOUNTS PAYABLE BALANCES

5.5.1 Introduction

Payables balances are usually accumulated as soon as the material is received on site. Depending on the delivery or Inco-terms, the material is invoiced accordingly, which also marks the start of the time to payment. To simplify the input parameters for the calculation program, all payment terms were expressed as time from the date of sale of the raw materials. Owing to the weekly demand calculation, a continuous stream of payments could be expected. In African Cables Ltd, however, materials are invoiced at the end of the respective months only, irrespective of delivery date, and the payments period only starts from the date of invoice. Thus payables balances can be expected to accumulate until payment and then to fall to a new level, from where accumulation starts again. The anticipated pattern therefore resembles a sawtooth pattern, similar to the inventory curves. The monthly values will reflect the minima of the weekly curve, as the accounts are normally published after payments have been made.
In order to determine the influence of purchasing constraints and demand uncertainty on accounts payable, the following need to be considered:

(1) supplier payment terms
(2) calculated monthly payables balances for the budget, with and without (EOQ) purchasing constraints
(3) calculated monthly payables balances for the actual demand, with and without purchasing constraints

5.5.2 Supplier payment terms

The payment terms used in the following calculations are shown in annexure 8. Except for imports from international suppliers, most of the local suppliers only provide 30 days' payment grace with few discounts. International suppliers generally provide between 60 and 120 days' payment period without discount. All periods as indicated are taken as the time from the date of sale of the raw materials. Using these parameters, the expected accounts payable can be calculated.

5.5.3 Calculated monthly payables balances for budget

Table 5.3 is relevant to 5.5.3 (budget demand) and 5.5.4 (actual demand).
The calculated accounts payable balances for different demand and purchasing conditions are shown in table 5.4 below and annexures 26 to 29.
The monthly averages for the budget demand vary only slightly between R43 501 591 and R43 003 849. The weekly averages are considerably higher with R54 million to R56 million. This difference is the result of the noncontinuous payment pattern as discussed in section 5.5.1.

Table 5. 3: Accounts payable values at month ends

Payables balances at month-ends (rands)						
Month	Demand type					
	Budget			Actual		
Purchasing condition	With EOQ	with real purchasing quantities and no safety stocks	with real purchasing quantities and safety stocks	with EOQ	with real purchasing quantities and no safety stocks	with real purchasing quantities and safety stocks
0	----	13 930 918	31 372 859	----	13 455 990	30 836 971
1	40 351 792	39 059 437	45 218 964	42 954 512	41 905 667	49 412 211
2	52 098 499	50 935 042	52 018 375	63 945 715	63 035 062	63 267 415
3	44 021 649	43 525 144	45 353 932	36 648 597	36 596 749	35 143 031
4	43 681 272	45 253 627	42 669 337	38991 005	37 446 100	38 741 584
5	52 013 232	51 891 420	52353 633	30 869 536	30 951 684	30 976 314
6	44 104 183	43 129 877	44 299 130	46 265 203	46892 120	46 096 760
7	43 657 664	43 311 095	42 818 354	47 179 470	47 904 370	47 643 160
8	52 034 420	52 846 632	52 784 894	53 970 386	53 344 354	54 299 277
9	43 991 933	44 203 101	43 835 466	43 331 839	42 769 466	42 380 535
10	33 355 797	32 873 170	33 675 304	35951301	35 074 552	36 197 637
11	32 775 612	32 686 641	31 963 644	56 925 591	57 090 241	57 137 443
12	39 933 035	39 297 336	40 686 140	39 862 270	40 783 795	39 254 367

Average	43 501 591	40 995 649	43 003 849	44 741 285	42 096 165	43 952 824
Std dev	6 471 857	10 315 179	7 227 574	9 572 409	12 564 363	10 131 765
No of samples	12	13	13	12	13	13
Weekly Avg	54 137 295	54 334 944	56 407 858	56 693 675	56 139 271	57 877 204
Std dev	20 647 024	19 522 132	18 330 332	21 726 256	21 478 222	20 596 330
No of samples	56	56	56	56	56	56

Source: Calculations from annexures 26, 28 and 29

Both series, budget demand and actual demand with EOQ, showed outliers in the first data element, which were eliminated. To test the differences between the sample means, statistical hypothesis testing as outlined in section 4.3 was applied again. Table 5.4 summarizes the results.

Table 5. 4: Summary of statistical tests of accounts payable figures

Budget with EOQ	**Compared to**		
$\hat{X}_1$ = 43501591 s_1 = 6471857 N_1 = 12	Budget with real purchasing conditions, no safety stocks	Budget with real purchasing conditions	Real demand with real purchasing conditions
$\hat{X}_2$	40 995 649	43 003 849	43 952 824
s_2	10 315 179	7 227 574	10 131 765
N_2	13	13	13
t-score	0.72	0.18	0.13
Decision	Accept H_0	Accept H_0	Accept H_0
F-score	2.54	1.25	2.45
Decision	Reject H_0 F(0.1,13,12)=2.105	Accept H_0 F(0.1,13,12)=2.105	Reject H_0 F(0.1,13,12)=2.105
Budget with real purchasing conditions	**Compared to real demand with real purchasing conditions**		
t-score	-0.27		
Decision	Accept H_0		

F-score	1.96
Decision	Accept H_0 at F(0.1,13,13)=2.053

Source: Table 5.3

The statistical results show, that it can be assumed that the averages do not originate from the same population, except when comparing (1) budget demand and EOQ with budget demand and actual purchasing conditions, and (2) budget demand and actual purchasing conditions with actual demand and actual purchasing conditions. In all other cases the null hypothesis H_0 is rejected.
In conclusion, this means that accounts payable will change significantly from the budgeted average in response to purchasing constraints and uncertainty in demand, when introducing real purchasing conditions without safety stocks and real demand with actual purchasing conditions.

5.5.4 Calculated monthly payables balances for actual demand

The calculated balances reflecting material requirements computation based on actual demand as shown on the left-hand side of table 5.3, range from R44 741 285 to R43 952 824 with an average of R43 952 824. The graphical representation of the data is shown in annexures 28 and 29.
As shown in the previous section, there is probably no significant difference between the means and variances of the budget demand with actual purchasing conditions and actual demand with actual purchasing conditions. This indicates that payables balances on average will remain the same when moving from budget to actual demand with actual purchasing conditions in both cases. Hence the finding was that in the case of annual actual demand values demand uncertainty does not appear to influence accounts payable.

5.6 ACCOUNTS RECEIVABLE

What was said about the payment of accounts payable also holds true for accounts receivable. African Cables Ltd generally invoices at the end of the month and collects receivables once a month, hence say, in the case of a 30-day payment term. A similar sawtooth pattern as shown for accounts payable can be expected for accounts receivable. In order to determine the influence of demand uncertainty on accounts receivable, the following need to be considered:

(1) credit terms per customer group
(2) calculated monthly receivable balances for the budget
(3) calculated monthly receivable balances for the actual demand

5.6.1 African Cables Ltd's credit terms per customer group

African Cables Ltd's customer groups were briefly introduced in section 2.5.2. These customer groups exhibit a general pattern of payment terms and can be classified as follows:

Table 5. 5: Customer groups and payment terms

Group	**Payment terms**
General market	5%, 60 days from date of sale
Mining industry	2.5%, 30 days from date of sale
Municipalities	2.5%, 30 days from date of sale
Projects	0%, 30 days from date of sale
Export	0%, 90 days from date of sale

Source: African Cables Ltd, Sales Information (2003)

Using these payment terms, the weekly and monthly receivable balances can be calculated from the previously determined materials requirements.

5.6.2 Calculated receivables balances for budget

The calculated balances for budgeted receivables are summarized in table 5.6 (left-hand side) and shown in annexure 30. The average receivables balances were found to be R53 841 613 with a maximum of R71 867 965 and a minimum of R13 365 922. The minimum values are typically realized at the beginning of and end of the year because no carry-overs from the previous and to the next year could be taken into account. These values were identified as outliers, and hence eliminated.

Table 5. 6: Receivables balances at month-ends

Receivables balances at month-ends (rands)		
Month	Demand type	
	Budget	Actual
0	----	29 383 317
1	53 410 414	69 160 160
2	51 246 961	58 780 684
3	47 301 470	46 194 424
4	54 175 138	46 337331

5	51 399 906	51 340 937
6	47 301 470	54 461 640
7	54175 138	71 670 996
8	51 399 906	68 568 692
9	71 867 965	97 494 117
10	61 354 696	92 537 311
11	48 624 674	74 565 863
12	----	20 395 873
Average	53 841 613	60 068 565
Std dev	7 163 963	22 286 771
No of samples	11	13
Weekly avg	57 240 087	69 900 426
Std dev	17 114 798	24 954 794
No of samples	54	54
t-score	-0.89	
Decision	Accept H_0	
F-score	9.678	
Decision	Reject H_0 (F(0.1,12,12) = 2.147)	

Source: Calculated from annexures 30 and 31

5.6.3 Calculated receivables balances for actual demand

The calculated balances for actual receivables are summarized in table 5.6 (right-hand side) and shown in annexure 31. The average receivables balances were found to be R60 068 565 with a maximum of R97 494 117 and a minimum of R20 395 873. No outliers could be identified according to Dixon's test. It is clear that there is a relatively large standard deviation in the case of the actual demand values, with a coefficient of variation (CV) of 0.371 or 37.1% variation compared with a CV of 0.133 or 13.3% variation for the receivables balances based on budget demand.
Although the statistical comparison of means shows that there is no significant difference between the means of the two data series, it must be concluded that the data series stem from two different populations, based on the fact that the variances are significantly different as shown by the F-test at a 5% significance level. This means that the monthly values of the actual receivables vary significantly stronger around the mean.

In terms of the influence of demand uncertainty on accounts receivables, there is a difference between the two populations. Although the averages are similar, there is a significant degree of fluctuation around the two sample averages.

5.7 MONTE CARLO SIMULATION (MCS) OF ACTUAL DEMAND

5.7.1 Introduction

As detailed in section 4.5, it is necessary to qualify and verify the results obtained from the calculations using the actual annual demand figures. Since the demand is variable, it is clear that the demand figures for a following year might change considerably. Different demand, however, would result in different working capital figures, which could lead to a different conclusion compared with the one based on the actual demand data. In order to provide more trustworthy data, a simulation is performed which produces different sets of demand data based on the pdf's of the actual demand figures. Because the simulation is performed over multiple periods, the reliability of the average demand values increases and will lead to data that can be expected to be more realistic than a set of data for only one period or year.

To determine the simulated demand sets and subsequently the working capital figures and benchmark ratios as set out in secondary objectives (5) to (9), it is necessary to consider the following:

(1) the parameters for the simulation
(2) the simulated demand
(3) the expected outcomes of raw material stock levels, accounts payable and accounts receivable based on simulated demand

5.7.2 Parameters for simulation

The main parameters in the simulation are the input parameters for the MCS and the required sample size. The key to MCS is generating a set of random numbers that serves as input. Generally, random numbers are greater than zero and smaller than one. The random number will be generated using the built-in random number generator of Excel 2000, sampling from a normal distribution. Ranges of random numbers will be allocated to the intervals of the discrete cdf, characterizing the probabilities of occurrence of particular cable lengths. To this end, the range of cable length experienced in the actual demand period, will be divided into quartile ranges, denominating low, medium low, medium high and high demand. The probabilities of cable length occurring in each quartile provide the probability density required. Since a specific cable length had to be considered for each quartile, the average length was used.

In essence, if it was found that 30% of all cable lengths lie within the first quartile, say, from 0 to 300 m, then the number range of 1 to 30 as generated by the random generator (random number times 100), will be allocated to the average length of 150 m (average length of the first quartile). If the next 20% of all cable lengths occur within the second quartile from say, 301 to 600 m, this means that the number range, 31 to 60, is allocated to an average length of 450 m. This allocation procedure is repeated until all cumulative 100% occurrences of cable lengths have received number allocations. This procedure is repeated for each cable, because each follows a different pdf.
In the next phase, random numbers must be generated as outlined above, for or exceeding the number of times as indicated by the minimum number of samples to be taken, and also for each cable. The appropriate average length of the

respective quartile, according to the random numbers returned, is taken as the simulated cable demand. According to Hopkins (2001:3), the sample size for each cable should be approximately 400. However, an Excel spreadsheet is used for the calculations. These spreadsheets have 65 536 rows and 256 columns. Since the calculation of payables, receivables and stock levels requires more than 256 entries in one direction, the sample size had to be limited to a maximum of 256. In fact, multiples of 49 were used to provide data for complete years. In this case, the samples size of 5*49 =245 was used, which equals five years of demand data.

5.7.3 Simulated demand

The simulated demand was calculated as described in the above paragraph. A sample page containing the layout and the results of the simulation of demand is shown in annexure 9. As detailed above, each entry constitutes the average length of a quartile of real demand, depending on the random number chosen. The demand calculated in this manner provides the input for the calculation of the different elements of working capital.

5.7.4 Expected outcomes of raw material stock levels, payables and receivables under simulated demand conditions

The raw material stock levels, payables balances and receivables balances were calculated in the same way as the actual annual demand figures. The figures extracted from the simulation are shown in annexures 10, 32 to 35. A statistical test for outliers in accordance with Rosner's test method, as detailed in section 4.5.2, did not show any abnormalities.

The monthly average of the simulated *stock levels* without safety stocks was found to be R4 746 514 and with safety stocks R16 102 262. These values are close to the previously calculated annual values of R4 933 651 and R16 510 680 respectively.
The expected weekly *payables balances* are R64 042 585 and R64 072 362 for the cases with and without safety stocks respectively. These values are higher than those found in the instances of the annual calculations, R42 096 165 and R43 952 824, which is attributable to the higher sales forecast from the simulation. The average monthly *receivables balance* from the simulation is R92 512 407, which is much higher than the R60 068 565 of the annual actual figures.

In order to show the differences between budget demand with EOQ and actual purchasing conditions with safety stocks and the simulated stock levels, payables and receivables, statistical testing was performed in terms of differences between means and variances, where applicable. Table 5.7 summarizes the results.

Table 5. 7: Summary of statistical tests for simulated conditions

Stock levels with simulated demand with real purchasing conditions	**Compared to**	
$\hat{X}_1$ = 16 102 262 s_1 = 494 382 N_1 = 60	Budget with real purchasing conditions, no safety stocks	Budget with real purchasing conditions
$\hat{X}_2$	4 933 651	16 510 680
s_2	409 489	467 953
N_2	12	13
t-score	73.27	-2.72
Decision	Reject H_0 (t_{crit}=1.997)	Reject H_0 (t_{crit}=1.997)
Payables with simulated demand and actual purchasing conditions	**Compared to**	
$\hat{X}_1$= 64 072 362 s_1 = 8 620 429 N_1= 55	Payables balances with budget demand and EOQ	Payables balances with budget demand and real purchasing conditions
$\hat{X}_2$	43 501 591	43 003 849
s_2	6 471 857	7 227 574
N_2	12	13
t-score	7.78	8.04
Decision	Reject H_0 (t_{crit}=1.997)	Reject H_0 (t_{crit}=1.997)
Receivables with simulated demand	**Compared to**	

$\hat{X}_1$ = 92 512 407 s_1 = 14 724 351 N_1= 54	Receivables as per budget
$\hat{X}_2$	53 841 613
s_2	7 163 963
N_2	11
t-score	8.4
Decision	Reject H_0 (t_{crit}=1.997)

Source: Calculations based on annexure 10.

5.7.5 Conclusion

The results of table 5.7 show that in the first instance, the five years' simulated actual *receivables* are significantly different from the budgeted receivables. One may therefore conclude that the demand is significantly different from the budget. This is a confirmation of the results obtained in preceding sections dealing with the variability of the demand in terms of differences between actual and budgeted demand.

The *inventory* values obtained from the material explosion of the simulated actual demand considering actual purchasing conditions, are significantly different from the budgeted material demand with EOQ. This shows the influence of purchasing conditions and demand uncertainty on these stock values. In this instance, the simulated inventory positions also differ significantly from the stock values of the budget demand with real purchasing conditions, attributable to the increased demand level. It is therefore clear that the simulation confirmed that purchasing constraints and demand uncertainty impact significantly on inventory levels.

The *payables* balances based on budget demand with EOQ and with actual purchasing conditions both differ significantly from the values obtained from the simulation. This confirms that, both the level of demand, and the purchasing conditions, play a major role in determining the level of payables.

5.8 CALCULATION OF BENCHMARK RATIOS

As detailed in section 1.5, working capital ratios will be expressed as ratios in relation to average daily sales. To be able to express the calculated working capital figures as ratios of sales, all necessary components of each category must be taken into consideration. Accounts payable and accounts receivable cannot be broken down into individual components in the traditional DSO and DPO ratios, and may be taken as computed. However, the inventory levels still require the addition of WIP values, FG values and any raw material stock normally found on the shop floor. These figures were extracted from the SAP enterprise resource planning system in use at African Cable Ltd. Annexures 11 to 16 show the final working capital values and ratios for the actual demand conditions incorporating the different purchasing scenarios, EOQ, actual purchasing conditions with safety stocks and actual purchasing conditions without safety stocks. The same figures for simulated demand are presented in annexure 17. For discussion purposes, the average WC ratios are repeated in table 5.8.

Table 5. 8: Average working capital ratios

Actual demand, actual purchasing conditions					
Condition	**DPO**	**DSO**	**DRM**	**DI**	**DWC**
1*	39.2	54.4	14.3	56.3	71.6
2**	39.3	54.4	0.1	42.1	57.2
3***	38.7	54.4	4.3	46.2	62.0
4****	33.9	49.2	8.5	34.5	49.7
5*****	33.9	49.2	2.5	27.8	43.1
6******	34.0	49.2	0.1	25.7	40.8

Source: Calculated from annexures 11 to 17.

1* = actual demand, actual purchasing conditions
2** = actual demand, EOQ purchasing conditions
3*** = actual demand, actual purchasing conditions, no safety stocks
4**** = simulated demand, actual purchasing conditions
5***** = simulated demand, actual purchasing conditions, no safety stocks
6****** = simulated demand, EOQ purchasing conditions

In both cases, the actual demand and the simulated demand show the same pattern, namely an increase in working capital coverage, moving from EOQ through actual, no safety stocks to actual purchasing conditions with safety stocks.

In particular, the contribution of the increase in DWC from EOQ to actual purchasing conditions without safety stocks amounts to only 8.4%. This increase consists of an increase of 19.7% in total inventory days and a small decrease of 1.5% in DPO. The introduction of safety stocks increases DWC by another 16.7%, comprising an increase of 17.8% in total inventory days and a decrease of 1.2% in DPO. The overall increase amounts to 25.1%.
The simulation produced the following results: an increase of 5.6% from EOQ to actual purchasing without safety stocks and an increase of 16.2% due to the introduction of safety stocks, resulting in an overall increase of 21.8%.
The simulation produced a higher level of sales.

In conclusion, the computation and comparison of the benchmark ratios as required by secondary objectives 8 and 9, indicates that the investment in working capital could be curtailed by 17.9% in total, by eliminating purchasing constraints completely. A partial elimination of purchasing constraints by eradicating safety stocks will result in a 13.3% reduction in working capital investment.

CHAPTER 6: DISCUSSION OF RESULTS AND CONCLUSIONS AND RECOMMENDATIONS

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6.1 DISCUSSION OF RESULTS

The research results presented in the previous chapter indicate that the actual working capital accounts may differ significantly from the planned values. This is particularly true of the simulated figures, in which the expected values were extracted from a simulation spanning a period of five years. All the results differ significantly from the budgeted inventory levels, payables balances and receivables balances. A slightly dissimilar situation was obtained when calculating the annual values. In the first instance, all inventory levels certainly differed significantly statistically from the optimal planned scenario (budget with EOQ).

Large discrepancies were prevalent in the budget demand type when applying different purchasing conditions, moving from EOQ to actual demand without safety stocks and actual demand with safety stocks. However, no major difference was evident between budget and actual demand using actual purchasing conditions. This does not imply that demand uncertainty does not have any influence on the working capital items; it merely states that by using the same method of calculation as for budget demand, it was assumed that the suppliers would meet the material requirements based on the actual demand in all cases, and that the requirement quantities were known in advance of the actual suppliers' delivery lead time.

Because the uncertainty of demand, coupled with uncertainty about the ability to supply material, would have to be modelled in a completely different manner, one way of showing the effects of demand uncertainty, for the purpose of this research, is to fix the material supplies calculated from the budget demand, superimposing the actual demand and recalculating the stock values. The graphs in annexure 24 show this scenario for EOQ purchasing conditions in the cases of copper rod and PVC polymer. The graphs in annexure 25 show the scenario using actual purchasing conditions for the same materials. The graphs indicate that in both cases and for both materials, the forecast was inadequate as designated by negative stock values. However, in the case of EOQ purchasing, African Cables Ltd would be out of copper after five weeks and out of PVC after two weeks, whereas in the case of actual purchasing practices, copper and PVC will last for six weeks. The only difference between the two scenarios is in the purchasing conditions and one may therefore conclude that larger supply quantities and safety stocks keep the company running for some slightly longer periods, if augmented material requirement quantities are not known sufficiently in advance, which enables the company to source the material in time. Although this inference may be common knowledge, it is important to note that changes in demand impact differently on different materials, depending on the safety stock levels and minimum purchasing quantities.

If it could further be assumed that the supplier has the capability to deliver, or that material could be obtained from a second supplier at short notice, then one could adjust the previous stock value graphs by purchasing a minimum lot (ignoring the safety stocks in this case) every time the stock values turn negative. Without cancelling any existing orders, the graphs as per annexures 36 and 37 were obtained. The new average monthly stock value levels at R21 634 187, - an increase of R5 035 691 or 30%. The accounts payable of R43 338 779 are similar to the actual demand case with actual purchasing conditions.

However, the sharp increase in stock values suggests that strong manual intervention is required to once again reduce the values again to previous levels.

In the second instance, the payables balances initially appeared to stem from the same population, implying that there was no difference, no matter what scenario was chosen. This hypothesis had to be rejected when inspecting the variances of the data sets, stating that the population means may be statistically the same, but

the basic population parameters in terms of spread differed significantly in the cases of comparing budget with EOQ and budget with actual purchasing conditions without safety stocks, and budget with EOQ and actual demand with actual purchasing conditions. The introduction of safety stocks in the budget demand scenario compared with the values without safety stocks did not show a statistically significant change in payables.
In the third instance, when comparing receivables, based on budget demand and those based on actual demand, no significant variation was evident in the annual case.

In general, the reaction of stock values to variation in purchasing conditions and demand appears to be most sensitive. A reaction is immediately felt if either requirements cannot be met or if too much material is purchased. The payables balances also detect a change in purchasing conditions, but not with the same sensitivity as the stock levels. Only a test of difference in variances showed significant underlying differences. The receivables balances appear to react only if more significant changes in demand are encountered, as would be expected.

These results are potent when inspecting the benchmark values, DRM, DPO and DSO. The high sensitivity of raw material stock values to constraints in purchasing have become apparent in the increase from an almost stockless system as produced by EOQ purchasing to four days' coverage when introducing transport and associated minimum order quantities, to 14 days', after the establishment of safety stock.

6.2 CONCLUSIONS

The hypothesis of this study is that purchasing constraints and variable demand have a negative impact on working capital levels by increasing average raw material inventory levels and accounts payable. In addition, accounts receivable may either be reduced or increased, depending on the product mix realized.

From the above discussion, it is apparent that working capital and associated indicators are influenced by operational variables in the ways stated in the hypothesis. An inventory value reacts strongly to constraints and increases or decreases in demand. Accounts payable also tend to move to higher levels when constraints hamper the optimal flow of products, but not with the same sensitivity as stock values. Sampling from the cdf of each cable type produced increased accounts payable balances. The uncertainty of supply in the situation of emergency purchases was not modelled in this research, but the assumption that materials can be obtained, without cancelling any other predetermined requirements, indicates that raw material levels may rise a further 30% over and above the current values.

In conclusion, it can therefore be stated that African Cables Ltd has the potential to reduce its working capital requirements by reducing the uncertainty in its current method of operation. This will specifically reduce the requirements for safety stocks and ensure better timing between the receipt and consumption of raw materials, thus decreasing the time required to store the products. A closer similarity between forecast and actual demand will improve purchasing and material planning, thus reducing the need for emergency purchases and for manual intervention in the predetermined and possibly optimized purchasing cycle. As shown above, manual intervention will render an optimal material supply plan nonoptimal, resulting in higher working capital requirements. The uncertainty, however, does not only appear on the supply side, but also on the consumption side. Unreliable manufacturing leads to unreliable material consumption requiring materials to be kept in stores longer than necessary, or leading to stock-out situations.

It is therefore necessary to consider the operational variables when setting working capital goals. Goals set in isolation, are unlikely to be met. The relevant variables require observation and control. Only with meaningful indicators will it be possible to produce better forecasts and expectations to meet the set goals.

6.3 RECOMMENDATIONS

As detailed in this research, the influences on working capital are multifaceted. However, in order to produce more reliable working capital requirements, the uncertainty stemming from the constraints as discussed in this work need to be eliminated as far as possible. In particular, strong measures relating to the uncertainty in supply lead time need to be established. Furthermore, the parameters that determine the purchasing policy within the ERP environment, safety stocks and minimum order quantities should be carefully revised so that they reflect real conditions. Material planning should be expedited by more accurate demand forecasts and deviations need to be communicated long enough in advance to enable purchasing to revise and re-optimize their plans.

In short, better tracking of budget versus actual conditions is necessary. The adoption of the integrated supply chain management approach, which includes supplier and customer alliances, integrated systems and instruments, such as total cost of ownership (TCO) might be exactly what cable companies in South Africa, such as African Cables Ltd, need.

LITERATURE REFERENCES

Angerhofer, BJ & Angelides, MC. 2000. System dynamics modeling in supply chain management: research review. Proceedings of the Winter Simulation Conference.

Atkins, JC & Yong, HK. 1977. Comment and correction: opportunity cost in the evaluation of investment in accounts receivable. *Financial Management*, Winter: 71-74.

Atrill, P. 2000. *Financial management for non-specialists*. 2nd edition. Pearson Education Ltd. UK.

Baccardax, M. 2002. The 2002 Working capital survey from REL in association with CFO Europe. July/August.

Benton, W. 1995. Inventory chain optimization: the next dimension for supply chain management. 5. Montgomery Research Inc. <http://www.ascet.com/login.asp?s_id=0&d_ID=212&login=true&mode=print> [Accessed on 10.04.2003.]

Brigham, EF & Ehrhardt, MC. 2002. Financial management: theory and practice. 10th edition. Thomson Learning.

CFO Staff. 2001. 2001 Working capital survey: chart 21, industrial equipment. CFO Magazine. <http://www.cfo.com/Article?article=3934> [Accessed on 10.04.2003.]

CFO Staff. 2002. 2002 Working capital survey: chart 11, electrical components & equipment". CFO Magazine. <http://www.cfo.com/charts/1,5520,M|365|312,00.html> [Accessed on 10.04.2003.]

Conference Summary: 2001.Working capital management: lessons from the leaders. CFO Publishing.

Coyle, JJ, Bardi, EJ & Langley, CJ. 2003. The management of business logistics: a supply chain perspective. 7th edition. Canada: South-Western.

Cybertec. 2002. Cybertec: the planning and scheduling company. Triest.

Daellenbach, HG. 1974. Are cash management optimization models worthwhile ? *Journal of Finance and Quantitative Analysis*, September: 607-626.

Dong, M.2001. Process modelling, performance analysis and configuration simulation in integrated supply chain network design. PhD Thesis Virginia Polytechnic Institute and State University. Blacksburg Virginia.

Du Toit, GS & Marx, J. 1994. *Guidelines for managing a research project in financial management*. Pretoria: Department of Business Mangement. University of South Africa.

Eck, Van M. 2003. Advanced planning and scheduling. BWI Paper. Amsterdam: Faculty of Sciences. Vrije Universiteit Amsterdam, April.

Eiteman, DK, Stonehill, AI & Moffet, MH. 2004. *Multinational business finance.* 10th Edition. Pearson Addison Wesley. USA.

Emery, DR, Finnerty, JD & Stowe JD: *Corporate financial management*. 2nd edition. 2004. Pearson Education. USA.

Fallon, A & Spada, C. 1997. Detection and accommodation of outliers in normally distributed data sets. http://www.cee.vt.edu/program_areas/environmental/teach/smprimer/outlier/outlier.html [Accessed on 27.09.2004.]

Fink, R. 2001. Forget the Float? *CFO Magazine*. <http://www.cfo.com/article/1,5309,3897|0|||,00.html.> [Accessed on 10.04.2003.]

Fitzgerald, KR. 2002. Best practices in procurement. Ascet 4. <http://www.ascet.com/documents.asp?d_ID=1087> [Accessed on 26.10.2004.]

Gallinger, GW & Healy, PB. 1988. Liquidity analysis and management. Addison Wesley.

Ganeshan, R & Harrison, TP. 1995. An introduction to supply chain management. Department of Management Science and Information Systems. <http://silmaril.smeal.psu.edu/misc/supply_chain_intro.html.> [Accessed on 10.04.2003.]

Hartmut, MS & Hebsaker, R. [sa]. Planung und steuerung der SC. Huter_Online,Business Process Web. <http://www.huter_online.de/Process_Web/scm/planung_und_steuerung_der_SC/planung> [Accessed on 07.08.2003.]

Heinhold, L. 1990. *Power cables and their application, part 1*. 3rd edition. Berlin and Munich: Siemens AG.

Hodge, K. 1998. Improving returns and cash flow in process industries through aggressive working capital management. Mercer Management Consulting, Inc.

Hopkins, WG. 2003. A new view of statistics: sample size formulae. <http://www.sportsci.org/resource/stats/ssdetermine.html> [Accessed on 15.09.2004.]

Hugo, WMJ, Badenhorst-Weiss, JA & Van Rooyen, DC. 2002. *Purchasing and supply chain management*. 4th edition. Pretoria: Van Schaik.

Hugo, WMJ, Badenhorst-Weiss, JA & Van Biljon, EHB. 2004. *Supply chain management: logistics in perspective*. 1st edition. Pretoria: Van Schaik.

ICC, International Chamber of Commerce. 1999. *The Incoterms 2000: ICC official rules for the interpretation of trade terms.*

Invest-Tech Limited. [sa]. Managing working capital. White Paper. <http://www.planware.org/workcap.htm> [Accessed on 10.04.2003.]

Joppe, M. [sa]. The research process.
<http://www.ryerson.ca/~mjoppe/rp.htm>[Accessed on 05.11.2004.]

Kalakota, R., Stalleart, J. & Whinston AB. 1996. *Implementing real-time supply chain optimization systems.*
<http://crec.bus.utexas.edu/jan/sc_imp.html> [Accessed on 19.09.2003].

Kalido Group: 2002. Information integration in the global enterprise. *IDC*, May.

Kuhlemeyer, GA. 2001. *Fundamentals of financial management*. Prentice-Hall Inc.

La Londe, BJ & Ginter, JL.2000. *Logistics/distribution manager's bookshelf bibliography*. The Supply Chain Management Research Group. Marketing Department. Max M Fisher College of Business. Ohio State University.
Paper #111. January.

Lambert, DM. 2001. Supply chain mangement: what does it involve? Supply Chain & Logistics Journal, Fall.
<http://www.infochain.org/quarterly/F01/Lambert.html>
[Accessed on 02.09.2002.]

Lee CB. 2002. Demand chain optimization: pitfalls and key principles. Nonstop Solutions.

Lustig, I. 1999. Optimization: achieving maximum ROI within the supply chain. Ascet 1. <http://www.ascet.com/documents.asp?d_ID=222.>
[Accessed on 10.04.2003.]

Mbendi. 2001. Association of Electric Cable Manufacturers of South Africa.
<http://www.mbendi.co.za/orgs/cdam.htm> [Accessed on 27.04.2004.]

Merville, LJ & Tavis, LA. 1973. Optimal working policies: a chance-constrained programming approach. *Journal of Finance and Quantitative Analysis*. January: 47-60.

Mintz, SL. 2000. Lean, green machines: the 2000 optimal cash scorecard".
CFO Magazine. <http://www.cfo.com/printarticle/0,5317,919|,00.html>
[Accessed on 10.04.2003.]

Moshe, BH & Levy, H. 1983. Management of accounts receivable under inflation. *Financial Management*, Spring: 42-48.

Myers, DM. 2004. Qualitative research in information systems. 8 September.
<http://www.qual.auckland.ac.nz/> [Accessed on 02.10.2004.]

Myers, R. 2000. Cash crop: the 2000 working capital survey. *CFO Magazine.*
<http://www.cfoeurope.com/20007g.html> [Accessed on 10.04.2003.]

Neff, JC. 2003. Agents, distributors and joint ventures in international commerce. Michigan District Export Council. <http://www.exportmichigan.com/reps_agents_distributors_and_joint_ventures.htm.> [Accessed on 29.03.2004.]

OFWAT. 2002. Section 2, Chapter 26: Regulatory Accounts – Working Capital. June return reporting requirements & definitions manual. <http://www.ofwat.gov.uk/aptrix/ofwat/publish.nsf/AttachmentsByTitle/ repreq02_sec2_chap26.doc/$FILE/repreq02_sec2_chap26.doc> [Accessed on 11.08.2004.]

REL Consultancy Group. 2001. Financial executives international working capital management. June.

REL Consultancy Group. 2002. Improving shareholder value through total working capital management. White Paper.

Ross, S, Westerfield, RW, Jordan, BD & Firer C. 2003. *International Finance*. 2nd South African edition. Australia: Irwin/MacGraw-Hill.

SAP: 1999. SAP Mill products: from production to marketing. SAP AG.

Shapiro, A. 1973. Optimal inventory and credit granting strategies under inflation and devaluation. *Journal of Finance and Quantitative Analysis*. January: 37-46.

Shapiro, J. 2002. Modeling approaches for supply chain decisions. *Ascet 4*. <http://www.ascet.com/documents.asp?ID=221&d_ID=1002>. [Accessd on 10.04.2003.]

Shapiro, J. 2004. Achieving competitive supply chain management: explore and exploit". *Ascet 6*. <http://www.ascet.com/documents.asp?d_ID=2515>. [Accessed on 26.10.2004.]

Schönsleben P. 2000. *Integral logistics management: planning and control of comprehensive business processes.* CRC Press LLC. USA.

Schonberger, RJ & Knod, EM. 2001. *Operations management: customer-focused principles*. 7th edition. McGraw Hill.

Seely, O.[sa]. Chapter 6: The reliability of data in quantitative chemistry". <http://www.csudh.edu/oliver/che230/textbook/reliab06.htm> [Accessed on 27.09.2004.]

StatSoft: 2003. Distribution tables. <http://www.statsoft.com/textbook/sttable.html [Accessed on 02.09.2004.]

Stock, JR & Lambert, DM. 2001. *Strategic logistics management*. 4th edition. New York: McGraw-Hill Irwin.

Stone, BK & Hill, NC. 1980. Cash transfer scheduling for efficient cash concentration. *Financial Management*. Autumn: 35-43.

Supply Chain Resource Consortium. [sa]. Home Page: SCM basics. <http://scrc.ncsu.edu/Pbasics.html>. [Accessed on 02.07.2003.]

Tellis, W. 1997. Introduction to case study. *The Qualitative Report*, Volume 3, Number 2, July. <http//:www.nova.edu.ssss/QR/QR3-2/tellis1.html> [Accesed on 05.11.2004.]

United States EPA. 2000. Guidance for data quality assessment: practical methods for data analysis. EPA QA/G-9, July, Washington.

University of Michigan. 2003. Proposal writer's guide (contents). <http://www.research.umich.edu/proposals/PWG/pwgcontents.html> [Accessed on 10.04.2003.]

University of South Australia. 2003. Section 6: Guidelines for the preparation of research proposals. Research Services. <http://www.unisa.edu.au/orc/resdeg/Section06.htm> [Accessed on 10.04.2003.]

Van Den Berg, L. 2002. Theft of non-ferrous metals in South Africa. *ESI Africa 3*. <http://www.esi.co.za/last/ESI_3_2002/ESI32002_058_1.htm>. [Accessed on 10.04.2003.]

Walsh, C. 2003. *Key management ratios*. 2nd edition. Prentice Hall. UK.

Winston, WL. 1994. *Operations research*. 3rd edition. California: Duxbury Press.

Wyllys, RE. 2003: Which standardized statistical procedure should I use? - Mathematical Notes for LIS 397.1: Introduction to research in Library and Information Science. The University of Texas at Austin School of Information.

ANNEXURES

1 PERCENTAGE MARKET SHARE PER PRODUCT TYPE

2 EXPLANATION OF CABLE TYPES

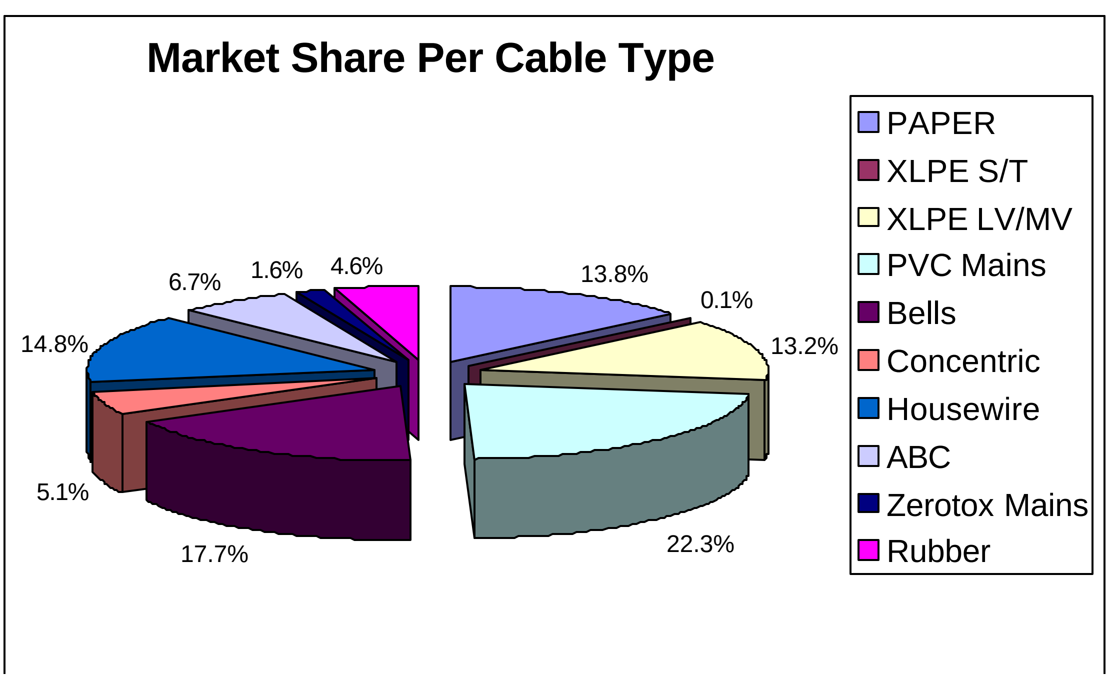
3 ABC ANALYSIS OF AFRICAN CABLES' SUPPLIERS

4 EOQ CALCULATION OF AFRICAN CABLES' RAW MATERIALS

5 BUDGET DEMAND FOR AFRICAN CABLES' END ITEMS

6 REAL DEMAND FOR AFRICAN CABLES' END ITEMS

ANNEXURE 1: PERCENTAGE MARKET SHARE PER PRODUCT TYPE



ANNEXURE 2: EXPLANATION OF CABLE TYPES

Paper: Paper insulated power cables 6.6 to 44 kV for energy distribution purposes and fixed installation.

XLPE S/T: Cross-linkable polyethylene insulated high-voltage cables 66 to 132 kV for energy distribution purposes and fixed installation.

XLPE LV/MV: Cross-linkable polyethylene insulated medium- and low-voltage cables, 6.6 to 44 kV for energy distribution purposes and fixed installation.

PVC Mains: PVC insulated power cables with cross-section 25mm² and larger up to 6.6 kV for energy distribution purposes and fixed installation.

Bells: PVC insulated and sheathed and cross-linkable polyethylene insulated and halogen-free compound sheathed power cables with cross-sections smaller than 25 mm² up to 3.3 kV for energy distribution purposes and fixed installation.

Concentric: Cross-linkable polyethylene insulated and polyethylene sheathed overhead cables with concentrically arranged conductors for the supply of energy from the lighting pole to the house.

Housewire: Single PVC insulated wires or multicore PVC insulated and sheathed cables for house-wiring applications over and under plaster.

ABC: Arial Bundled Conductor, cross-linkable polyethylene insulated for the low cost energy distribution in townships, from pole to pole.

Zerotox Mains: Cross-linkable polyethylene insulated and halogen free compound sheathed power cables with cross-section of 5 mm² and larger up to 6.6 kV for energy distribution purposes and fixed installation.

Rubber: Rubber-insulated and sheathed cables up to 33 kV for energy distribution where flexibility in installation is required.

ANNEXURE 3: ABC ANALYSIS OF AFRICAN CABLES' SUPPLIERS

Vendor no	Vendor	Value ZAR	% of Total	Cum-%	Class
65671	PALABORA	130,442,237.21	46.45	46.45	A
60364	BILLITON	17,049,755.25	6.07	52.52	A
67397	SPRINGBOK BOX (PTY)LTD	11,448,500.06	4.08	56.60	A
63022	FRY'S METALS (PTY) LTD	11,099,682.30	3.95	60.55	A
66849	CAPE GATE (PTY)LTD	10,460,507.26	3.72	64.27	A
67902	DOW CHEMICALS DIVISION	10,336,831.78	3.68	67.95	A
50576	BOREALIS A/S	9,744,387.56	3.47	71.42	A
60077	SASOL POLYMERS-VINYL	8,554,332.00	3.05	74.47	A
67949	INDEPENDANT GALVANISING	6,897,290.85	2.46	76.93	B
50602	ZAMEFA METAL FABRICA	6,816,617.55	2.43	79.35	B
61062	COPALCOR ROLLED METALS	6,348,195.32	2.26	81.61	B
65383	CHLOR ALKALI	4,838,098.00	1.72	83.34	B
67951	MALESELA TAIHAN ELEC.	3,982,349.02	1.42	84.76	B
66144	SASOL POLYMERS – VINYL	3,636,273.50	1.29	86.05	B
50007	EUROALLOYS	3,469,558.48	1.24	87.29	B
62333	DUSSEK CAMPBELL (PTY)LTD	2,559,965.00	0.91	88.20	B

Vendor no	Vendor	Value ZAR	% of Total	Cum-%	Class
61440	CHEMPRO	2,369,777.50	0.84	89.04	B
50566	MUNKSJO PAPER AB	2,199,265.79	0.78	89.82	B
60162	ATC (PTY) LTD	1,989,592.61	0.71	90.53	B
50605	ALUSUISSE TRADING	1,674,784.80	0.60	91.13	B
64075	ISO-TECH SYSTEMS C.C	1,630,347.57	0.58	91.11	B
50030	DOW CHEMICAL CO	1,598,831.21	0.57	91.68	B
50033	IDWALA SALES & DISTR	1,563,469.72	0.56	92.24	B
64515	IDWALA SALES & DISTR	1,259,849.75	0.45	92.69	B
50002	CABLE COMPONENTS LTD	1,242,705.83	0.44	93.13	B
50620	BP GLOBAL SPECIAL	1,224,638.09	0.44	93.57	B
67950	MALESELA TECHNOLOGIES	1,041,150.40	0.37	93.94	B
50623	POLYONE NORWAY	1,012,902.83	0.36	94.30	B
65967	CLARIENT SOUTHERN AFR.	879,917.74	0.31	94.61	B
61458	CHEMSERVE POLYMER SC	756,573.92	0.27	94.88	B
60000	ABERDARE CABLES AFRICA	746,713.50	0.27	95.15	C
60583	ASSOCIATED ADDITIVES	738,136.00	0.26	95.41	C
60078	SASOL POLYMERS	650,880.00	0.23	95.64	C
50500	LENZING PLASTICS GmbH	625,672.12	0.22	95.86	C
60111	CHEMGRIT SA (PTY) LTD	594,000.00	0.21	96.08	C
61290	CARST & WALKER (PTY) LTD	556,135.00	0.20	96.27	C
62652	EXCEED GEARCUTTING	542,078.20	0.19	96.47	C
50503	LANTOR BV.,FIRET	531,748.51	0.19	96.66	C
67850	TRIDENT JUTE PRODUCTS	419,433.80	0.15	96.81	C
50561	CARTIERE FEDRIGONI	404,319.75	0.14	96.95	C
50003	SCAPA POLYMERICS	382,264.26	0.14	97.09	C
65745	PERFORMANCE MASTERB.	358,062.24	0.13	97.21	C
60261	ROTOFLEX-QUIX	356,484.50	0.13	97.34	C
67173	ABERDARE CABLES/S.A.	341,476.62	0.12	97.46	C
68392	NATIONAL INDUSTRIES	311,681.90	0.11	97.57	C
66061	DIVERSIFIED CABLE	286,629.90	0.10	97.67	C
64744	MACOTECH SERVICES	284,109.75	0.10	97.78	C
66694	ROUW ENG.& INDUSTRIAL	262,190.58	0.09	97.87	C
61311	CAR PLATES & SIGNS	256,794.42	0.09	97.96	C
61990	OMG MARKETING SOUTH A.	255,585.20	0.09	98.05	C
50585	MULTIFOIL LTD	238,408.39	0.08	98.14	C
50027	TUKA LTD,	218,839.45	0.08	98.21	C
61521	CIBA SPECIALITY CHEMICALS	212,629.80	0.08	98.29	C
50553	POLYONE BELGIUM S.A.	194,199.78	0.07	98.36	C
60392	ExxonMobil Chemicals	173,580.00	0.06	98.42	C
60212	ENGEN PETROLEUM LTD	168,520.00	0.06	98.48	C
50542	NOVA-BOREALIS COMPOUND	161,211.60	0.06	98.54	C
63847	DEGUSSA AFRICA (PTY)LTD	143,425.30	0.05	98.59	C
63459	HAGGIE RAND LIMITED.	137,107.28	0.05	98.64	C
67026	FOCHEM INTERNATIONAL	134,487.50	0.05	98.69	C
60006	A.A. ALLOY FOUNDRY	121,960.50	0.04	98.73	C

Vendor no	Vendor	Value ZAR	% of Total	Cum-%	Class
64695	3 M SOUTH AFRICA (PTY)LTD	120,690.95	0.04	98.77	C
60218	MARBRIDGE BITUMINOUS	114,149.25	0.04	98.81	C
65469	NOBLE MOTOR & CONTROL	112,142.00	0.04	98.85	C
65762	TANK INDUSTRIES (PTY)LTD	108,965.30	0.04	98.89	C
63846	HULETTS ALUMINIUM (PTY)	101,515.26	0.04	98.93	C
60106	ABE CONSTRUCTION CHEM.	97,780.31	0.03	98.96	C
66218	RAND ADVERTISING TAPES	92,220.00	0.03	99.00	C
67839	MASTERBATCH S.A. C.C	89,814.50	0.03	99.03	C
65275	HEREFORD IND (PTY) LTD	83,600.20	0.03	99.06	C
61713	CONTACT PLASTICS C.C.	81,880.00	0.03	99.09	C
67845	F.J.C. BOLT & NUT (PTY)LTD	71,464.75	0.03	99.11	C
65361	NATIONAL SOLDER CO	67,694.00	0.02	99.14	C
63214	GERBER GOLDSMIDT GROUP	67,523.10	0.02	99.16	C
66618	SOUTHERN CHEMICALS	65,575.32	0.02	99.18	C
66318	FIBREGLASS ACCESSORIES	52,568.60	0.02	99.20	C
60149	ACCORD ENGINEERING	38,767.95	0.01	99.22	C
60905	NADO TECHNICAL SERVICES	38,489.00	0.01	99.23	C
60214	K-SYSTEMS CC	38,100.60	0.01	99.24	C
61811	COPPER CABLES	37,955.80	0.01	99.26	C
61981	DEBCO TECHNOLOGIES CC	36,568.50	0.01	99.27	C
60322	GELLETICH SALES (PTY)LTD	34,725.00	0.01	99.28	C
64991	MEGA BAGS CC.	34,013.49	0.01	99.29	C
61230	C & T SALES ENTERPRISE	33,977.60	0.01	99.31	C
68465	WHITELEYS	32,100.00	0.01	99.32	C
62400	EAST RAND PLASTICS	24,871.25	0.01	99.33	C
66272	ABERDARE CABLES(PTY)LTD	24,753.77	0.01	99.34	C
62519	ELITE CHEMICALS (PTY)LTD	21,955.50	0.01	99.34	C
60329	TECHNO THREADS CC	20,578.40	0.01	99.35	C
60340	VANTICO AG	19,536.00	0.01	99.36	C
60025	DUNROSE TRADING 57	16,955.00	0.01	99.36	C
60294	ITALPAC CC	13,952.98	0.00	99.37	C
61231	ERICO TECHNOLOGIES	13,507.01	0.00	99.37	C
66836	C-TEC INDUSTRIAL (PTY)LTD	12,907.64	0.00	99.38	C
61875	CULLINAN INDUSTRIAL	9,606.24	0.00	99.38	C
67851	FAG VAAL TRIANGLE	8,358.90	0.00	99.38	C
60293	PROCURECO(EDMS)BPK	7,679.04	0.00	99.39	C
63197	GERM LUBRICANTS	5,974.50	0.00	99.39	C
61040	COPYREEL CARIBONIUM	5,551.16	0.00	99.39	C
50532	SCAPA TAPES	4,855.51	0.00	99.39	C
62472	ELEC.MOULDED COMPONE	4,626.00	0.00	99.39	C
68099	VAAL STEAM SUPPLIES	4,023.50	0.00	99.40	C
66085	PROTEA INDUSTRIAL CH	3,320.25	0.00	99.40	C
64620	LOZDAN & CLARK (PTY)LTD	3,090.00	0.00	99.40	C
67446	SWIFT INDUSTRIAL SUPPLIES	2,998.80	0.00	99.40	C
63306	GLOBAL WRAPPING	2,785.00	0.00	99.40	C

Vendor no	Vendor	Value ZAR	% of Total	Cum-%	Class
63631	BILL SCHUTER ADHESIVES	2058.75	0.00	99.40	C
60341	AMYSA STATIONERS CC	1,227.84	0.00	99.40	C
61360	ELEGANCE LIGHTING	1,056.60	0.00	99.40	C
68174	VER-BOLT (PTY) LTD	1,056.00	0.00	99.40	C
60280	ALL.BOLT & NUT MANUFACT.	1,012.00	0.00	99.40	C
62506	ELECTROWARE INDUSTRIES	736.50	0.00	99.40	C
50508	SUMITOMO ELECTRIC	636.41	0.00	99.40	C
61529	CITIWOOD VAAL (PTY)LTD	564.00	0.00	99.40	C
61039	SERVOCHEM	500.00	0.00	99.40	C
68375	WALTONS STATIONERY CC	150.00	0.00	99.40	C
50533	FUJIKURA KASEI CO.LTD	54.40	0.00	99.40	C
	Total	280,830,375.18	100.00		

ANNEXURE 4: EOQ CALCULATION FOR AFRICAN CABLES' RAW MATERIALS

Mat no	Description	Annual demand qty	Material price R	Order cost R	Holding cost %	EOQ
R0000001	ALUMINIUM ROD 9.50mm E-C GRADE CLASS A	66,550.04	14.48	48.71	12.31	632
R0000005	ALUMINIUM ROD:ARMOURING 9.50mm CLASS E	180.22	19.22	48.71	12.31	29
R0000007	AL,MG,SI ALLOY ROD 9.5mm	1,635.10	15.08	48.71	12.31	97
R0000510	AL,MG,SI ALLOY STRAND 35mm2 7 WIRES	99.16	3.00	48.71	12.31	54
R0000511	AL,MG,SI ALLOY STRAND 54,6mm2 7/3,15mm	313.97	4.15	48.71	12.31	82
R0002026	ALUMINIUM TAPE 55mm x 0.10mm	434.78	32.34	48.71	12.31	35
R0004035	SOLID ALUMINIUM CONDUCTOR 35mm2x90deg	382.82	26.93	48.71	12.31	36
R0004095	SOLID ALUMINIUM CONDUCTOR 95mm2x90deg	3,133.88	21.86	48.71	12.31	112
R0004120	SOLID ALUMINIUM CONDUCTOR 120mm2x90deg	2,638.86	21.56	48.71	12.31	104
R0004150	SOLID ALUMINIUM CONDUCTOR 150mm2x90deg	1,615.45	20.90	48.71	12.31	82
R0004185	SOLID ALUMINIUM CONDUCTOR 185mm2x90deg	4,063.00	21.06	48.71	12.31	130
R0004300	SOLID ALUMINIUM CONDUCTOR 300mm2x90deg	3,347.10	26.35	48.71	12.31	105
R0005002	COPPER ROD 7.90mm	583,809.36	14.56	48.71	12.31	1865
R0005656	1.78mm TINNED SOFT DRAWN COPPER WIRE	3,060.00	0.60	48.71	12.31	666
R0005657	1.33mm TINNED SOFT DRAWN COPPER WIRE	13,532.20	0.37	48.71	12.31	1782
R0005659	1.25mm TINNED HARD DRAWN COPPER WIRE	22,687.02	0.37	48.71	12.31	2307
R0005660	1.60mm TINNED HARD DRAWN COPPER WIRE	34,854.12	0.52	48.71	12.31	2412
R0005661	2.00mm TINNED HARD DRAWN COPPER WIRE	44,979.43	0.90	48.71	12.31	2083
R0007006	COPPER TAPE SOFT TEMPER 30mm x 0.10mm	8,711.29	28.23	48.71	12.31	164
R0007008	COPPER TAPE SOFT TEMPER 40mm x 0.10mm	8,883.23	28.23	48.71	12.31	166
R0007010	COPPER TAPE SOFT TEMPER 50mm x 0.10mm	1,504.78	24.11	48.71	12.31	74
R0011005	GALVANISED STEEL WIRE 1.25mm	22,408.87	4.99	48.71	12.31	625
R0011006	GALVANISED STEEL WIRE 1.60mm	16,634.49	4.11	48.71	12.31	593

Mat no	Description	Annual demand qty	Material price R	Order cost R	Holding cost %	EOQ
R0011007	GALVANISED STEEL WIRE 2.00mm	29,859.42	3.60	48.71	12.31	849
R0011008	GALVANISED STEEL WIRE 2.50mm	127,081.63	3.65	48.71	12.31	1738
R0011009	GALVANISED STEEL WIRE 3.15mm	127,987.48	3.60	48.71	12.31	1757
R0011017	3,66mm ACSR WIRE (MINK)	1,040.40	0.51	48.71	12.31	421
R0012048	GALVANISED STEEL TAPE 45mm x 0.80mm	53,303.14	4.72	48.71	12.31	990
R0012049	GALVANISED STEEL TAPE 30mm x 0.80mm	1,019.53	4.70	48.71	12.31	138
R0015001	PURE LEAD 99.97% PURITY	92,427.57	6.90	48.71	12.31	1078
R0015015	LEAD ALLOY E	105,795.66	7.02	48.71	12.31	1144
R0021002	ALUMINIUM NOT PERFORATED PAPER 0.125mm	709.55	47.68	48.71	12.31	36
R0023010	AVL TAPE 28mm X 0.10mm	30.77	41.00	48.71	12.31	9
R0023011	AVL TAPE 25mm X 0.10mm	14.77	41.00	48.71	12.31	6
R0023013	AVL TAPE 44mm X 0.10mm	12.20	41.00	48.71	12.31	6
R0023014	AVL TAPE 19mm X 0.10mm	15.80	41.00	48.71	12.31	6
R0024015	APL TAPE SINGLE SIDE 63 X 0.15mm	26.63	41.00	48.71	12.31	8
R0026002	NATURAL INSULATING PAPER 100% WP 0.125mm	41,123.51	6.48	48.71	12.31	742
R0026052	NATURAL MARKING PAPER No "1" 0.125mm	463.28	14.31	48.71	12.31	53
R0026053	NATURAL MARKING PAPER No "2" 0.125mm	463.28	14.31	48.71	12.31	53
R0026054	NATURAL MARKING PAPER No "3" 0.125mm	463.28	14.31	48.71	12.31	53
R0027011	NATURAL KRAFT PAPER 50 MICRON	36.05	32.10	48.71	12.31	10
R0027100	SEMI-CON CARBON BLACK PAPER 0.125mm	1,443.28	18.13	48.71	12.31	84
R0030001	LLDPE DFDG-6059 BLACK 9865(UC)/ LE 8707	16,492.16	9.39	48.71	12.31	391
R0030009	LDPE LK 7020/DFDA 7540 INS.GRADE - NAT.	19.01	10.58	48.71	12.31	13
R0030027	ESCORENE LL 1004 YB	1,520.29	7.43	48.71	12.31	134
R0031002	PE AMBICAT MB - RED 4500-RD-50	13.04	78.84	48.71	12.31	4
R0031004	PE AMBICAT MB - YELLOW 4500-YE-50	11.83	61.51	48.71	12.31	5
R0031005	PE AMBICAT MB - BLUE 4500-BU-50	11.83	75.05	48.71	12.31	4
R0031017	PE AMBICAT MB - WHITE 4500-WT-50	3.63	37.34	48.71	12.31	3
R0031101	PVC MB (WILSON) BLACK 1-BK-30	0.97	17.11	48.71	12.31	3
R0031102	PVC MB (WILSON) RED 1-RD-30	1.93	38.94	48.71	12.31	3
R0031107	PVC MB (WILSON) BROWN 2-BN-30	0.11	34.14	48.71	12.31	1
R0031205	PE MB (WILSON) BLUE 691-BU-50	0.13	46.68	48.71	12.31	1
R0031206	PE MB (WILSON) WHITE 83-WT-50	0.13	30.52	48.71	12.31	1
R0032003	SEMI-CON COMPOUND XLPE BLACK HFDA 0581	12,414.74	17.80	48.71	12.31	246
R0032009	S/C BLACK VULC. XLPE HFDA 0692	12,676.74	26.16	48.71	12.31	206
R0032018	LE 4423 VISICO BASE RESIN	10,166.70	9.81	48.71	12.31	300
R0032019	LE 4476 NATURAL AMBICAT CATALYST	256.16	9.81	48.71	12.31	48
R0032020	LE 4472 BLACK AMBICAT CATALYST	426.92	9.81	48.71	12.31	62
R0032021	LE 4438 NATURAL TIN CATALYST FOR NORMAL	2.82	29.05	48.71	12.31	3
R0032201	HFDE-4201 SC NATURAL XLPE INS COMPOUND	12,594.84	12.73	48.71	12.31	293
R0032203	HFDE-4201 EC NATURAL XLPE INS COMPOUND	48,112.29	12.24	48.71	12.31	584
R0035311	GP PVC GD1/B105/108BK NATURAL(INS.GRADE)	188.15	6.60	48.71	12.31	50
R0035600	GP PVC G2/B242/901 BK (BEDDING GRADE)	666.01	6.67	48.71	12.31	94
R0035607	GP PVC GD2/B223/904	1,042.52	6.47	48.71	12.31	119
R0035610	GP PVC G2/B137/001 WH	272.31	5.95	48.71	12.31	64
R0035613	RED STRIPE G2/B223/404 SHEATH.MATS	1.05	6.44	48.71	12.31	4
R0036001	EVA PIGMENT MASTERBATCH BLACK EV 1755	2,328.09	18.65	48.71	12.31	105
R0036002	EVA PIGMENT MASTERBATCH RED JP 921	163.59	68.13	48.71	12.31	15

Mat no	Description	Annual demand qty	Material price R	Order cost R	Holding cost %	EOQ
R0036003	EVA PIGMENT MASTERBATCH WHITE 902/2	135.01	22.83	48.71	12.31	23
R0036004	EVA PIGMENT MASTERBATCH BLUE JP 1914	104.12	38.01	48.71	12.31	16
R0036006	EVA PIGMENT MASTERBATCH YELLOW JP 797	94.23	28.92	48.71	12.31	17
R0036008	EVA PIGMENT MASTERBATCH ORANGE JP 801	35.07	33.40	48.71	12.31	10
R0036030	CM 155 BLACK EVA MASTERBATCH	279.03	16.01	48.71	12.31	39
R0045120	ECCOH FR 120 NC	5,926.00	15.28	48.71	12.31	184
R0051060	PPL TAPE 60mm x 130 MICRON	3,248.65	16.27	48.71	12.31	132
R0051061	PPL TAPE 40mm X 130 MICRON	400.43	16.27	48.71	12.31	47
R0056402	SEMI-CON NON WOVEN W/B TAPE 3C 1460 60mm	552.45	79.61	48.71	12.31	25
R0056403	SEMI-CON NON WOVEN W/B TAPE 3C 1151 60mm	300.35	92.08	48.71	12.31	17
R0057012	SEMI-CON TAPE SC 48/90 45mm x 0.13mm	278.45	134.85	48.71	12.31	14
R0057030	SEMI-CON TAPE SC 36/65 45mm x 0.10mm	182.91	116.66	48.71	12.31	12
R0057031	SEMI-CON POLYESTER/NYLON TAPE 45x0.12mm	326.42	111.27	48.71	12.31	16
R0057032	TAPE:SEMI-CON POLYESTER/NYLON	326.42	111.27	48.71	12.31	16
R0057033	TAPE:SEMI-CON POLYESTER/NYLON	326.42	111.27	48.71	12.31	16
R0059230	TAPE:A.W.F	304.12	90.20	48.71	12.31	18
R0060006	JUTE:CABLE YARN 2500 TEX H1	6,053.23	6.12	48.71	12.31	293
R0060008	JUTE:CABLE YARN 5900 TEX	3,312.20	6.13	48.71	12.31	217
R0063301	YARN: PP FILLER 30000 DEN	21.29	17.87	48.71	12.31	11
R0063302	YARN : PP FILLER 120000 DEN	1,231.86	17.87	48.71	12.31	78
R0063306	YARN: PP FILLER 60000 DEN	229.34	17.87	48.71	12.31	34
R0063324	YARN: PP FILLER 240000 DEN	8,213.25	17.87	48.71	12.31	200
R0063330	RIPCORD BC 331	4.78	20.66	48.71	12.31	5
R0065015	AMEO SILANE	89.43	130.35	48.71	12.31	8
R0066012	SPICCO M3F FLAKES OR	4,615.79	11.09	48.71	12.31	191
R0066052	CALCIUM STEARATE	226.30	11.04	48.71	12.31	43
R0066055	POLYREM UV 30-242.(RED)	1.55	53.75	48.71	12.31	2
R0066061	TINUVIN 622 FB	44.71	113.12	48.71	12.31	6
R0066062	PRINTEX P	135.69	34.48	48.71	12.31	19
R0066065	IRGANOX 1010	44.71	59.13	48.71	12.31	9
R0066099	ANTIMONY OXIDE	2,442.53	14.85	48.71	12.31	120
R0068701	POLIFIN S6617 (PVC)	115,963.17	5.80	48.71	12.31	1317
R0068801	ELVAX 260	4,514.00	9.20	48.71	12.31	207
R0068802	VAMAC N 123	268.29	107.20	48.71	12.31	15
R0068805	ELVAX 670	2,658.75	9.90	48.71	12.31	153
R0068811	AC 400 OR PE 890 WAX	228.05	23.83	48.71	12.31	29
R0070011	KULUBRITE 2	74,465.69	1.14	48.71	12.31	2381
R0070012	MARTINAL OL 104 LE / SF 4 ED	14,505.44	4.27	48.71	12.31	543
R0070013	KULU 10	993.31	1.48	48.71	12.31	242
R0070027	DIACAL - CC	4,159.94	3.60	48.71	12.31	317
R0072007	MINEX GM200 GRAPHITE	216.17	74.82	48.71	12.31	16
R0072008	MICA POWDER 325	284.81	4.63	48.71	12.31	74
R0075002	D O P	36,786.32	6.70	48.71	12.31	691
R0075003	PLASTICLOR 52 LG	27,424.94	4.00	48.71	12.31	772
R0075102	COMPOUND:INSULATING ND 321	53,731.31	10.35	48.71	12.31	672
R0077000	40/50 PENETRATION BITUMEN	790.89	3.55	48.71	12.31	140

Mat no	Description	Annual demand qty	Material price R	Order cost R	Holding cost %	EOQ
R0077202	MOBIL CABLE COMPOUND	2,156.15	4.47	48.71	12.31	205
R0080204	RESONITE PACKING FILM:	8.22	14.60	48.71	12.31	7
R0081400	PULLING EYE 400MM SQ	5.13	209.00	48.71	12.31	2
R0081800	PULLING EYE FOR 800 sqmm	4.10	198.00	48.71	12.31	2
R0081950	ALUMINIUM:PULLING EYE:ANNEALED	2.07	189.00	48.71	12.31	1
R0059032	TAPE:ID:GRASS FOR PAPER CABLES	3,132.48	0.45	48.71	12.31	778
R0036007	EVA PIGMENT MASTERBATCH BROWN JP 876	0.93	21.98	48.71	12.31	2
R0035701	YELLOW TINTED CRYSTAL PVC X2/U22/2A 56	366.81	13.52	48.71	12.31	49
R0031108	PVC MB (WILSON) GREY 1-GY-30	1.07	40.4	48.71	12.31	2
R0031109	PVC MB (WILSON) ORANGE 8-OR-30	0.11	30.99	48.71	12.31	1
R0031016	PE AMBICAT MB - GREY 4500-GY-50	0.17	5.11	48.71	12.31	2
R0031015	PE AMBICAT MB - BROWN 4500-BN-50	0.17	10.63	48.71	12.31	2
R0031014	PE AMBICAT MB - ORANGE 4500-OR-50	0.17	12	48.71	12.31	2
R0023007	AVL TAPE 38mm X 0.10mm	10.53	41	48.71	12.31	5
R0023009	AVL TAPE 32mm X 0.10mm	27.72	30.91	48.71	12.31	9
R0012047	GALVANISED STEEL TAPE 60mm x 0.80mm	1,978.44	4.72	48.71	12.31	191
R0012006	GALVANISED STEEL TAPE 20mm x 0.40mm	216.51	5.88	48.71	12.31	57
R0005662	2.50mm TINNED HARD DRAWN COPPER WIRE	106,880.77	0.9	48.71	12.31	3210
R0005655	1.12mm TINNED SOFT DRAWN COPPER WIRE	3,080.09	0.27	48.71	12.31	995
R0005653	0.85mm TINNED SOFT DRAWN COPPER WIRE	7,175.70	0.17	48.71	12.31	1914
R0004240	SOLID ALUMINIUM CONDUCTOR 240mm2x90deg	2,665.81	22.74	48.71	12.31	101
R0004070	SOLID ALUMINIUM CONDUCTOR 70mm2x90deg	789.00	18.87	48.71	12.31	61
R0000516	AL,MG,SI ALLOY STRAND 50mm2 7WIRES	282.99	15.95	48.71	12.31	40
R0000513	AL,MG,SI ALLOY STRAND 70mm2 7/3.50 mm	141.50	15.2	48.71	12.31	29
R0000015	ALUMINIUM BILLETS-UNMACHINED AA1070	10,245.11	19.71	48.71	12.31	213
H0000010	MACHINED ALUMINIUM BILLETS 175mm x 438mm	9,042.64	21.91	48.71	12.31	190

ANNEXURE 5: BUDGET DEMAND FOR AFRICAN CABLES' END ITEMS

Cable type	Forecast length m	Cable weight kg	Cable type	Forecast length m	Cable weight kg
F0MINK	2504000	636016	F4CA1060FLEX	5000	1135
F1DC307042292	7200	39960	F4CC1004	668000	34068
F1EA307016195	900	4824	F4CC1006	222700	15589
F1EA309524195	2400	16008	F4CC1010	156400	16734.8
F1EA315016195	600	4692	F4CC1016	156400	25649.6
F1EA318536008	1500	10035	F4CC1025000	36000	9540
F1EC307044313	4500	35685	F4CC1035000	36200	12887.2
F1EC315044313	5700	72105	F4CC1050000	10800	5184
F1FA307017191	2100	11382	F4CC1070000	54100	35651.9
F1FA309517191	54600	341250	F4CC1070000	16000	10700
F1FA312017191	600	4266	F4CC1095000	9600	8889.6
F1FA312019191	9000	63630	F4CC1300001	4000	12648
F1FA312039191	11400	80598	F4CC1400001	4000	15912
F1FA315025511	600	6522	F4CC1500001	3000	15219
F1FA318518591	3900	39000	F4CC1630001	4500	27049.5
F1FA318519191	600	5454	F4CC1915	1015800	22347.6
F1FA324017191	11100	113775	F4CC1925	1015800	32505.6
F1FA324039191	4800	50688	F4CC2004111	25000	13025
F1FA330017191	1500	17760	F4CC2004212	23000	13662
F1FA330019191	3300	40260	F4CC2006111	25000	15300
F1FA330039191	6900	84870	F4CC2006121	1500	918
F1FA340039191	11100	153069	F4CC2006212	1000	688
F1FC163030001	3900	38649	F4CC2010111	45000	33120
F1FC163030343	1200	13776	F4CC2010121	1500	1104
F1FC302539191	24300	115425	F4CC2016111	211000	235265

Cable type	Forecast length m	Cable weight kg	Cable type	Forecast length m	Cable weight kg
F1FC303518191	1500	9210	F4CC2016121	46500	59892
F1FC303539191	4500	24120	F4CC2025111	1500	3211.5
F1FC305017191	3000	17940	F4CC2915111	52000	18044
F1FC305018191	1800	12780	F4CC2925111	43000	17673
F1FC305019191	1800	11160	F4CC2925212	1500	718.5
F1FC307017191	11400	75126	F4CC3004111	107500	66542.5
F1FC307018111	5100	44931	F4CC3006111	64500	47794.5
F1FC307018191	2100	16212	F4CC3010111	82000	75604
F1FC307019191	12600	86436	F4CC3010212	2500	2502.5
F1FC307037111	3000	22860	F4CC3016111	111500	154873.5
F1FC307038008	8700	61857	F4CC3016212	1000	1276
F1FC307038191	1800	13896	F4CC3035212	1800	3812.4
F1FC307038511	20700	183609	F4CC3050111	4200	11062.8
F1FC307039191	9000	61740	F4CC3150111	1200	7928.4
F1FC309518191	18600	170376	F4CC3185111	600	5091
F1FC309518591	1500	13605	F4CC3185121	600	4697.4
F1FC309537008	1500	9435	F4CC3915111	86000	34486
F1FC309538292	2400	21864	F4CC3925111	201000	95676
F1FC309538511	4500	49545	F4CC4004002	17000	5508
F1FC309539191	21300	174447	F4CC4004111	259500	188656.5
F1FC309539313	1500	13695	F4CC4004121	3000	2181
F1FC312018191	8100	83916	F4CC4004212	487000	294148
F1FC312037191	1800	16578	F4CC4006002	11500	4807
F1FC312038111	15600	192192	F4CC4006111	104000	92456
F1FC312038292	3600	37296	F4CC4010002	13500	8059.5
F1FC312038511	10500	128415	F4CC4010111	226000	250860
F1FC315018111	1800	24876	F4CC4010212	25000	22950
F1FC315018191	1800	21168	F4CC4016002	12000	10164
F1FC315038008	3600	34416	F4CC4016111	476000	528360
F1FC315038511	4200	57666	F4CC4016212	302500	441650
F1FC318518191	3000	40620	F4CC4025111	81000	173421
F1FC318519191	3600	44928	F4CC4025121	20100	44119.5
F1FC318538191	2100	28434	F4CC4025212	2700	5953.5
F1FC318539191	59400	741312	F4CC4035111	63000	165753
F1FC324038511	24700	459420	F4CC4035121	14400	38534.4
F1FC324038511	15300	284580	F4CC4035212	36300	96158.7
F1HC309540191	3000	38181	F4CC4050111	42000	139860
F1HC318540191	13200	216348	F4CC4050121	1200	4062
F1JC309521198	2100	30093	F4CC4050212	3600	12056.4
F2CA3120002	6900	9963.6	F4CC4070111	122100	568986
F2CA4035002	12300	8314.8	F4CC4070121	4800	22718.4
F2CA4070002	6500	7774	F4CC4070212	11700	54837.9
F2CA4095111	87900	234693	F4CC4095111	42600	237111.6
F2CA4095111	87900	234693	F4CC4095121	5100	30492.9
F2CC1050001	51400	27190.6	F4CC4095212	83700	505966.5
F2CC1050001	51400	27190.6	F4CC4120111	32400	249156
F2CC1240001	23860	57454.88	F4CC4120121	1200	9422.4

Cable type	Forecast length m	Cable weight kg	Cable type	Forecast length m	Cable weight kg
F2CC1240001	23860	57454.88	F4CC4120212	14100	108372.6
F2CC1999001	12300	121241.1	F4CC4150111	16200	146156.4
F2CC1999001	12300	121241.1	F4CC4150121	900	8244
F2CC4035111	53000	126670	F4CC4150212	1200	10880.4
F2CC4035111	53000	126670	F4CC4185111	19800	215226
F2CC4070111	52000	224900	F4CC4185121	2100	22161.3
F2CC4070111	52000	224900	F4CC4240111	3600	49046.4
F2CC4150111	23450	198082.15	F4CC4240121	1500	20541
F2CC4150111	23450	198082.15	F4CC4300111	1500	25975.5
F2CC4300111	14000	205478	F4CC4915002	7000	1169
F2CC4300111	14000	205478	F4CC4915111	122000	55998
F2DC3010P2	455000	227045	F4CC4915212	6500	3289
F2EC1120BOND	1200	1432.8	F4CC4925002	89500	19511
F2EC1185BOND	8100	14531.4	F4CC4925111	202500	111578
F2EC3185111	1200	14541.6	F4CC4925212	45000	21195
F2FA3050001	1200	2450.4	F4CC7004111	4500	4666.5
F2FA3050111	1200	5782.8	F4CC7004212	16500	17110.5
F2FA3070001	6900	16718.7	F4CC7915111	40000	24680
F2FA3095001	600	1597.8	F4CC7915212	19000	11723
F2FA3095111	2100	13034.7	F4CC7925002	20500	7154.5
F2FC1025081	3300	2428.8	F4CC7925111	50000	37900
F2FC1500083	1800	10216.8	F4CC7925212	6500	4907.5
F2FC1500141	600	4155.6	F4CCA004111	9500	17157
F2FC1630071	3300	23238.6	F4CCA004212	1000	1806
F2FC1630141	10800	92329.2	F4CCA915111	15000	14100
F2FC3025111	20700	93895.2	F4CCA925111	26000	34138
F2FC3025212	600	2758.2	F4CCB004111	5000	13405
F2FC3035111	37200	189348	F4CCB004212	1000	2681
F2FC3035119	600	3086.4	F4CCB915111	7500	10620
F2FC3035212	6600	34359.6	F4CCB925111	3500	6223
F2FC3035212	900	4727.7	F4CCB925212	500	889
F2FC3035313	900	4603.5	F4CCC915111	6500	13344.5
F2FC3050081	1200	3727.2	F4CCC925111	7500	19455
F2FC3050111	30000	171030	F4CCD915111	4500	11403
F2FC3050111	10200	58150.2	F4CCD925111	5000	17505
F2FC3050313	5700	32940.3	F4CS4035111	14400	24120
F2FC3070001	600	2202	F4CS4070111	7200	20116.8
F2FC3070111	41100	276644.1	F4CS4095111	3600	12445.2
F2FC3070212	600	4087.8	F4CS4095121	10800	37335.6
F2FC3070313	600	4085.4	F4CS4095131	11100	27405.9
F2FC3070313A	6000	40806	F4CS4120111	6300	25036.2
F2FC3095111	24600	194758.2	F4CS4120131	300	896.7
F2FC3095111	37500	296887.5	F4CS4150111	1200	6178.8
F2FC3095212	1200	9589.2	F4CS4185111	1500	9043.5
F2FC3095313	600	4805.4	F4CS4185131	45300	188855.7
F2FC3120111	13200	119829.6	F4CS4240111	1800	13080.6
F2FC3150111	25500	278817	F4CS4300111	900	7687.8

Cable type	Forecast length m	Cable weight kg	Cable type	Forecast length m	Cable weight kg
F2FC3150212	4200	46389	F4DC3050111	1200	3070.8
F2FC3150313	600	6627	F4DC3095111	1200	6000
F2FC3150313A	21900	243896.1	F4EC3035111	12600	50689.8
F2FC3185111	36400	459331.6	F4EC3035313	30900	111464.7
F2FC3185111	18300	230927.7	F4EC3070111	900	4156.2
F2FC3185114	13800	168636	F4EC3070313	48300	223049.4
F2FC3185212	600	7640.4	F4EC3095111	3300	19974.9
F2FC3185212	600	7704	F4EC3095313	3300	20615.1
F2FC3185313A	19800	252014.4	F4EC3150111	900	7239.6
F2FC3240111	13800	205468.2	F4EC3240111	1500	20775
F2FC3240114	300	4332.9	F4FC1035TAIL	1200	770.4
F2FC3240212	900	13605.3	F4FC1070TAIL	7000	7021
F2FC3300001	3000	32829	F4FC1185TAIL	6000	13014
F2FC3300111	3000	52800	F6CC2006313	12500	7525
F2GC3070111	2400	18208.8	F6CC2010313	1500	1132.5
F2GC3095212	600	5851.2	F6CC2915313	15500	5840.5
F2GC3150313	900	10860.3	F6CC2925313	9500	4246.5
F2HC1035071	900	887.4	F6CC4004313	433500	234090
F2HC3095114	3000	30486	F6CC4006313	44000	34188
F2HC3120212	600	7019.4	F6CC4010313	131500	134393
F2HC3185111	1200	17541.6	F6CC4016313	193000	245110
F2JA1120141	5700	13149.9	F6CC4035313	40500	98658
F2JA1500141	7800	38313.6	F6CC4070313	40500	175527
F2JA1630141	900	5087.7	F6CC4095313	20100	111896.7
F2JC1150141	4200	14977.2	F6CC4150313	2100	17864.7
F2JC1185071	900	2736.9	F6CC4915313	17500	7245
F2JC1240081	600	2218.2	F6CC4925313	22000	12034
F2JC1240141	3900	18544.5	F6CC7004313	22000	18282
F2JC1300141	2400	13154.4	F6CC7925313	5000	3395
F2JC1300149	8400	46107.6	F6CCA004313	12000	15300
F2JC1300242	1800	10029.6	F6CCA925313	3000	2913
F2JC1400242	2400	16480.8	F6CCB925313	2500	4157.5
F2JC1630081	900	7446.6	F7CA1035EB0	905000	209055
F2JC3050111	900	9126	F7CA2025SA0	20500	3731
F2JC3095111	600	7590	F7CA2035EB0	166500	60939
F2JC3185111	1500	26245.5	F7CA3025EB0	4500	1777.5
F2MA1400068	9483	49216.77	F7CA3025SD0	8500	4326.5
F2MA1800068	4842	35089.974	F7CA3035EB0	81500	40750
F2NA1999068	8160	74182.56	F7CA3035EB1	48500	29100
F2PA1400068	6408	49822.2	F7CA3035EC1	4500	2889
F2PC1999068	5099	85438.844	F7CA3035SD1	3500	2499
F4AC2004F1	46800	7956	F7CA3050SD0	229500	167076
F4AC2004P1	23100	3649.8	F7CA3050SD1	8500	6868
F4AC2006F1	23100	5659.5	F7CA3070EC1	4500	4369.5
F4AC2006P1	4400	910.8	F7CA3070EK1	5000	6685
F4AC2010F1	13800	5340.6	F7CA3070ND3	138000	139104
F4AC2010P1	4300	1427.6	F7CA3070SD1	14500	15123.5

Cable type	Forecast length m	Cable weight kg	Cable type	Forecast length m	Cable weight kg
F4AC2016F1	13700	8041.9	F7CA3095EC1	14500	17545
F4AC2910F1	46800	2574	F7CA3095ND3	48900	57213
F4AC2915F1	458600	34395	F7CA3095SD0	10000	11770
F4AC2915P1	458600	36688	F7CA3095SD1	11000	14047
F4AC2925F1	458600	52280.4	F7CCS004N2	120000	14688
F4AC2925P1	550400	63296	F7CCS010N2	208000	69930
F4AC3004P1	23100	5197.5	F7CCS010N4	250000	61400
F4AC3006P1	4300	1307.2	F7CCS016N2	489000	233427
F4AC3915P1	46800	5148	F4AC4915P1	46800	4633.2
F4AC3925P1	46800	7581.6	F4AC4925P1	46800	6973.2
F4AC4004P1	23100	4943.4	F4AC4006P1	4400	1293.6

ANNEXURE 6: REAL DEMAND FOR AFRICAN CABLES' END ITEMS

Cables produced	Monthly manufactured quantities m													
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total	kg/m	Total kg
F1DC307042292	0	700	0	0	0	0	0	0	0	0	0	0	700	5.55	3885
F1EA315016195	0	0	0	0	0	0	0	0	0	0	300	0	300	7.82	2346
F1EC315044313	0	1500	8200	2500	0	1500	0	0	0	0	0	300	14000	12.65	177100
F1FA309517191	0	2998	5700	1800	4495	0	3900	0	0	0	6300	8968	34161	6.25	213506
F1FA312017191	0	0	0	0	0	0	0	300	0	0	300	0	600	7.11	4266
F1FA312039191	3510	3000	1282	0	0	0	5400	600	0	0	0	0	13792	7.07	97509
F1FA318519191	0	400	0	0	0	0	0	0	0	0	0	0	400	9.09	3636
F1FA324017191	0	0	0	1800	0	0	0	0	0	0	0	0	1800	10.25	18450
F1FA324039191	0	600	0	0	0	2100	654	0	0	0	1500	3000	7854	10.56	82938
F1FA330039191	300	0	0	0	0	0	0	0	0	0	0	3300	3600	12.3	44280
F1FC163030001	0	300	0	0	0	0	0	0	4600	0	800	0	5700	9.91	56487
F1FC163030343	0	0	290	0	0	0	0	0	0	0	0	0	290	11.48	3329
F1FC302539191	600	0	0	600	2400	0	1800	0	0	0	1800	300	7500	4.75	35625
F1FC303539191	0	0	0	900	0	0	0	600	0	0	0	0	1500	5.36	8040
F1FC305019191	0	0	0	0	0	0	0	0	0	0	3144	1175	4319	6.2	26778
F1FC307018111	1500	0	0	0	0	0	0	0	0	0	0	0	1500	8.81	13215
F1FC307018191	300	900	0	0	0	0	0	0	0	0	0	0	1200	7.72	9264
F1FC307019191	1500	5700	0	900	0	0	3600	0	0	0	0	0	11700	6.86	80262
F1FC307037111	0	0	0	0	0	0	2700	0	0	0	0	0	2700	7.62	20574
F1FC307038008	300	0	0	0	0	0	0	0	0	0	0	0	300	7.11	2133
F1FC307038191	0	0	0	0	0	0	0	0	0	0	2370	0	2370	7.72	18296
F1FC307038511	0	8987	1500	13173	300	6000	0	0	0	0	6600	4500	41060	8.87	364202
F1FC307039191	5700	1200	0	600	300	6000	4200	9399	2230	2300	3600	255	35784	6.86	245478
F1FC309518191	2100	498	0	0	0	1800	3300	760	0	0	2780	0	11238	9.16	102940
F1FC309518591	300	0	0	0	0	0	0	0	0	0	0	0	300	9.07	2721
F1FC309539191	600	2100	0	600	300	641	256	2045	1200	0	0	1425	9167	8.19	75078
F1FC312018191	0	0	0	0	0	0	0	1796	300	0	0	0	2096	10.36	21715
F1FC312037191	0	0	0	0	0	0	0	300	0	0	1800	0	2100	9.21	19341
F1FC312038111	2360	593	0	0	0	600	300	0	0	0	0	900	4753	12.32	58557
F1FC312038511	0	0	0	0	0	0	5100	4800	0	0	0	900	10800	12.23	132084
F1FC315018191	0	0	0	0	0	1762	0	0	0	0	0	0	1762	11.76	20721
F1FC315038008	0	300	0	0	0	0	0	0	0	0	0	0	300	9.56	2868
F1FC315038511	0	0	1800	0	0	0	0	2687	4200	1800	300	2700	13487	13.65	184098
F1FC318518191	300	0	0	0	2639	0	0	900	0	0	0	0	3839	13.54	51980
F1FC318519191	0	0	0	0	0	0	0	2400	1800	0	0	0	4200	12.48	52416
F1FC318539191	10834	12562	9387	8599	9899	6789	13498	9300	19357	7800	1514	3590	113129	12.48	1411850
F1FC324038511	0	0	1200	2063	0	0	0	0	0	0	0	2100	5363	18.6	99752
F1HC309540191	0	0	0	0	0	0	0	300	0	0	0	0	300	12.727	3818
F2CA3120002	0	0	0	0	0	0	0	2700	600	0	0	900	4200	1.444	6065

Cables produced	Monthly manufactured quantities m													
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total	kg/m	Total kg
F2CA4035002	0	0	0	0	0	0	0	900	900	0	0	0	1800	0.676	1217
F2CA4070002	0	0	0	0	0	0	0	1800	0	564	1500	0	3864	1.196	4621
F2CC1050001	1979	10925	0	0	0	0	6000	1990	0	0	0	0	20894	0.542	11325
F2CC1999001	0	3000	1000	0	0	0	1000	1000	0	0	0	0	6000	9.857	59142
F2CC4035111	496	1800	0	0	0	0	7480	2500	0	0	0	0	12276	2.39	29340
F2CC4070111	0	0	0	0	0	0	9500	450	0	0	0	2500	12450	4.253	52950
F2CC4150111	0	0	0	0	0	0	0	0	0	0	3796	0	3796	8.41	31924
F2DC3010P2	50665	7090	0	15500	6308	24686	43829	2970	2000	0	12351	4681	170080	0.499	84870
F2EC1185BOND	0	0	901	0	3629	3509	5974	1080	0	0	0	1030	16123	1.794	28925
F2EC3185111	0	0	0	0	0	0	0	750	0	0	0	0	750	11.477	8608
F2FA3070001	0	0	0	600	0	0	0	0	0	0	0	0	600	2.417	1450
F2FC1025081	0	0	500	0	0	0	0	0	0	0	0	0	500	0.736	368
F2FC1500083	0	0	0	0	0	2800	0	0	0	0	0	0	2800	5.837	16344
F2FC1500141	0	0	0	0	0	0	0	0	0	0	1000	0	1000	6.843	6843
F2FC1630071	1620	0	0	240	0	270	0	0	0	0	0	0	2130	7.042	14999
F2FC3025111	0	4200	6650	0	0	0	0	0	0	0	0	0	10850	4.319	46861
F2FC3035111	6000	4200	3300	0	0	0	10500	0	0	0	0	8195	32195	4.804	154665
F2FC3035119	0	0	0	0	0	0	0	5700	2700	0	0	0	8400	4.581	38480
F2FC3035212	0	0	0	2400	0	0	0	0	0	0	0	0	2400	4.851	11642
F2FC3050081	8000	300	0	0	0	0	0	0	500	0	500	0	9300	3.102	28849
F2FC3050111	3275	0	0	900	0	0	1500	2700	3300	0	0	3000	14675	5.437	79788
F2FC3050313	0	0	0	900	0	0	0	1200	600	289	0	0	2989	5.432	16236
F2FC3070111	6900	1500	300	0	0	17600	4000	12400	300	1100	2390	5400	51890	6.372	330643
F2FC3070212	0	0	0	1500	300	0	0	0	300	900	1500	0	4500	6.427	28922
F2FC3070313	0	0	0	300	0	0	0	0	0	0	0	0	300	6.366	1910
F2FC3070313A	0	0	0	4200	300	0	0	3900	600	300	0	0	9300	6.358	59129
F2FC3095111	300	5700	280	0	0	0	5300	2690	0	0	0	5620	19890	7.603	151224
F2FC3095212	0	0	900	1800	0	0	0	0	0	0	0	1200	3900	7.595	29621
F2FC3095313	0	0	300	0	0	0	600	0	0	0	0	0	900	7.545	6791
F2FC3120111	293	0	1500	7800	10996	3100	1820	18100	1992	0	400	1800	47801	8.678	414817
F2FC3150111	5073	0	0	1500	0	0	600	1500	0	0	3900	1760	14333	10.554	151270
F2FC3150212	0	0	0	900	600	0	0	0	0	0	0	0	1500	10.627	15941
F2FC3150313	0	0	0	0	0	0	3900	0	0	0	0	0	3900	10.528	41059
F2FC3150313A	0	11600	9092	2700	1800	0	0	0	0	0	0	0	25192	10.528	265221
F2FC3185111	0	0	4280	2540	0	0	3300	3900	0	300	0	5100	19420	12.106	235099
F2FC3185114	0	0	0	1608	4170	600	3899	8698	1200	575	4800	2996	28546	11.654	332675
F2FC3185212	600	4148	600	1200	0	600	0	0	0	0	600	0	7748	12.187	94425
F2FC3240111	600	600	0	0	0	0	3500	800	400	10393	15500	8800	40593	14.414	585108
F2FC3300001	300	0	0	0	0	0	0	0	0	0	0	300	600	11.04	6624
F2FC3300111	0	0	0	0	0	0	0	0	0	0	0	1600	1600	16.816	26906
F2GC3095212	0	0	0	0	0	0	0	0	1500	500	0	0	2000	9.221	18442
F2HC1035071	0	500	0	0	0	0	0	0	0	0	0	0	500	0.986	493
F2HC3095114	0	0	0	0	1200	0	0	0	0	0	0	0	1200	9.496	11395
F2JC1185071	0	0	0	0	600	0	0	0	0	0	0	0	600	3.041	1825
F2JC1240141	0	0	0	0	0	0	3000	17300	9989	0	0	0	30289	4.727	143176
F2JC3185111	0	0	0	0	0	9400	600	0	0	0	0	0	10000	16.568	165680
F2MA1800068	0	0	0	0	0	0	2979	0	0	0	0	0	2979	7.247	21589
F2NA1999068	0	0	3600	0	0	0	0	0	0	0	0	0	3600	9.28	33408

Cables produced	Monthly manufactured quantities m													
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total	kg/m	Total kg
F2PA1400068	0	0	0	0	4406	1497	505	0	0	0	0	0	6408	7.775	49822
F4AC2004F1	0	0	0	8000	0	0	0	0	0	900	0	0	8900	0.14	1246
F4AC2004P1	0	0	0	2500	2600	1600	0	0	0	900	0	0	7600	0.146	1110
F4AC2006P1	0	0	0	3100	0	0	0	0	500	3800	0	0	7400	0.207	1532
F4AC2910F1	2000	0	0	0	0	53700	0	0	0	0	14600	45200	115500	0.067	7739
F4AC2915F1	1000	0	24500	6100	46400	3400	13900	4400	0	0	124600	44800	269100	0.084	22604
F4AC2915P1	0	0	0	27200	0	1200	0	0	0	0	0	1500	29900	0.081	2422
F4AC2925F1	2700	71100	21600	38800	86100	21800	21300	118800	100200	35900	13800	236000	768100	0.124	95244
F4AC2925P1	19300	6000	0	0	0	29100	26400	5000	32200	35100	33200	11300	197600	0.118	23317
F4AC3004P1	6000	0	0	0	0	1300	0	1300	0	2000	0	0	10600	0.208	2205
F4AC3006P1	0	0	0	0	0	0	0	800	0	0	0	0	800	0.279	223
F4AC3915P1	0	0	0	0	0	5700	7100	0	0	0	0	0	12800	0.103	1318
F4AC3925P1	0	0	0	0	0	8900	3700	500	0	400	0	0	13500	0.162	2187
F4AC4004P1	0	0	0	5400	0	0	0	3900	1200	8000	0	3400	21900	0.262	5738
F4AC4006P1	0	0	0	0	0	0	0	0	2000	0	0	0	2000	0.355	710
F4AC4915P1	600	0	0	0	0	0	5300	0	0	0	0	2400	8300	0.127	1054
F4AC4925P1	6700	0	0	0	0	0	3800	0	0	2900	0	0	13400	0.188	2519
F4CC1004	11400	228300	42300	5500	116600	71600	71100	4500	9900	0	61200	0	622400	0.052	32365
F4CC1006	10000	0	7600	2600	6600	0	17700	0	6900	0	0	0	51400	0.07	3598
F4CC1010	0	0	900	10600	3600	0	18900	0	9200	2400	2000	0	47600	0.107	5093
F4CC1016	7300	7600	3500	52700	6400	13600	8100	3300	0	6500	5400	3400	117800	0.164	19319
F4CC1025000	0	0	0	1500	0	0	0	0	0	0	0	0	1500	0.265	398
F4CC1035000	0	0	0	1800	3000	0	500	0	0	0	0	0	5300	0.346	1834
F4CC1095000	0	0	0	0	0	0	0	0	0	0	1500	0	1500	0.912	1368
F4CC1300001	0	0	900	0	0	0	0	0	0	0	6500	0	7400	3.162	23399
F4CC1400001	0	600	0	0	0	0	0	600	0	0	0	600	1800	3.946	7103
F4CC1500001	0	0	300	0	0	0	0	0	0	0	0	0	300	5.073	1522
F4CC1915	35500	129800	9200	78500	0	54000	75100	7900	30900	18900	516200	104100	1060100	0.022	23322
F4CC1925	17400	292800	442300	167300	367600	578800	161200	162400	107400	11600	347000	843500	3499300	0.033	115477
F4CC2004111	0	0	0	0	0	0	11500	10450	500	380	0	475	23305	0.548	12771
F4CC2004212	0	0	0	0	0	0	0	0	3500	0	500	0	4000	0.528	2112
F4CC2006111	0	0	0	3000	0	868	4000	475	500	500	2950	5000	17293	0.618	10687
F4CC2006121	0	5353	0	0	4000	1500	0	0	0	0	0	0	10853	0.618	6707
F4CC2010111	0	0	0	0	0	0	0	0	0	0	0	11975	11975	0.765	9161
F4CC2016111	3987	0	13850	975	1950	1464	9425	450	0	2180	3475	24950	62706	0.949	59508
F4CC2016121	474	0	24875	26700	20450	36800	15925	14800	2450	450	0	4475	147399	0.984	145041
F4CC2915111	0	0	0	0	0	0	5000	0	0	0	4000	10500	19500	0.387	7547
F4CC2925111	0	0	0	0	0	0	4000	0	1000	2000	0	5000	12000	0.396	4752
F4CC3004111	4306	148	0	0	0	0	14000	2950	5500	4410	950	4000	36264	0.619	22447
F4CC3006111	9667	0	500	0	0	0	5475	8900	1500	3500	3975	8450	41967	0.719	30174
F4CC3010111	8322	22252	2900	0	0	0	11235	0	0	5500	3000	16975	70184	0.911	63938
F4CC3016111	0	0	0	3425	450	33080	500	2000	0	355	0	18000	57810	1.157	66886
F4CC3035212	0	0	0	600	0	0	0	0	0	0	300	2500	3400	2.047	6960
F4CC3150111	0	0	0	0	0	0	0	0	0	0	1500	0	1500	6.476	9714
F4CC3185111	0	0	0	0	0	0	0	0	0	0	0	2300	2300	8.485	19516
F4CC3915111	3907	16915	500	1950	0	0	10000	14900	1000	5270	10000	14475	78917	0.428	33776
F4CC3925111	2206	27611	500	0	0	715	0	28875	6500	425	132975	4000	203807	0.494	100681
F4CC4004002	0	0	0	0	0	0	0	500	0	0	3000	500	4000	0.321	1284

Cables produced	Monthly manufactured quantities m													
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total	kg/m	Total kg
F4CC4004111	4888	70910	2975	0	500	3398	1925	900	950	6500	18450	24450	135846	0.706	95907
F4CC4004121	0	0	0	0	3450	475	1000	0	0	0	0	1000	5925	0.718	4254
F4CC4004212	115862	21918	3871	14500	22875	14500	1500	8500	85500	7000	0	18860	314886	0.702	221050
F4CC4006002	0	0	0	0	0	0	0	500	0	0	1500	0	2000	0.418	836
F4CC4006111	17436	2660	6900	9015	0	500	23975	2950	1425	750	11875	24375	101861	0.828	84341
F4CC4010002	0	0	0	0	0	0	0	0	0	0	1500	0	1500	0.592	888
F4CC4010111	48282	12272	0	475	0	19400	3975	15925	4475	1965	8000	3975	118744	1.058	125631
F4CC4010212	1328	11616	2975	0	0	0	0	1335	0	0	1174	0	18428	1.056	19460
F4CC4016002	0	0	0	0	0	0	0	0	0	3500	0	0	3500	0.847	2965
F4CC4016111	33280	18015	29300	4400	0	10290	49217	13975	1475	21679	22200	35475	239306	1.572	376189
F4CC4016212	5623	46657	25825	12950	43500	63000	9500	49000	61500	1000	6451	7000	332006	1.57	521249
F4CC4025111	2112	1000	1500	0	500	3000	15450	0	29200	5700	7994	9946	76402	2.098	160291
F4CC4025121	1500	991	500	2500	0	0	0	0	0	0	0	0	5491	2.144	11773
F4CC4035111	10190	3700	1247	3000	1500	8500	1330	12200	3000	3995	8192	13800	70654	2.609	184336
F4CC4035121	0	0	0	0	500	600	0	0	0	3500	500	0	5100	2.656	13546
F4CC4035212	0	6855	4500	600	1200	0	3300	5700	0	0	2400	2100	26655	2.628	70049
F4CC4050111	6175	0	0	0	1000	900	4793	0	0	0	6800	8700	28368	3.264	92593
F4CC4050212	0	0	2400	0	0	0	2700	0	0	0	0	0	5100	3.762	19186
F4CC4070111	19552	16182	13192	20646	3200	2287	6190	0	3300	0	10900	13783	109232	4.581	500392
F4CC4070121	0	266	0	0	0	0	0	0	0	0	0	500	766	4.401	3371
F4CC4070212	0	0	5400	0	0	0	3000	0	2700	295	0	0	11395	4.57	52075
F4CC4095111	7800	300	900	9277	0	300	3600	0	1500	7141	8000	2800	41618	5.897	245421
F4CC4095121	0	0	0	0	0	0	0	0	0	0	975	1000	1975	5.979	11809
F4CC4095212	13063	9788	17375	1500	293	0	15000	900	14400	836	6300	0	79455	5.906	469261
F4CC4120111	2700	900	0	535	0	0	0	1200	1800	2694	0	4495	14324	7.546	108089
F4CC4120121	0	0	0	0	0	0	0	0	0	0	0	300	300	7.852	2356
F4CC4120212	900	0	2400	1800	2100	1800	2400	0	0	0	0	0	11400	7.534	85888
F4CC4150111	300	2093	1200	2267	0	0	0	0	1400	0	900	0	8160	8.871	72387
F4CC4150121	0	0	0	0	600	0	0	0	0	0	0	0	600	8.871	5323
F4CC4150212	0	900	0	0	300	0	0	600	300	0	0	0	2100	8.886	18661
F4CC4185111	0	2999	2400	3894	300	1500	300	300	300	0	898	1500	14391	10.724	154329
F4CC4185121	0	0	0	0	594	0	0	0	0	0	0	300	894	10.724	9587
F4CC4240111	0	0	900	2400	300	900	2000	0	0	0	0	0	6500	13.466	87529
F4CC4240121	1200	0	0	0	0	0	0	0	0	0	0	0	1200	13.599	16319
F4CC4300111	0	0	0	0	0	0	780	400	0	0	0	0	1180	16.238	19161
F4CC4915002	0	0	0	0	0	0	0	0	0	0	500	0	500	0.165	83
F4CC4915111	38798	7392	1500	450	0	9475	950	17450	5475	4700	4900	3000	94090	0.474	44599
F4CC4915212	0	0	0	0	500	0	0	8500	16000	0	0	2000	27000	0.473	12771
F4CC4925002	0	0	0	0	0	0	46500	3500	0	0	0	0	50000	0.216	10800
F4CC4925111	0	30749	500	1700	0	22500	2450	20425	7975	7950	7950	22355	124554	0.546	68006
F4CC4925212	0	9950	0	0	0	11500	2500	2500	0	0	0	0	26450	0.545	14415
F4CC7004212	0	6762	600	2500	3000	0	4975	500	0	0	0	0	18337	1.438	26369
F4CC7915111	0	0	0	7450	0	3944	8925	4000	11400	2800	2000	0	40519	0.747	30268
F4CC7915212	1462	0	6390	8925	0	0	0	0	0	0	0	0	16777	0.754	12650
F4CC7925002	0	0	0	0	0	0	0	0	0	0	6000	3500	9500	0.345	3278
F4CC7925111	25935	0	1000	7475	1000	14371	37350	13350	11475	1595	0	475	114026	0.891	101597
F4CC7925212	5250	7591	1000	1500	0	0	11000	25000	2500	300	3500	0	57641	0.891	51358
F4CCA915111	0	0	5995	0	10425	360	5500	5000	0	0	1000	0	28280	1.041	29439

Cables produced	Monthly manufactured quantities m													
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total	kg/m	Total kg
F4CCA925111	0	0	0	0	1080	444	0	3000	1140	0	0	0	5664	0.985	5579
F4CCB004212	0	0	0	300	0	0	0	0	0	0	0	0	300	2.585	776
F4CCB915111	0	0	2750	1500	0	441	0	1500	1000	0	0	4000	11191	1.401	15679
F4CCB925111	8000	6967	0	450	1975	0	0	0	1500	0	0	0	18892	1.386	26184
F4CCB925212	1000	0	0	0	0	0	0	0	0	0	0	0	1000	1.96	1960
F4CS4070111	855	0	0	0	0	0	0	0	0	0	0	0	855	2.794	2389
F4CS4095121	0	0	4200	0	1800	0	2400	1190	0	0	600	1800	11990	3.326	39879
F4CS4095131	3943	0	563	0	0	0	0	0	0	0	0	0	4506	2.458	11076
F4CS4120111	0	0	900	588	900	0	600	300	0	3300	0	900	7488	4.039	30244
F4CS4120131	2970	900	0	391	0	0	0	0	0	0	0	0	4261	2.989	12736
F4CS4185111	0	300	0	0	0	0	0	0	0	0	0	0	300	6.029	1809
F4CS4185131	5997	2996	5100	4188	900	6006	0	0	300	8998	4197	6600	45282	4.203	190320
F4DC3050111	0	0	0	0	0	0	0	0	1200	0	0	0	1200	2.901	3481
F4EC3035111	0	0	300	0	0	0	0	0	600	4495	0	0	5395	3.507	18920
F4EC3035313	280	900	2357	14100	7200	0	6000	0	0	0	0	0	30837	3.515	108392
F4EC3070313	15900	6900	0	594	0	600	400	0	2100	0	0	0	26494	4.718	124999
F4EC3095111	0	1200	0	0	0	0	0	0	0	0	0	0	1200	5.989	7187
F4FC1035TAIL	0	0	0	0	0	0	0	500	300	0	0	0	800	0.642	514
F4FC1070TAIL	1000	1000	0	2000	0	0	0	2500	0	0	0	0	6500	1.009	6559
F4FC1185TAIL	0	500	1000	500	0	500	0	0	0	0	0	0	2500	2.175	5438
F6CC2915313	0	0	0	0	0	0	13375	0	0	7000	0	0	20375	0.368	7498
F6CC2925313	7829	455	0	7950	1500	0	475	10950	1500	0	11000	3000	44659	0.398	17774
F6CC4004313	66872	21186	39195	75150	62150	93077	14425	16425	24425	37425	8500	55375	514205	0.586	301324
F6CC4006313	0	0	12975	24725	18950	2234	13900	9500	12175	3500	11450	5000	114409	0.742	84891
F6CC4010313	0	0	5950	24300	17925	1234	19675	5000	14000	18450	6825	0	113359	0.972	110185
F6CC4016313	30570	62472	4000	6975	13000	14276	33250	2500	0	0	21875	0	188918	1.221	230669
F6CC4035313	700	5100	13500	18861	145	0	0	11100	9560	9000	0	0	67966	2.385	162099
F6CC4070313	4398	3300	300	4496	0	10393	1500	0	5400	5400	600	3000	38787	4.261	165271
F6CC4095313	4460	6000	2968	6225	2100	0	4800	4500	2311	300	0	0	33664	5.471	184176
F6CC4150313	0	0	600	260	0	0	900	0	0	0	1200	0	2960	8.414	24905
F6CC4915313	500	0	0	13900	0	4785	0	0	4000	18450	1500	1950	45085	0.414	18665
F6CC4925313	0	0	0	4000	3500	6500	850	1500	3600	3275	2000	8000	33225	0.488	16214
F6CC7004313	4478	205	1475	5950	950	1520	5322	3475	0	0	0	0	23375	0.832	19448
F6CC7925313	500	8884	3975	0	0	680	2500	0	0	0	1500	0	18039	0.638	11509
F6CCA004313	0	0	0	4000	0	0	0	1000	0	0	3000	0	8000	1.275	10200
F6CCB925313	0	0	0	0	0	0	0	0	800	0	0	0	800	1.272	1018
F7CA1035EB0	9000	64000	37500	0	99679	73379	0	31500	500	6000	113000	321116	755674	0.228	172294
F7CA2035EB0	18000	6000	3993	64780	1872	6860	1982	853	0	0	0	50000	154340	0.366	56488
F7CA3035EB0	935	4997	5989	73778	22992	3949	0	8441	1000	500	0	480	123061	0.5	61531
F7CA3035EB1	0	0	1600	0	7180	1756	0	3000	472	0	0	934	14942	0.6	8965
F7CA3035EC1	0	0	0	0	0	0	0	0	0	0	0	996	996	0.642	639
F7CA3035SD1	0	0	0	0	0	0	0	2000	980	0	0	0	2980	0.714	2128
F7CA3050SD0	6480	500	51970	11187	28912	28265	75547	69560	26882	68236	47777	7836	423152	0.714	302131
F7CA3070EC1	5500	0	0	0	9945	1415	0	0	1000	500	0	0	18360	0.971	17828
F7CA3070SD1	0	0	0	0	500	0	0	0	0	0	1000	495	1995	1.043	2081
F7CA3095EC1	0	0	0	0	0	0	0	0	0	500	500	0	1000	1.21	1210
F7CA3095SD0	15949	4981	7949	422	34497	1430	500	0	15972	495	0	2920	85115	1.157	98478
F7CCS010N2	87565	108769	62650	43237	28525	112500	113875	49300	15675	7375	82025	108825	820321	0.315	258401

Cables produced	Monthly manufactured quantities m													
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total	kg/m	Total kg
F7CCS010N4	0	0	0	16209	76900	2225	0	0	28075	14925	0	31875	170209	0.336	57190
F7CCS016N2	105713	69626	15500	73000	39450	101600	87975	192847	81075	100350	121665	74900	1063701	0.474	504194
F00C10161	0	0	0	500	0	0	0	0	0	0	0	0	500	0.136	68
F00C10351	0	0	0	0	0	0	0	0	0	0	0	0	0	0.298	0
F00C10501	0	0	0	500	0	0	0	2000	0	0	1000	3000	6500	0.404	2626
F00C10701	0	0	0	500	0	0	0	0	0	0	0	0	500	0.583	292
F00C10951	0	0	231	0	0	0	0	0	0	0	1200	0	1431	0.81	1159
F00C11201	0	0	0	0	0	0	2200	0	0	0	0	0	2200	1.022	2248
F00H10702	0	0	0	0	0	0	0	0	0	1000	0	0	1000	0.583	583
F1EA318516191	0	0	0	0	0	0	0	600	0	0	600	0	1200	8.69	10428
F1EA318564008	0	0	0	0	1188	0	0	0	0	0	0	0	1188	6.96	8268
F1EA324016191	0	0	0	0	0	0	0	0	300	0	300	0	600	10.12	6072
F1EA330016191	0	0	0	0	0	0	0	0	0	0	0	300	300	11.81	3543
F1EC318544111	0	0	0	0	0	0	2400	580	0	0	0	0	2980	14.5	43210
F1FA303517191	0	0	0	0	0	0	0	300	0	0	0	0	300	4.64	1392
F1FA305017191	0	0	0	300	0	0	0	0	0	0	0	0	300	5.25	1575
F1FA312017111	0	0	300	0	2210	0	0	0	0	0	0	0	2510	8.3	20833
F1FA318517191	0	300	0	0	0	0	0	0	0	0	600	0	900	9.04	8136
F1FA318537591	0	0	0	0	0	300	0	0	0	0	0	0	300	8.84	2652
F1FA324038511	0	0	0	0	0	0	0	0	300	0	0	0	300	14.13	4239
F1FA330039199	300	0	0	0	0	0	0	0	0	0	0	0	300	12.3	3690
F1FC124030001	0	0	0	0	950	0	0	0	0	0	0	0	950	4.62	4389
F1FC130030008	0	500	0	0	0	0	0	0	0	0	0	0	500	5.52	2760
F1FC130030141	0	0	0	0	0	0	0	0	0	0	1000	0	1000	6.56	6560
F1FC150030141	0	0	0	0	0	0	0	0	0	0	1000	0	1000	9.43	9430
F1FC302537591	0	0	0	0	0	0	0	0	300	0	0	0	300	4.7	1410
F1FC303517191	0	0	300	0	0	0	0	0	0	0	2495	0	2795	5.22	14590
F1FC303519191	0	0	0	300	300	0	0	2500	0	0	500	0	3600	5.36	19296
F1FC303537591	0	0	0	0	300	0	0	300	0	0	0	0	600	5.3	3180
F1FC303538111	0	0	0	0	0	0	0	0	600	0	0	0	600	7.25	4350
F1FC305037591	0	300	0	0	0	0	0	0	0	0	0	0	300	6	1800
F1FC305039191	0	0	0	0	0	0	0	0	300	0	0	0	300	6.13	1839
F1FC307037591	0	0	300	0	0	0	300	0	0	0	0	0	600	6.55	3930
F1FC307038111	6000	0	0	0	0	600	0	0	0	0	0	0	6600	8.81	58146
F1FC309517191	0	0	0	0	0	0	0	300	0	0	0	0	300	7.9	2370
F1FC309517511	0	300	0	0	0	0	0	0	0	0	0	0	300	8.96	2688
F1FC309519191	0	0	0	0	0	0	0	0	300	0	0	0	300	8.19	2457
F1FC309537591	0	0	0	0	0	0	0	294	0	0	0	0	294	7.85	2308
F1FC309538111	2700	300	0	300	0	0	0	0	0	0	0	0	3300	11.3	37290
F1FC312018111	0	0	0	0	0	0	0	4800	1190	0	0	0	5990	12.32	73797
F1FC312039191	485	0	0	0	0	0	0	900	0	0	300	2700	4385	9.29	40737
F1FC315037591	0	0	0	0	0	0	0	300	0	0	0	0	300	10.5	3150
F1FC315038111	900	0	0	0	0	600	0	0	0	0	0	0	1500	13.82	20730
F1FC315039111	0	0	0	0	1400	600	0	0	0	0	0	0	2000	12.55	25100
F1FC315046517	0	0	0	0	0	0	0	0	0	0	0	1200	1200	15.86	19032
F1FC318518111	0	0	0	0	0	300	0	0	0	0	0	0	300	15.7	4710
F1FC318519596	0	0	0	1200	0	3000	0	1800	1200	0	0	0	7200	12.33	88776
F1FC318538111	1500	1084	900	0	600	0	0	0	0	0	0	600	4684	15.7	73539

Cables produced	Monthly manufactured quantities m														
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F1FC318546517	0	300	0	0	0	0	0	0	0	0	0	0	300	17.83	5349
F1FC324019191	0	0	0	600	0	0	0	0	0	0	0	0	600	15.18	9108
F1FC324038008	0	3000	5000	300	0	300	0	0	0	0	0	0	8600	13.66	117476
F1FC324039008	0	900	300	0	0	0	0	0	0	0	0	0	1200	12.58	15096
F1FC324039191	0	0	0	0	0	600	0	0	0	0	0	0	600	14.92	8952
F1FC330049511	0	0	0	0	1500	0	0	0	0	0	0	0	1500	19.4	29100
F1HC130031141	550	0	0	0	0	0	0	0	0	0	0	0	550	7.7	4235
F1HC163031001	600	0	0	0	0	0	0	0	0	0	0	0	600	10.97	6582
F1JA150032008	0	0	5000	11500	0	0	0	0	0	0	0	0	16500	6.77	111705
F1JC130032141	0	0	0	0	0	680	1360	0	0	0	0	0	2040	8.19	16708
F1JC330041498	0	300	0	0	0	0	0	0	0	0	0	0	300	30.22	9066
F1LC124020008	0	0	0	0	1240	616	0	0	0	0	0	0	1856	9.13	16945
F2CA1500002	0	0	0	0	0	0	0	0	5500	0	0	4500	10000	1.883	18830
F2CA3070002	0	0	0	0	0	0	0	0	0	0	0	1300	1300	0.921	1197
F2CA3095002	0	0	0	0	0	0	0	0	0	0	0	600	600	1.183	710
F2CA3150002	0	0	0	0	0	0	0	0	0	0	900	0	900	1.78	1602
F2CA3185002	0	0	0	0	0	0	0	0	0	0	600	0	600	2.193	1316
F2CA3240002	0	0	0	0	0	0	0	0	300	0	0	2400	2700	2.802	7565
F2CA4050002	0	0	0	0	0	0	0	0	0	0	1200	0	1200	0.888	1066
F2CA4095002	0	0	0	0	0	0	0	0	0	0	600	1200	1800	1.578	2840
F2CA4120002	0	0	0	0	0	0	0	600	0	0	0	0	600	1.917	1150
F2CA4150002	0	0	0	0	0	0	0	0	0	0	300	400	700	2.334	1634
F2CA4240111	0	0	0	0	0	0	0	3000	0	0	0	0	3000	6.642	19926
F2CC1070001	3958	7974	0	0	0	0	8000	0	0	0	0	0	19932	0.754	15029
F2CC1095001	0	6000	0	0	0	0	6000	2000	0	0	0	0	14000	0.994	13916
F2CC1120001	2000	0	0	0	0	0	0	0	0	0	0	0	2000	1.217	2434
F2CC1150001	1000	0	0	0	0	0	8000	0	0	0	0	0	9000	1.555	13995
F2CC1185001	0	0	0	0	0	0	9000	1000	0	0	0	0	10000	1.923	19230
F2CC1300001	0	0	0	0	0	0	0	10000	0	0	4500	0	14500	3.133	45429
F2CC1400001	2000	1000	0	0	0	0	0	5000	0	0	0	0	8000	3.792	30336
F2CC1500001	4500	1500	0	0	0	0	4000	1000	0	0	0	0	11000	4.853	53383
F2CC1630001	11990	3000	0	0	0	0	2500	2500	0	0	0	0	19990	6.182	123578
F2CC1800001	0	0	0	0	0	0	500	1500	0	0	0	0	2000	8.114	16228
F2CC3025111	0	0	0	0	0	0	0	0	0	0	0	370	370	1.482	548
F2CC3035111	0	0	0	0	0	0	0	0	0	0	7500	0	7500	1.908	14310
F2CC4025111	6503	35407	7978	2925	0	0	3000	26000	11997	3494	0	0	97304	1.96	190716
F2CC4050111	0	500	500	0	592	9000	914	0	0	0	0	0	11506	2.977	34253
F2CC4095111	0	0	0	0	0	0	0	0	0	0	5282	900	6182	5.464	33778
F2CC4120111	0	0	0	0	0	0	0	0	0	0	0	5207	5207	6.607	34403
F2CC4185111	0	0	0	0	0	0	0	0	0	0	0	1900	1900	10.143	19272
F2DA1630002	0	0	0	0	0	0	0	0	300	0	0	0	300	2.307	692
F2DA3185002	0	0	0	0	0	0	0	0	0	0	600	0	600	2.29	1374
F2DC1070141	0	0	590	0	0	0	0	0	0	0	0	0	590	1.259	743
F2DC1630001	2400	0	0	0	0	0	0	0	0	0	0	0	2400	6.192	14861
F2DC3095111	0	0	0	6000	3500	0	0	485	0	0	0	0	9985	4.733	47259
F2EC1185CONBOND	0	0	0	200	0	0	500	0	0	0	0	0	700	3.92	2744
F2EC1500141	0	0	0	1200	0	0	0	0	500	0	0	0	1700	6.867	11674
F2EC1630081	0	0	0	0	0	0	0	0	900	0	0	0	900	7.31	6579

Cables produced	Monthly manufactured quantities m														
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total	kg/m	Total kg
F2EC3240111	0	0	0	0	0	0	0	250	0	0	0	0	250	13.836	3459
F2FA1500084	0	0	0	0	0	0	0	800	0	0	0	0	800	2.549	2039
F2FA3025111	0	0	0	0	0	0	0	0	0	0	0	12971	12971	3.845	49873
F2FA3185001	0	0	0	600	0	0	0	0	0	0	0	0	600	3.84	2304
F2FC1240081	0	0	0	0	0	300	0	0	0	0	0	0	300	3.105	932
F2FC1300081	0	0	5880	690	0	0	0	0	0	0	0	0	6570	3.676	24151
F2FC1300141	0	0	0	0	0	0	7525	0	720	0	0	0	8245	4.322	35635
F2FC1400081	0	0	0	0	0	0	0	1200	0	0	0	0	1200	4.713	5656
F2FC1500082	0	0	0	0	0	0	0	0	0	900	0	0	900	5.846	5261
F2FC1630081	0	0	0	0	0	0	0	0	960	0	0	0	960	7.361	7067
F2FC1630144	0	0	0	2000	3700	0	0	0	900	2900	1500	0	11000	8.162	89782
F2FC3070081	0	0	0	0	0	0	0	0	500	0	0	0	500	3.839	1920
F2FC3095114	900	0	0	300	0	0	0	0	0	600	296	0	2096	7.236	15167
F2FC3095313A	0	0	0	1500	0	0	0	0	0	0	0	0	1500	7.518	11277
F2FC3120313	800	400	0	0	0	0	0	0	0	0	0	900	2100	8.653	18171
F2GC3150212	0	0	0	1500	5700	0	0	0	0	0	0	0	7200	11.5	82800
F2HA3120212	0	0	0	0	0	0	0	0	0	400	0	0	400	8.891	3556
F2HA3150002	0	0	0	0	0	0	0	0	0	1600	400	0	2000	4.386	8772
F2HA3300002	0	0	0	0	0	0	0	0	0	1400	3127	0	4527	6.61	29923
F2HC1630144	0	0	0	900	0	0	0	0	0	0	0	0	900	8.335	7502
F2HC3185114	0	0	1200	600	900	0	0	0	0	0	5099	2997	10796	13.285	143425
F2JA1240081	0	1940	0	0	0	0	0	0	0	0	0	0	1940	2.182	4233
F2JA1500081	0	500	0	0	0	0	0	0	500	0	0	0	1000	3.517	3517
F2JA1500144	0	6500	0	0	0	0	0	0	0	0	0	0	6500	4.583	29790
F2JA1800081	0	0	0	0	0	0	500	0	0	0	0	0	500	4.884	2442
F2JC1150071	0	0	0	0	600	0	0	0	0	0	0	0	600	2.619	1571
F2JC1150081	3450	0	0	0	0	0	0	0	0	0	0	0	3450	2.647	9132
F2JC1185081	3600	0	0	0	0	0	0	0	0	0	0	0	3600	3.041	10948
F2JC1185141	0	0	0	0	0	0	7060	500	0	0	0	0	7560	4.049	30610
F2JC1240141A	0	0	0	0	0	0	0	0	0	0	0	0	0	4.755	0
F2JC1240148	0	0	0	0	0	0	0	2832	0	0	0	0	2832	5.549	15715
F2JC1300081	3600	0	0	0	0	0	0	0	0	0	0	0	3600	4.347	15649
F2JC1300741	0	0	0	0	0	0	0	0	0	0	1500	0	1500	10.659	15989
F2JC1400141	0	0	0	500	0	0	0	0	0	0	0	0	500	6.483	3242
F2JC1500141	0	0	0	0	0	880	300	0	0	0	0	0	1180	7.99	9428
F2JC1500148	0	0	0	9420	0	0	0	0	0	0	0	0	9420	7.732	72835
F2JC1630071	0	0	300	0	0	0	0	0	0	0	0	0	300	9.59	2877
F2JC3120111	0	0	0	0	0	10000	0	0	0	0	0	0	10000	13.511	135110
F2JC3150111	0	0	0	0	0	0	0	300	0	0	0	0	300	14.744	4423
F2MA1050081	0	0	495	0	0	0	0	0	0	0	0	0	495	1.529	757
F2PA1300068	0	0	0	1491	0	0	0	0	0	0	0	0	1491	7.576	11296
F2PA1630068	0	0	839	0	0	0	0	0	0	0	0	0	839	8.776	7363
F2PC1300068	0	2461	0	0	0	0	0	0	0	0	0	0	2461	9.791	24096
F2PC1800068	8409	0	0	0	0	0	0	0	0	0	0	0	8409	14.797	124428
F4CA4185121	0	0	0	0	300	0	0	0	0	0	0	0	300	6.57	1971
F4CC1025001	0	0	0	0	0	0	0	300	0	0	0	0	300	0.342	103
F4CC1025	0	0	0	1500	0	0	1500	465	500	0	0	0	3965	0.257	1019
F4CC1035	0	0	0	0	0	0	0	1680	438	0	0	0	2118	0.346	733

Cables produced	Monthly manufactured quantities m													
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total	kg/m	Total kg
F4CC1050	0	0	0	2000	0	0	1500	0	0	0	0	0	3500	0.346	1211
F4CC1070	0	0	0	0	0	860	2000	0	0	0	4000	0	6860	0.672	4610
F4CC1070001	0	0	0	0	0	500	0	0	0	0	0	0	500	0.787	394
F4CC1070	0	0	0	0	0	860	2000	0	0	0	4000	0	6860	0.672	4610
F4CC1095	0	0	0	0	0	0	0	1000	0	0	0	0	1000	0.912	912
F4CC1120	0	0	0	0	0	0	0	4200	0	0	0	0	4200	1.134	4763
F4CC1300004	0	0	0	0	0	0	0	7500	4500	0	0	500	12500	3.037	37963
F4CC1400141	0	0	0	0	300	0	0	0	0	0	0	0	300	4.798	1439
F4CC1500141	0	0	1100	0	0	0	2000	0	0	0	500	0	3600	6.149	22136
F4CC1500242	0	0	0	0	0	0	0	1000	0	0	0	0	1000	6.577	6577
F4CC2925002	0	0	0	0	0	0	0	0	0	0	28500	500	29000	0.171	4959
F4CC3004002	0	0	0	0	0	0	0	2000	0	4000	0	0	6000	0.294	1764
F4CC3004171	0	0	0	0	0	0	0	0	0	0	12000	0	12000	0.619	7428
F4CC3006002	0	0	0	0	0	0	0	500	0	0	1500	500	2500	0.39	975
F4CC3006171	0	0	0	0	0	0	0	0	0	0	10500	0	10500	0.469	4925
F4CC3010002	0	0	0	0	0	0	0	500	0	500	500	0	1500	0.544	816
F4CC3010171	0	0	0	0	0	0	0	0	0	0	0	5500	5500	0.631	3471
F4CC3016002	0	0	0	0	0	0	0	0	500	0	0	500	1000	0.761	761
F4CC3025111	2800	0	0	2000	0	0	0	0	0	0	1000	0	5800	1.734	10057
F4CC3025171	0	0	0	0	0	0	0	0	0	0	1700	0	1700	1.212	2060
F4CC3035171	0	0	0	0	0	0	0	0	0	0	3500	300	3800	1.539	5848
F4CC3050171	0	0	0	0	0	0	0	0	0	0	2300	0	2300	1.981	4556
F4CC3070111	0	0	0	0	0	0	0	0	0	0	0	1500	1500	3.281	4922
F4CC3070171	0	0	0	0	0	0	0	0	0	0	3800	0	3800	2.649	10066
F4CC3070212	0	0	0	0	0	0	0	1200	0	0	0	0	1200	3.275	3930
F4CC3095111	0	0	0	0	0	0	0	0	0	0	0	300	300	4.669	1401
F4CC3095171	0	0	0	0	0	0	0	0	0	0	2100	2600	4700	4.669	21944
F4CC3095212	0	0	0	0	0	0	0	5400	0	0	0	0	5400	4.697	25364
F4CC3120111	0	0	0	0	0	0	0	0	0	0	5100	2600	7700	6.358	48957
F4CC3120171	0	0	0	0	0	0	0	0	0	0	1400	0	1400	4.331	6063
F4CC3120212	0	0	0	0	0	0	0	900	0	0	0	0	900	5.566	5009
F4CC3150171	0	0	0	0	0	0	0	0	0	0	0	600	600	5.279	3167
F4CC3150212	0	600	0	0	0	0	0	0	0	0	0	0	600	6.312	3787
F4CC3185171	0	0	0	0	0	0	0	0	0	0	0	600	600	6.579	3947
F4CC3185212	0	0	0	0	0	0	0	1200	0	0	0	0	1200	8.526	10231
F4CC3915212	0	0	0	0	0	0	0	2000	1000	0	0	0	3000	0.458	1374
F4CC3925002	0	0	0	0	0	0	0	0	0	6500	0	0	6500	0.207	1346
F4CC3925212	5762	2875	0	2500	0	0	0	1500	0	0	0	0	12637	0.5	6319
F4CC4006121	0	0	0	0	975	0	5940	500	0	0	0	0	7415	0.889	6592
F4CC4016121	0	0	78950	37650	26175	25675	9950	31250	475	950	475	975	212525	1.493	317300
F4CC4025002	0	0	0	0	0	0	0	0	0	0	500	0	500	1.223	612
F4CC4185212	0	0	0	900	600	900	0	0	300	300	0	0	3000	10.724	32172
F4CC4925121	0	0	0	0	500	0	0	0	0	0	0	0	500	0.685	343
F4CC7004002	0	0	0	0	0	0	0	0	0	0	1500	0	1500	0.499	749
F4CC7006002	0	0	0	0	0	0	0	0	0	0	500	500	1000	0.663	663
F4CC7915002	0	0	0	0	0	0	0	0	0	0	1000	0	1000	0.248	248
F4CCA915002	0	0	0	0	0	0	0	0	0	0	500	0	500	0.406	203
F4CCA925002	0	0	0	0	0	0	0	0	0	0	1000	0	1000	0.547	547

Cables produced	Monthly manufactured quantities m													
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total	kg/m	Total kg
F4CCA925212	0	1400	1000	0	0	0	0	0	0	0	0	0	2400	1.343	3223
F4CCB0042A2	0	0	0	0	0	0	0	0	5975	0	0	0	5975	3.27	19538
F4CCC925212	0	1000	0	0	0	930	0	0	0	0	0	0	1930	2.502	4829
F4CH1016	21729	0	0	0	0	0	0	0	0	0	0	0	21729	0.164	3564
F4CS2050111	0	0	0	0	0	0	0	0	0	0	0	500	500	1.36	680
F4DC1300004	0	0	0	0	0	0	0	0	0	0	0	800	800	3.097	2478
F4DC1500242	0	0	0	0	0	0	0	300	0	0	0	0	300	5.987	1796
F6CC2004313	0	0	0	0	0	0	0	0	0	0	4500	4500	9000	0.458	4122
F6CC3006313	0	0	0	0	6000	1950	0	0	0	0	0	0	7950	0.641	5096
F6CC3925003	0	0	0	0	0	0	0	0	0	0	8000	0	8000	0.222	1776
F6CC5004313	0	4500	0	0	0	460	0	0	0	0	0	0	4960	0.54	2678
F6CCB004313	0	0	0	0	0	3008	0	0	0	0	500	0	3508	1.866	6546
F6CCB915313	0	0	0	0	0	0	0	0	900	0	0	285	1185	1.207	1430
F7CA1025SD0	0	0	0	0	1000	0	500	500	0	500	500	0	3000	0.309	927
F7CA1070EC0	0	0	0	0	4500	0	0	0	0	0	0	500	5000	0.382	1910
F7CA2025NA0MR	0	0	0	0	0	0	65500	42500	5500	0	2000	0	115500	0.182	21021
F7CA2070EC0	0	0	0	0	10000	2000	0	0	0	0	6454	3000	21454	0.627	13452
F7CA3025SD1	0	0	0	0	0	0	0	0	0	0	0	2000	2000	0.609	1218
F7CA3035SD0	0	0	0	0	500	0	0	0	0	0	0	0	500	0.602	301
F7CA3050EC0	0	0	0	0	2700	0	450	0	500	0	0	0	3650	0.656	2394
F7CA3070EC0	0	0	0	38477	1300	0	0	0	2000	0	0	5486	47263	0.871	41166
F7CA3070SD0	0	0	0	0	0	0	0	0	14772	988	13500	15786	45046	0.926	41713
F7CA3095EC0	0	0	0	0	0	750	0	0	0	0	0	0	750	1.106	830
F7CA3095SA0	0	0	0	9500	0	0	0	0	0	0	0	0	9500	0.968	9196
F7CA4025NA0MR	0	0	0	0	0	0	5000	15500	27500	0	999	0	48999	0.4	19600
F7CA4050NA1MR	0	0	0	0	0	0	14500	4999	488	5000	471	0	25458	0.776	19755
F7CA4050SA0	0	0	0	0	0	0	0	0	0	0	0	4000	4000	0.679	2716
F7CA4070NA1MR	0	0	0	0	0	14000	10436	1000	500	5000	1481	0	32417	1.059	34330
F7CA4095NA1MR	0	0	0	0	0	20474	4932	500	3000	0	2955	470	32331	1.368	44229
F7CA4095SA1	0	0	0	0	0	988	0	0	0	0	0	0	988	1.368	1352
F7FA3035SGB	0	0	0	0	0	0	0	0	0	300	0	0	300	2.155	647
F7FA3050SGB	0	0	0	0	0	0	0	300	0	0	0	500	800	2.433	1946
F7FA3070SGB	0	0	0	1783	0	0	0	0	0	0	0	0	1783	6.301	11235
F7FA3095SGB	7463	977	0	5965	3488	500	1000	499	0	0	0	0	19892	5.412	107656

ANNEXURE 7: DEMAND VARIABILITY CALCULATION RESULTS

Budget cable	Length	Weight	Actual manuf.	Sum diff^2	Std var	Avg	Minimum	Maximum	CV
	m	kg	m	m²	m	m	m	m	%
F0MINK	2,504,000	636016	1024571	213807844826	133481.54	208666.67	35744	236825	64.0
F1DC307042292	7,200	39,960	3646	1922420	400.25	600.00	103	1060	66.7
F1EA307016195	900	4,824	368	27621	47.98	75.00	13	85	64.0
F1EA309524195	2,400	16,008	982	196416	127.94	200.00	34	227	64.0
F1EA315016195	600	4,692	546	106324	94.13	50.00	9	357	188.3
F1EA318536008	1,500	10,035	614	76725	79.96	125.00	21	142	64.0
F1EC307044313	4,500	35,685	1841	690526	239.88	375.00	64	426	64.0
F1EC315044313	5,700	72,105	16332	70329604	2420.91	475.00	81	8320	509.7
F1FA307017191	2,100	11,382	859	150381	111.95	175.00	30	199	64.0
F1FA309517191	54,600	341,250	56502	130480120	3297.48	4550.00	1075	11464	72.5
F1FA312017191	600	4,266	846	178412	121.93	50.00	9	357	243.9
F1FA312019191	9,000	63,630	3683	2762104	479.77	750.00	128	851	64.0
F1FA312039191	11,400	80,598	18457	40666634	1840.89	950.00	163	5648	193.8
F1FA315025511	600	6,522	246	12276	31.98	50.00	9	57	64.0
F1FA318518591	3,900	39,000	1596	518662	207.90	325.00	56	369	64.0
F1FA318519191	600	5,454	646	156308	114.13	50.00	9	430	228.3
F1FA324017191	11,100	113,775	6342	5391735	670.31	925.00	158	2156	72.5
F1FA324039191	4,800	50,688	9818	14128860	1085.08	400.00	69	3109	271.3
F1FA330017191	1,500	17,760	614	76725	79.96	125.00	21	142	64.0
F1FA330019191	3,300	40,260	1350	371350	175.91	275.00	47	312	64.0
F1FA330039191	6,900	84,870	6423	9644259	896.49	575.00	98	3457	155.9

Budget cable	Length	Weight	Actual manuf.	Sum diff^2	Std var	Avg	Minimum	Maximum	CV
	m	kg	m	m²	m	m	m	m	%
F1FA340039191	11,100	153,069	4542	4201467	591.71	925.00	158	1050	64.0
F1FC163030001	3,900	38,649	7296	20419766	1304.47	325.00	56	4710	401.4
F1FC163030343	1,200	13,776	781	89873	86.54	100.00	17	315	86.5
F1FC302539191	24,300	115,425	17443	16930432	1187.80	2025.00	479	4098	58.7
F1FC303518191	1,500	9,210	614	76725	79.96	125.00	21	142	64.0
F1FC303539191	4,500	24,120	3341	1176354	313.10	375.00	64	1044	83.5
F1FC305017191	3,000	17,940	1228	306900	159.92	250.00	43	284	64.0
F1FC305018191	1,800	12,780	737	110484	95.95	150.00	26	170	64.0
F1FC305019191	1,800	11,160	5056	11246942	968.11	150.00	26	3314	645.4
F1FC307017191	11,400	75,126	4665	4431642	607.70	950.00	163	1078	64.0
F1FC307018111	5,100	44,931	3587	2393297	446.59	425.00	73	1677	105.1
F1FC307018191	2,100	16,212	2059	863393	268.23	175.00	30	1005	153.3
F1FC307019191	12,600	86,436	16856	40557181	1838.41	1050.00	180	6331	175.1
F1FC307037111	3,000	22,860	3928	6599125	741.57	250.00	43	2765	296.6
F1FC307038008	8,700	61,857	3860	2417318	448.82	725.00	124	823	61.9
F1FC307038191	1,800	13,896	3107	5823328	696.62	150.00	26	2540	464.4
F1FC307038511	20,700	183,609	49530	306139579	5050.90	1725.00	408	13836	292.8
F1FC307039191	9,000	61,740	39467	173247510	3799.64	750.00	190	9701	506.6
F1FC309518191	18,600	170,376	18849	23538078	1400.54	1550.00	266	4539	90.4
F1FC309518591	1,500	13,605	914	122981	101.23	125.00	21	352	81.0
F1FC309537008	1,500	9,435	614	76725	79.96	125.00	21	142	64.0
F1FC309538292	2,400	21,864	982	196416	127.94	200.00	34	227	64.0
F1FC309538511	4,500	49,545	1841	690526	239.88	375.00	64	426	64.0
F1FC309539191	21,300	174,447	17882	9623817	895.54	1775.00	419	3166	50.5
F1FC309539313	1,500	13,695	614	76725	79.96	125.00	21	142	64.0
F1FC312018191	8,100	83,916	5410	3836881	565.46	675.00	116	2068	83.8
F1FC312037191	1,800	16,578	2837	3459616	536.94	150.00	26	1970	358.0
F1FC312038111	15,600	192,192	11136	8131920	823.20	1300.00	223	2902	63.3
F1FC312038292	3,600	37,296	1473	441937	191.91	300.00	51	340	64.0
F1FC312038511	10,500	128,415	15096	40863024	1845.33	875.00	150	5328	210.9
F1FC315018111	1,800	24,876	737	110484	95.95	150.00	26	170	64.0
F1FC315018191	1,800	21,168	2499	2918125	493.13	150.00	26	1828	328.8
F1FC315038008	3,600	34,416	1773	460081	195.81	300.00	51	480	65.3
F1FC315038511	4,200	57,666	15206	33001572	1658.35	350.00	60	4318	473.8
F1FC318518191	3,000	40,620	5067	6721574	748.42	250.00	59	2682	299.4
F1FC318519191	3,600	44,928	5673	7866516	809.66	300.00	51	2521	269.9
F1FC318538191	2,100	28,434	859	150381	111.95	175.00	30	199	64.0
F1FC318539191	59,400	741,312	137434	704531322	7662.31	4950.00	4943	21027	154.8
F1FC324038511	40000	744,000	27094	31869276	1629.65	2257.75	571	5408	72.2
F1HC309540191	3,000	38,181	1528	307338	160.04	250.00	43	401	64.0
F1HC318540191	13,200	216,348	5401	5941592	703.66	1100.00	188	1248	64.0
F1JC309521198	2,100	30,093	859	150381	111.95	175.00	30	199	64.0
F2CA3120002	6900	9,964	7023	7020177	764.86	575.00	98	2932	133.0
F2CA4035002	12300	8,315	6833	4454857	609.29	1025.00	176	1313	59.4
F2CA4070002	6500	7,774	6524	5837190	697.45	541.67	93	2115	128.8
F2CA4095111	175800	469,386	71934	154848907	3592.22	5994.40	2510	16627	59.9
F2CC1050001	102800	54,381	83851	631633951	7255.08	8566.67	1467	26997	84.7

Budget cable	Length	Weight	Actual manuf.	Sum diff^2	Std var	Avg	Minimum	Maximum	CV
	m	kg	m	m²	m	m	m	m	%
F2CC1240001	47720	114,910	19526	77648069	2543.75	3976.67	681	4513	64.0
F2CC1999001	24600	242,482	22065	41739663	1865.02	2050.00	351	7232	91.0
F2CC4035111	106000	253,340	67923	362222248	5494.10	8833.33	1513	17265	62.2
F2CC4070111	104000	449,800	67454	439917767	6054.73	8666.67	1485	21261	69.9
F2CC4150111	46900	396,164	26783	140655423	3423.64	3908.33	669	12028	87.6
F2CC4300111	28000	410,956	11456	26735980	1492.65	2333.33	400	2648	64.0
F2DC3010P2	455,000	227,045	356254	5224093727	20864.83	37916.67	8960	66467	55.0
F2EC1120BOND	1,200	1,433	491	49104	63.97	100.00	17	113	64.0
F2EC1185BOND	8,100	14,531	19437	50975696	2061.06	675.00	160	6150	305.3
F2EC3185111	1,200	14541.6	1241	522042	208.57	100.00	17	790	208.6
F2FA3050001	1,200	2450.4	491	49104	63.97	100.00	17	113	64.0
F2FA3050111	1,200	5782.8	491	49104	63.97	100.00	17	113	64.0
F2FA3070001	6,900	16718.7	3423	1558784	360.41	575.00	98	821	62.7
F2FA3095001	600	1597.8	246	12276	31.98	50.00	9	57	64.0
F2FA3095111	2,100	13034.7	859	150381	111.95	175.00	30	199	64.0
F2FC1025081	3,300	2428.8	1850	415902	186.17	275.00	47	570	67.7
F2FC1500083	1,800	10216.8	3537	7478515	789.44	150.00	26	2866	526.3
F2FC1500141	600	4155.6	1246	1025770	292.37	50.00	9	1057	584.7
F2FC1630071	3,300	23238.6	3480	2441885	451.10	275.00	47	1735	164.0
F2FC1630141	10,800	92329.2	4419	3977430	575.72	900.00	154	1021	64.0
F2FC3025111	20,700	93895.2	19320	53549729	2112.46	1725.00	295	7086	122.5
F2FC3025212	600	2758.2	246	12276	31.98	50.00	9	57	64.0
F2FC3035111	37,200	189348	47416	156709229	3613.74	3100.00	531	11309	116.6
F2FC3035119	600	3086.4	8646	39273034	1809.08	50.00	9	5720	3618.2
F2FC3035212	7,500	39087.3	7869	21250388	1330.74	655.73	107	5040	202.9
F2FC3035313	900	4603.5	368	27621	47.98	75.00	13	85	64.0
F2FC3050081	1,200	3727.2	9791	63629183	2302.70	100.00	17	8042	2302.7
F2FC3050111	40200	229,180	45799	88356007	2713.48	3816.57	574	7946	71.1
F2FC3050313	5,700	32940.3	5321	2007119	408.97	475.00	81	1391	86.1
F2FC3070001	600	2202	246	12276	31.98	50.00	9	57	64.0
F2FC3070111	41,100	276644.1	68707	419544583	5912.87	3425.00	587	19101	172.6
F2FC3070212	600	4087.8	4746	5316716	665.63	50.00	13	1557	1331.3
F2FC3070313	600	4085.4	546	83810	83.57	50.00	9	319	167.1
F2FC3070313A	6,000	40806	11755	28828458	1549.96	500.00	126	4392	310.0
F2FC3095111	62,100	491646	65189	275044681	4787.52	5432.47	886	14509	88.1
F2FC3095212	1,200	9589.2	4391	5008616	646.05	100.00	17	1838	646.1
F2FC3095313	600	4805.4	1146	395518	181.55	50.00	9	613	363.1
F2FC3120111	13,200	119829.6	53202	468248662	6246.66	1100.00	260	18543	567.9
F2FC3150111	25,500	278817	24767	45686905	1951.22	2125.00	364	6312	91.8
F2FC3150212	4,200	46389	3219	1035682	293.78	350.00	83	1035	83.9
F2FC3150313	600	6627	4146	14934030	1115.57	50.00	9	3913	2231.1
F2FC3150313A	21,900	243896.1	34153	190903965	3988.57	1825.00	431	12696	218.6
F2FC3185111	54700	690,259	61223	160876613	3661.47	5101.82	781	11446	71.8
F2FC3185114	13,800	168636	34193	115542949	3103.00	1150.00	291	9161	269.8
F2FC3185212	1,200	15344.4	15987	60787655	2250.70	1332.51	18	8356	168.9
F2FC3185313A	19,800	252014.4	8102	13368583	1055.48	1650.00	283	1873	64.0
F2FC3240111	13,800	205468.2	46240	408801050	5836.67	1150.00	197	16805	507.5

Budget cable	Length	Weight	Actual manuf.	Sum diff^2	Std var	Avg	Minimum	Maximum	CV
	m	kg	m	m²	m	m	m	m	%
F2FC3240114	300	4332.9	123	3069	15.99	25.00	4	28	64.0
F2FC3240212	900	13605.3	368	27621	47.98	75.00	13	85	64.0
F2FC3300001	3,000	32829	1828	290400	155.56	250.00	43	404	62.2
F2FC3300111	3,000	52800	2828	2285499	436.42	250.00	43	1668	174.6
F2GC3070111	2,400	18208.8	982	196416	127.94	200.00	34	227	64.0
F2GC3095212	600	5851.2	2246	2374700	444.85	50.00	9	1517	889.7
F2GC3150313	900	10860.3	368	27621	47.98	75.00	13	85	64.0
F2HC1035071	900	887.4	868	247681	143.67	75.00	13	545	191.6
F2HC3095114	3,000	30486	2428	1249679	322.71	250.00	59	1243	129.1
F2HC3120212	600	7019.4	246	12276	31.98	50.00	9	57	64.0
F2HC3185111	1,200	17541.6	491	49104	63.97	100.00	17	113	64.0
F2JA1120141	5,700	13149.9	2332	1107911	303.85	475.00	81	539	64.0
F2JA1500141	7,800	38313.6	3192	2074647	415.80	650.00	111	738	64.0
F2JA1630141	900	5087.7	368	27621	47.98	75.00	13	85	64.0
F2JC1150141	4,200	14977.2	1719	601525	223.89	350.00	60	397	64.0
F2JC1185071	900	2736.9	968	313038	161.51	75.00	18	613	215.4
F2JC1240081	600	2218.2	246	12276	31.98	50.00	9	57	64.0
F2JC1240141	3,900	18544.5	31885	396131123	5745.51	325.00	56	17431	1767.9
F2JC1300141	2,400	13154.4	982	196416	127.94	200.00	34	227	64.0
F2JC1300149	8,400	46107.6	3437	2406099	447.78	700.00	120	794	64.0
F2JC1300242	1,800	10029.6	737	110484	95.95	150.00	26	170	64.0
F2JC1400242	2,400	16480.8	982	196416	127.94	200.00	34	227	64.0
F2JC1630081	900	7446.6	368	27621	47.98	75.00	13	85	64.0
F2JC3050111	900	9126	368	27621	47.98	75.00	13	85	64.0
F2JC3095111	600	7590	246	12276	31.98	50.00	9	57	64.0
F2JC3185111	1,500	26245.5	10614	87365471	2698.23	125.00	21	9455	2158.6
F2MA1400068	9,483	49,217	3880	3066525	505.51	790.25	135	897	64.0
F2MA1800068	4,842	35,090	4960	7897097	811.23	403.50	69	3084	201.0
F2NA1999068	8,160	74,183	6939	11572860	982.04	680.00	116	3772	144.4
F2PA1400068	6,408	49,822	9030	18112615	1228.57	534.00	126	4497	230.1
F2PC1999068	5,099	85,439	2086	886594	271.81	424.92	73	482	64.0
F4AC2004F1	46,800	7956	28049	95726862	2824.40	3900.00	668	9499	72.4
F4AC2004P1	23,100	3649.8	17052	14249023	1089.69	1925.00	487	3240	56.6
F4AC2006F1	23,100	5659.5	9452	18196126	1231.40	1925.00	330	2185	64.0
F4AC2006P1	4,400	910.8	9200	21189780	1328.84	366.67	63	3887	362.4
F4AC2010F1	13,800	5340.6	5647	6494013	735.64	1150.00	197	1305	64.0
F4AC2010P1	4,300	1427.6	1759	630510	229.22	358.33	61	407	64.0
F4AC2016F1	13,700	8041.9	5606	6400238	730.31	1141.67	196	1296	64.0
F4AC2910F1	46,800	2574	134649	4733277979	19860.51	3900.00	668	55409	509.2
F4AC2915F1	458,600	34395	456747	20714432629	41547.60	38216.67	9031	167974	108.7
F4AC2915P1	458,600	36688	217547	6500700037	23274.99	38216.67	6546	43374	60.9
F4AC2925F1	458,600	52280.4	955747	65376487519	73810.84	38216.67	18627	246443	193.1
F4AC2925P1	550,400	63296	422809	6231796844	22788.51	45866.67	7857	85256	49.7
F4AC3004P1	23,100	5197.5	20052	36422161	1742.18	1925.00	330	6802	90.5
F4AC3006P1	4,300	1307.2	2559	928184	278.12	358.33	61	944	77.6
F4AC3915P1	46,800	5148	31949	91675668	2763.99	3900.00	668	8118	70.9
F4AC3925P1	46,800	7581.6	32649	102950880	2929.03	3900.00	668	10609	75.1

Budget cable	Length	Weight	Actual manuf.	Sum diff^2	Std var	Avg	Minimum	Maximum	CV
	m	kg	m	m²	m	m	m	m	%
F4AC4004P1	23,100	4943.4	31352	81708188	2609.41	1925.00	330	8455	135.6
F4AC4006P1	4,400	1293.6	3800	3688340	554.40	366.67	63	2124	151.2
F4AC4915P1	46,800	4633.2	27449	62008788	2273.19	3900.00	668	6318	58.3
F4AC4925P1	46,800	6973.2	32549	72765451	2462.48	3900.00	668	8325	63.1
F4CA1060FLEX	5,000	1135	2046	852501	266.54	416.67	71	473	64.0
F4CC1004	668,000	34068	895728	60948387156	71267.33	55666.67	13155	261745	128.0
F4CC1006	222,700	15589	142523	915290793	8733.51	18558.33	4386	22542	47.1
F4CC1010	156,400	16734.8	111595	582724984	6968.53	13033.33	3561	22300	53.5
F4CC1016	156,400	25649.6	181795	2296647001	13834.28	13033.33	4397	57711	106.1
F4CC1025000	36,000	9540	16230	40903845	1846.25	3000.00	514	3405	61.5
F4CC1035000	36,200	12887.2	20112	33262234	1664.89	3016.67	713	3517	55.2
F4CC1050000	10,800	5184	4419	3977430	575.72	900.00	154	1021	64.0
F4CC1070000	70,100	46351.9	61554	457141499	6172.12	5129.42	1001	21246	120.3
F4CC1095000	9,600	8889.6	5428	5716521	690.20	800.00	137	2408	86.3
F4CC1300001	4,000	12648	9037	43742101	1909.23	333.33	57	6878	572.8
F4CC1400001	4,000	15912	3437	936389	279.34	333.33	57	800	83.8
F4CC1500001	3,000	15219	1528	284838	154.07	250.00	43	363	61.6
F4CC1630001	4,500	27049.5	1841	690526	239.88	375.00	64	426	64.0
F4CC1915	1,015,800	22347.6	1475739	302891170665	158873.95	84650.00	14500	612273	187.7
F4CC1925	1,015,800	32505.6	3914939	1363401560535	337070.91	84650.00	31604	866630	398.2
F4CC2004111	25,000	13,025	33534	197944374	4061.45	2083.33	357	12044	194.9
F4CC2004212	23,000	13,662	13411	21907465	1351.16	1916.67	328	4147	70.5
F4CC2006111	25,000	15,300	27522	41814416	1866.69	2083.33	357	5569	89.6
F4CC2006121	1,500	918	11467	45407704	1945.24	125.00	30	5428	1556.2
F4CC2006212	1,000	688	409	34100	53.31	83.33	14	95	64.0
F4CC2010111	45,000	33,120	30388	147181824	3502.16	3750.00	642	13000	93.4
F4CC2010121	1,500	1,104	614	76725	79.96	125.00	21	142	64.0
F4CC2016111	211,000	235,265	149042	974504739	9011.59	17583.33	4962	29755	51.3
F4CC2016121	46,500	59,892	166426	2911660067	15576.85	3875.00	1366	38498	402.0
F4CC2025111	1,500	3211.5	614	76725	79.96	125.00	21	142	64.0
F4CC2915111	52,000	18,044	40777	149972754	3535.21	4333.33	742	11684	81.6
F4CC2925111	43,000	17,673	29594	46126896	1960.59	3583.33	614	5979	54.7
F4CC2925212	1,500	719	614	76725	79.96	125.00	21	142	64.0
F4CC3004111	107,500	66,543	80250	245509608	4523.18	8958.33	1535	16337	50.5
F4CC3006111	64,500	47,795	68359	181533172	3889.44	5375.00	921	11907	72.4
F4CC3010111	82,000	75,604	103736	704431600	7661.76	6833.33	1171	26357	112.1
F4CC3010212	2,500	2,503	1023	213125	133.27	208.33	36	236	64.0
F4CC3016111	111,500	154,874	103433	1189831825	9957.54	9291.67	2042	37151	107.2
F4CC3016212	1,000	1,276	409	34100	53.31	83.33	14	95	64.0
F4CC3035212	1,800	3812.4	4137	6166769	716.87	150.00	26	2541	477.9
F4CC3050111	4,200	11062.8	1719	601525	223.89	350.00	60	397	64.0
F4CC3150111	1,200	7928.4	1991	2339587	441.55	100.00	17	1613	441.5
F4CC3185111	600	5091	2546	5135123	654.16	50.00	9	2314	1308.3
F4CC3185121	600	4697.4	246	12276	31.98	50.00	9	57	64.0
F4CC3915111	86,000	34,486	114106	633863997	7267.87	7166.67	1228	21221	101.4
F4CC3925111	201,000	95,676	286051	20052913911	40878.80	16750.00	2869	151985	244.1
F4CC4004002	17000	5,508	10956	18626493	1245.88	1416.67	243	4608	87.9

Budget cable	Length	Weight	Actual manuf.	Sum diff^2	Std var	Avg	Minimum	Maximum	CV
	m	kg	m	m²	m	m	m	m	%
F4CC4004111	259,500	188,657	242027	5823215304	22028.80	21625.00	4204	83902	101.9
F4CC4004121	3,000	2,181	7153	12139147	1005.78	250.00	59	3493	402.3
F4CC4004212	487,000	294,148	514154	14739129992	35046.55	40583.33	12088	132775	86.4
F4CC4006002	11500	4,807	6705	6825488	754.18	958.33	164	2588	78.7
F4CC4006111	104,000	92,456	144415	1101971924	9582.85	8666.67	1485	26743	110.6
F4CC4010002	13500	8,060	7024	8920163	862.18	1125.00	193	2777	76.6
F4CC4010111	226,000	250,860	211217	2601120170	14722.77	18833.33	3226	56131	78.2
F4CC4010212	25,000	22,950	28657	135548328	3360.91	2083.33	357	12868	161.3
F4CC4016002	12000	10,164	8410	11814647	992.25	1000.00	171	3736	99.2
F4CC4016111	476,000	528,360	434073	3716192609	17597.80	39666.67	6795	67219	44.4
F4CC4016212	302,500	441,650	455781	8174159387	26099.42	25208.33	6957	74045	103.5
F4CC4025111	81,000	173421	109545	904710188	8682.89	6750.00	1656	31477	128.6
F4CC4025121	20,100	44119.5	13715	12846260	1034.66	1675.00	287	3144	61.8
F4CC4025212	2,700	5953.5	1105	248589	143.93	225.00	39	255	64.0
F4CC4035111	63,000	165753	96432	367344741	5532.82	5250.00	2399	15235	105.4
F4CC4035121	14,400	38534.4	10992	12124471	1005.17	1200.00	304	3784	83.8
F4CC4035212	36,300	96158.7	41508	79758098	2578.08	3025.00	715	8672	85.2
F4CC4050111	42,000	139860	45553	147811004	3509.64	3500.00	827	10772	100.3
F4CC4050121	1,200	4062	491	49104	63.97	100.00	17	113	64.0
F4CC4050212	3,600	12056.4	6573	11218809	966.90	300.00	51	2778	322.3
F4CC4070111	122,100	568986	159192	911938044	8717.50	10175.00	2405	24558	85.7
F4CC4070121	4,800	22718.4	2730	730771	246.77	400.00	69	609	61.7
F4CC4070212	11,700	54837.9	16182	34086537	1685.39	975.00	167	5647	172.9
F4CC4095111	42,600	237111.6	59049	196704784	4048.71	3550.00	608	12029	114.0
F4CC4095121	5,100	30492.9	4062	2331661	440.80	425.00	73	1457	103.7
F4CC4095212	83,700	505966.5	113703	632683505	7261.10	6975.00	1488	19139	104.1
F4CC4120111	32,400	249156	27581	25043709	1444.64	2700.00	463	5233	53.5
F4CC4120121	1,200	9422.4	791	95499	89.21	100.00	17	327	89.2
F4CC4120212	14,100	108372.6	17169	11313765	970.99	1175.00	278	2707	82.6
F4CC4150111	16,200	146156.4	14789	11675860	986.40	1350.00	231	2904	73.1
F4CC4150121	900	8244	968	313038	161.51	75.00	18	613	215.4
F4CC4150212	1,200	10880.4	2591	1166120	311.73	100.00	24	960	311.7
F4CC4185111	19,800	215226	22493	22396845	1366.16	1650.00	390	4528	82.8
F4CC4185121	2,100	22161.3	1753	344621	169.47	175.00	41	624	96.8
F4CC4240111	3,600	49046.4	7973	9282655	879.52	300.00	71	2515	293.2
F4CC4240121	1,500	20541	1814	1341750	334.38	125.00	21	1252	267.5
F4CC4300111	1,500	25975.5	1794	641294	231.17	125.00	21	813	184.9
F4CC4915002	7000	1,169	3364	1999619	408.21	583.33	100	1162	70.0
F4CC4915111	122,000	55,998	144009	1489624310	11141.60	10166.67	1742	43035	109.6
F4CC4915212	6,500	3,289	29660	314933762	5122.94	541.67	128	16183	945.8
F4CC4925002	89500	19,511	86621	1903824192	12595.71	7458.33	1278	48446	168.9
F4CC4925111	202,500	111,578	207412	1709196509	11934.53	16875.00	2891	40888	70.7
F4CC4925212	45,000	21,195	44863	209500569	4178.32	3750.00	642	13143	111.4
F4CC7004111	4,500	4,667	1841	690526	239.88	375.00	64	426	64.0
F4CC7004212	16,500	17,111	25088	64961736	2326.69	1375.00	325	7588	169.2
F4CC7915111	40,000	24,680	56886	195015268	4031.29	3333.33	571	12525	120.9
F4CC7915212	19,000	11,723	24551	99721269	2882.73	1583.33	271	9534	182.1

Budget cable	Length	Weight	Actual manuf.	Sum diff^2	Std var	Avg	Minimum	Maximum	CV
	m	kg	m	m²	m	m	m	m	%
F4CC7925002	20500	7,155	17888	56656116	2172.87	1708.33	293	7939	127.2
F4CC7925111	50,000	37,900	134485	2112290429	13267.41	4166.67	1614	38437	318.4
F4CC7925212	6,500	4,908	60301	819547290	8264.12	541.67	93	25218	1525.7
F4CCA004111	9,500	17,157	3887	3077529	506.42	791.67	136	898	64.0
F4CCA004212	1,000	1,806	409	34100	53.31	83.33	14	95	64.0
F4CCA915111	15,000	14,100	34418	158083453	3629.55	1250.00	295	10639	290.4
F4CCA925111	26,000	34,138	16303	18720043	1249.00	2166.67	512	3873	57.6
F4CCB004111	5,000	13,405	2046	852501	266.54	416.67	71	473	64.0
F4CCB004212	1,000	2,681	709	93323	88.19	83.33	14	332	105.8
F4CCB915111	7,500	10,620	14260	21561603	1340.45	625.00	107	4171	214.5
F4CCB925111	3,500	6,223	20324	113269626	3072.32	291.67	69	8122	1053.4
F4CCB925212	500	889	1205	959921	282.83	41.67	7	1017	678.8
F4CCC915111	6,500	13,345	2660	1440727	346.50	541.67	93	615	64.0
F4CCC925111	7,500	19,455	3069	1918128	399.80	625.00	107	709	64.0
F4CCD915111	4,500	11,403	1841	690526	239.88	375.00	64	426	64.0
F4CCD925111	5,000	17,505	2046	852501	266.54	416.67	71	473	64.0
F4CS4035111	14,400	24120	5892	7070986	767.63	1200.00	206	1362	64.0
F4CS4070111	7,200	20116.8	3801	1900356	397.95	600.00	103	1105	66.3
F4CS4095111	3,600	12445.2	1473	441937	191.91	300.00	51	340	64.0
F4CS4095121	10,800	37335.6	16409	20619830	1310.85	900.00	213	4428	145.6
F4CS4095131	11,100	27405.9	9048	15033009	1119.26	925.00	158	4328	121.0
F4CS4120111	6,300	25036.2	10066	9613387	895.05	525.00	177	3424	170.5
F4CS4120131	300	896.7	4384	9670240	897.69	25.00	4	2980	3590.8
F4CS4150111	1,200	6178.8	491	49104	63.97	100.00	17	113	64.0
F4CS4185111	1,500	9043.5	914	136785	106.77	125.00	21	375	85.4
F4CS4185131	45,300	188855.7	63818	137480961	3384.78	3775.00	985	9890	89.7
F4CS4240111	1,800	13080.6	737	110484	95.95	150.00	26	170	64.0
F4CS4300111	900	7687.8	368	27621	47.98	75.00	13	85	64.0
F4DC3050111	1,200	3070.8	1691	1330076	332.93	100.00	17	1234	332.9
F4DC3095111	1,200	6000	491	49104	63.97	100.00	17	113	64.0
F4EC3035111	12,600	50689.8	10551	17554434	1209.49	1050.00	180	4743	115.2
F4EC3035313	30,900	111464.7	43480	215629739	4239.00	2575.00	609	15090	164.6
F4EC3070111	900	4156.2	368	27621	47.98	75.00	13	85	64.0
F4EC3070313	48,300	223049.4	46257	269189319	4736.29	4025.00	689	17577	117.7
F4EC3095111	3,300	19974.9	2550	1547879	359.15	275.00	47	1365	130.6
F4EC3095313	3,300	20615.1	1350	371350	175.91	275.00	47	312	64.0
F4EC3150111	900	7239.6	368	27621	47.98	75.00	13	85	64.0
F4EC3240111	1,500	20775	614	76725	79.96	125.00	21	142	64.0
F4FC1035TAIL	1,200	770.4	1291	289639	155.36	100.00	17	540	155.4
F4FC1070TAIL	7,000	7021	9364	9596981	894.29	583.33	100	2735	153.3
F4FC1185TAIL	6,000	13014	4955	1442219	346.68	500.00	86	1126	69.3
F6CC2006313	12,500	7525	5115	5328132	666.34	1041.67	178	1182	64.0
F6CC2010313	1,500	1132.5	614	76725	79.96	125.00	21	142	64.0
F6CC2915313	15,500	5840.5	26717	196736090	4049.03	1291.67	221	13712	313.5
F6CC2925313	9,500	4246.5	48546	351591410	5412.88	791.67	187	11898	683.7
F6CC4004313	433,500	234090	691582	12728070103	32567.97	36125.00	23850	108905	90.2
F6CC4006313	44,000	34188	132413	1291758354	10375.28	3666.67	1528	26135	283.0

Budget cable	Length	Weight	Actual manuf.	Sum diff^2	Std var	Avg	Minimum	Maximum	CV
	m	kg	m	m²	m	m	m	m	%
F6CC4010313	131,500	134393	167165	891412093	8618.84	10958.33	2994	28513	78.7
F6CC4016313	193,000	245110	267889	5177191576	20770.96	16083.33	3801	72135	129.1
F6CC4035313	40,500	98,658	84538	618404154	7178.70	3375.00	723	20159	212.7
F6CC4070313	40,500	175,527	55359	124954936	3226.90	3375.00	578	11872	95.6
F6CC4095313	20,100	111,897	41888	100743313	2897.46	1675.00	458	7006	173.0
F6CC4150313	2,100	17,865	3819	2438942	450.83	175.00	30	1399	257.6
F6CC4915313	17,500	7245	52246	503238316	6475.84	1458.33	250	18795	444.1
F6CC4925313	22,000	12034	42227	104775503	2954.88	1833.33	464	8501	161.2
F6CC7004313	22,000	18282	32377	62394645	2280.25	1833.33	433	6655	124.4
F6CC7925313	5,000	3395	20085	97428366	2849.39	416.67	71	9134	683.9
F6CCA004313	12,000	15300	12910	25601618	1460.64	1000.00	171	4384	146.1
F6CCA925313	3,000	2913	1228	306900	159.92	250.00	43	284	64.0
F6CCB925313	2,500	4157.5	1823	632253	229.54	208.33	36	870	110.2
F7CA1035EB0	905,000	209055	1125976	101717909069	92067.87	75416.67	19677	341723	122.1
F7CA2025SA0	20,500	3731	8388	14330545	1092.80	1708.33	293	1939	64.0
F7CA2035EB0	166,500	60939	222467	5312686043	21041.00	13875.00	3279	70114	151.6
F7CA3025EB0	4,500	1777.5	1841	690526	239.88	375.00	64	426	64.0
F7CA3025SD0	8,500	4326.5	3478	2463728	453.11	708.33	121	804	64.0
F7CA3035EB0	81,500	40750	156409	5259891497	20936.20	6791.67	1772	76389	308.3
F7CA3035EB1	48,500	29100	34787	59274627	2222.51	4041.67	955	7872	55.0
F7CA3035EC1	4,500	2889	2837	1139658	308.17	375.00	64	1098	82.2
F7CA3035SD1	3,500	2499	4412	4302737	598.80	291.67	50	2118	205.3
F7CA3050SD0	229,500	167076	517057	14773196855	35087.03	19125.00	11990	80537	183.5
F7CA3050SD1	8,500	6868	3478	2463728	453.11	708.33	121	804	64.0
F7CA3070EC1	4,500	4369.5	20201	123129153	3203.24	375.00	95	10009	854.2
F7CA3070EK1	5,000	6685	2046	852501	266.54	416.67	71	473	64.0
F7CA3070ND3	138000	139,104	56466	649401309	7356.41	11500.00	1970	13052	64.0
F7CA3070SD1	14,500	15123.5	7928	7119944	770.28	1208.33	286	2371	63.7
F7CA3095EC1	14,500	17545	6933	6909810	758.83	1208.33	207	1871	62.8
F7CA3095ND3	48900	57,213	20009	81540375	2606.73	4075.00	698	4625	64.0
F7CA3095SD0	10,000	11770	89207	1701614422	11908.03	833.33	336	34640	1429.0
F7CA3095SD1	11,000	14047	4501	4126106	586.38	916.67	157	1040	64.0
F7CCS004N2	120,000	14688	49101	491040687	6396.88	10000.00	1713	11349	64.0
F7CCS010N2	208,000	69930	905429	58823924932	70014.24	17333.33	11471	120094	403.9
F7CCS010N4	250,000	61400	272502	5001159134	20414.78	20833.33	5269	80469	98.0
F7CCS016N2	489,000	233427	1263787	75991302192	79577.69	40750.00	25806	209266	195.3

ANNEXURE 8: PAYMENT CONDITIONS OF AFRICAN CABLES' SUPPLIERS

Vendor no	Vendor	Payment terms		Vendor no	Vendor	Payment terms	
		Days	Discount %			Days	Discount %
65671	PALABORA	30	0	**63459**	HAGGIE RAND LIMITED.	30	2.5
60364	BILLITON	30	0	**67026**	FOCHEM INTERNATIONAL	15	3.5
67397	SPRINGBOK BOX (PTY)L	30	1	**60006**	A.A. ALLOY FOUNDRY (	30	2.5
63022	FRY'S METALS (PTY) L	30	0	**64695**	3 M SOUTH AFRICA (PT	30	2.5
66849	CAPE GATE (PTY)LTD	30	0	**60218**	MARBRIDGE BITUMINOUS	30	0
67902	DOW CHEMICALS DIVISI	60	0	**65469**	NOBLE MOTOR & CONTRO	30	2.5
50576	BOREALIS A/S	49	0	**65762**	TANK INDUSTRIES (PTY	30	0
60077	SASOL POLYMERS-VINYL	30	0	**63846**	HULETTS ALUMINIUM (P	30	0
67949	INDEPENDANT GALVANIS	15	4	**60106**	ABE CONSTRUCTION CHE	30	0
50602	ZAMEFA METAL FABRICA	30	1	**66218**	RAND ADVERTISING TAP	30	0
61062	COPALCOR ROLLED META	30	0	**67839**	MASTERBATCH S.A. C.C	30	0
65383	CHLOR ALKALI A DIV O	30	0	**65275**	HEREFORD IND (PTY) L	30	0
67951	MALESELA TAIHAN ELEC	30	0	**61713**	CONTACT PLASTICS c.c	30	0
66144	SASOL POLYMERS - VIN	30	0	**67845**	F.J.C. BOLT & NUT (P	30	0
50007	EUROALLOYS	30	0	**65361**	NATIONAL SOLDER CO(T	30	0
62333	DUSSEK CAMPBELL (PTY	30	0	**63214**	GERBER GOLDSMIDT GRO	30	0
61440	CHEMPRO - A DIV OF P	30	0	**66618**	SOUTHERN CHEMICALS P	30	0
50566	MUNKSJO PAPER AB	60	0	**66318**	FIBREGLASS ACCESSORI	30	0
60162	ATC (PTY) LTD	30	0	**60149**	ACCORD ENGINEERING &	30	0
50605	ALUSUISSE TRADING	30	0	**60905**	NADO TECHNICAL SERVI	30	0
64075	ISO-TECH SYSTEMS C.C	30	2.5	**60214**	K-SYSTEMS CC	30	0
50030	DOW CHEMICAL CO.(UNI	60	0	**61811**	COPPER CABLES & CON	30	0
50033	IDWALA SALES & DISTR	60	0	**61981**	DEBCO TECHNOLOGIES C	30	0
64515	IDWALA SALES & DISTR	30	0	**60322**	GELLETICH SALES (PTY	30	0
50002	CABLE COMPONENTS LTD	30	0	**64991**	MEGA BAGS CC.	30	0
50620	BP GLOBAL SPECIAL PR	60	0	**61230**	C & T SALES ENTERPRI	30	0
67950	MALESELA TECHNOLOGIE	30	0	**68465**	WHITELEYS	30	0
50623	POLYONE NORWAY	65	0	**62400**	EAST RAND PLASTICS (	30	0

65967	CLARIENT SOUTHERN AF	30	0
61458	CHEMSERVE POLYMER SC	30	0
60000	ABERDARE CABLES AFRI	30	0
60583	ASSOCIATED ADDITIVES	30	0
60078	SASOL POLYMERS-POLYT	30	0
50500	LENZING PLASTICS Gmb	90	0
60111	CHEMGRIT SA (PTY) LT	30	0
61290	CARST & WALKER (PTY)	30	0
62652	EXCEED GEARCUTTING &	15	0
50503	LANTOR BV.,FIRET NON	60	0
67850	TRIDENT JUTE PRODUCT	30	0
50561	CARTIERE FEDRIGONI &	60	0
50003	SCAPA POLYMERICS LIM	60	0
65745	PERFORMANCE MASTERBA	30	0
60261	ROTOFLEX-QUIX	30	0
67173	ABERDARE CABLES/S.A.	30	0
68392	NATIONAL INDUSTRIES	30	2
66061	DIVERSIFIED CABLE TA	30	0
64744	MACOTECH SERVICES (P	30	0
66694	ROUW ENG.& INDUSTRIA	15	3.5
61311	CAR PLATES & SIGNS	30	0
61990	OMG MARKETING SOUTH	30	0
50585	MULTIFOIL LTD	30	0
50027	TUKA LTD,	60	0
61521	CIBA SPECIALITY CHEM	30	0
50553	POLYONE BELGIUM S.A.	90	0
60392	ExxonMobil Chemicals	30	0
60212	ENGEN PETROLEUM LTD	30	0
50542	NOVA-BOREALIS COMPOU	90	0
63847	DEGUSSA AFRICA (PTY	30	0

66272	ABERDARE CABLES(PTY)	30	0
62519	ELITE CHEMICALS (PTY	30	0
60329	TECHNO THREADS CC	30	0
60340	VANTICO AG	30	0
60025	DUNROSE TRADING 57 (	30	0
60294	ITALPAC CC	30	0
61231	ERICO TECHNOLOGIES A	30	0
66836	C-TEC INDUSTRIAL (PT	30	0
61875	CULLINAN INDUSTRIAL	30	0
67851	FAG VAAL TRIANGLE	30	0
60293	PROCURECO(EDMS)BPK	30	0
63197	GERM LUBRICANTS	30	0
61040	COPYREEL CARIBONIUM	30	0
50532	SCAPA TAPES	30	0
62472	ELEC.MOULDED COMPONE	30	0
68099	VAAL STEAM SUPPLIES	30	0
66085	PROTEA INDUSTRIAL CH	30	0
64620	LOZDAN & CLARK (PTY)	30	0
67446	SWIFT INDUSTRIAL SUP	30	0
63306	GLOBAL WRAPPING	30	0
63631	BILL SCHUTER ADHESIV	30	0
60341	AMYSA STATIONERS CC	30	0
61360	ELEGANCE LIGHTING &	30	0
68174	VER-BOLT (PTY) LTD	30	0
60280	ALL.BOLT & NUT MANUF	30	0
62506	ELECTROWARE INDUSTRI	30	0
50508	SUMITOMO ELECTRIC EU	30	0
61529	CITIWOOD VAAL (PTY)	30	0
61039	SERVOCHEM	30	0
68375	WALTONS STATIONERY C	30	0
50533	FUJIKURA KASEI CO.LT	30	0

ANNEXURE 9: SAMPLE PAGE OF SIMULATED DEMAND

Crt	Budget Cable	237 m	kg	Avg m	1	2	3	4	5	6	7	8	9	10
1	F0MINK	2,504,000	636016	85381	31342	19267	19267	11764	19267	11764	19267	11764	19267	19267
2	F1DC307042292	7,200	39,960	304	190	190	190	190	190	190	190	190	190	190
3	F1EA307016195	900	4,824	31	18	18	18	30	18	18	18	18	30	85
4	F1EA309524195	2,400	16,008	82	227	79	48	48	227	227	48	79	48	48
5	F1EA315016195	600	4,692	45	17	17	17	17	17	17	17	17	17	17
6	F1EA318536008	1,500	10,035	51	30	30	49	49	30	30	49	49	75	49
7	F1EC307044313	4,500	35,685	153	426	148	90	148	90	148	90	148	90	225
8	F1EC315044313	5,700	72,105	1361	2080	319	319	319	319	319	319	2080	319	319
9	F1FA307017191	2,100	11,382	72	42	69	42	42	42	69	105	69	69	69
10	F1FA309517191	54,600	341,250	4708	495	1238	1238	1238	1713	2709	1238	495	495	2709
11	F1FA312017191	600	4,266	70	338	17	17	17	17	17	17	338	17	17
12	F1FA312019191	9,000	63,630	307	297	179	179	297	451	179	297	451	297	297
13	F1FA312039191	11,400	80,598	1538	375	781	216	1025	1025	1025	375	375	375	375
14	F1FA315025511	600	6,522	20	12	30	30	12	12	12	20	20	20	20
15	F1FA318518591	3,900	39,000	133	78	78	129	78	78	78	78	129	129	78
16	F1FA318519191	600	5,454	54	20	20	20	20	20	20	20	20	20	20
17	F1FA324017191	11,100	113,775	528	403	1050	403	403	221	403	403	403	403	403
18	F1FA324039191	4,800	50,688	818	785	785	529	785	785	126	785	529	529	529
19	F1FA330017191	1,500	17,760	51	142	30	49	49	30	30	49	49	30	30
20	F1FA330019191	3,300	40,260	113	66	312	66	66	66	109	66	66	66	109
21	F1FA330039191	6,900	84,870	535	145	145	145	540	145	145	145	263	145	540
22	F1FA340039191	11,100	153,069	378	1050	366	366	221	221	366	366	1050	221	221
23	F1FC163030001	3,900	38,649	608	102	102	102	102	1169	1570	1169	102	102	1570
24	F1FC163030343	1,200	13,776	65	35	35	35	35	113	35	35	35	315	113
25	F1FC302539191	24,300	115,425	1454	951	562	951	562	951	951	304	304	562	562
26	F1FC303518191	1,500	9,210	51	49	49	75	49	75	49	142	30	30	30
27	F1FC303539191	4,500	24,120	278	751	1044	124	124	124	124	124	124	124	124
28	F1FC305017191	3,000	17,940	102	60	60	150	284	99	99	60	99	60	99
29	F1FC305018191	1,800	12,780	61	59	59	59	36	59	36	36	36	90	36
30	F1FC305019191	1,800	11,160	421	829	829	53	53	304	829	53	829	829	829
31	F1FC307017191	11,400	75,126	389	227	376	227	571	376	227	1078	376	376	227
32	F1FC307018111	5,100	44,931	299	322	102	322	166	102	322	102	322	102	322
33	F1FC307018191	2,100	16,212	172	1005	68	68	1005	68	68	68	68	373	68
34	F1FC307019191	12,600	86,436	1405	327	680	1471	680	327	680	327	327	327	327
35	F1FC307037111	3,000	22,860	327	81	553	284	553	553	81	81	81	81	553
36	F1FC307038008	8,700	61,857	322	519	173	283	173	173	519	283	519	283	173
37	F1FC307038191	1,800	13,896	259	51	635	635	51	51	51	635	51	635	635
38	F1FC307038511	20,700	183,609	4127	2494	2494	496	2494	2494	2494	496	1064	1689	1064
39	F1FC307039191	9,000	61,740	3289	1582	986	390	1582	986	390	986	986	986	1582
40	F1FC309518191	18,600	170,376	1571	427	678	427	427	427	678	678	678	427	427
41	F1FC309518591	1,500	13,605	76	42	142	352	42	42	42	142	42	42	42
42	F1FC309537008	1,500	9,435	51	30	49	49	30	49	30	75	30	142	30
43	F1FC309538292	2,400	21,864	82	227	48	79	48	79	79	79	227	79	79

ANNEXURE 10: SIMULATION RESULTS

Simulation results							
Month	Stock levels, with EOQ R	Stock levels, without safety stocks R	Stock levels, with safety stocks R	Payables balances, with EOQ R	Payables balances, without safety stocks R	Payables balances, with safety stocks R	Receivables balances R
1	133108	6055336	17323136	77876483	77535612	79223380.5	48576272
2	147130	5052620	15672177	65318817	64031757	65309515.4	92412263
3	133673	5087111	17102176	62906483	63593256	61543564.2	89548973
4	109700	5432646	16656579	79399762	78579194	80719554.1	87221517
5	124068	4759905	15804825	70549533	70877058	69901524.5	95058835
6	124595	4785387	17013527	61758017	61889083	62081296.6	88095178
7	139896	4936338	16359928	70212591	69657233	70259180.9	83193006
8	108249	4945574	15827390	65785060	67038846	66477339.3	95976623
9	143508	5444543	16270285	49042855	49343586	48517903.2	93289336
10	127093	4050191	16447309	51703207	51866705	52020114.8	109543663
11	145338	4539824	16271510	78129379	77423015	77580009.3	95255977
12	144889	3929671	16325233	63296230	62398983	62858568	96055401
13	131207	4645506	16300392	63249279	64049453	63327839.7	92513452
14	132196	4646545	15192557	71281985	70555537	71906929.4	104529128
15	137337	5157125	16198565	61945207	62714552	60740575.3	96519101
16	127979	4246867	16961980	63917788	63136685	65643437.9	89560386
17	144559	4621402	15692261	70833157	72690282	70338158.1	102700815
18	131172	4538034	16394995	65946150	65952769	66600005.4	96043263
19	149588	5248979	16467274	58338764	58200137	56797560.9	87549536
20	146055	4681607	16844056	68942096	68231487	68725053.5	100100404
21	127210	4180818	15056516	65095895	65461335	65679513.2	98393680
22	119253	4261278	16037049	50723191	49774496	50492069.8	119553099
23	131779	4254102	15753874	47593474	49109643	47509657.2	93215374
24	136448	4574383	16611198	70093375	69525993	69796278.9	92272587
25	112992	4470261	16582351	67264516	66698696	68237856.7	81856241
26	121339	4783719	15707641	65526394	66025022	63757435.3	93616071
27	132997	4834357	16322780	69191793	68100599	69166671.5	94100166
28	139087	5128048	15524829	60815445	61414615	62250661.2	91593138
29	134414	4073115	15632346	60316353	60237510	60805514.9	102717445
30	123207	4704534	16188545	66702842	67735704	66633093.6	98010224
31	122275	4478525	16164202	67000403	67275905	67313573.7	90072331

Simulation results							
Month	Stock levels, with EOQ R	Stock levels, without safety stocks R	Stock levels, with safety stocks R	Payables balances, with EOQ R	Payables balances, without safety stocks R	Payables balances, with safety stocks R	Receivables balances R
32	116587	5305477	16332430	63137529	61734180	62839718.8	103355924
33	103108	5030860	16118904	72576899	72789218	72801817.5	94846121
34	139693	4409679	16205340	65586572	65514500	64054004.2	113126033
35	139695	4650155	16683992	48581686	48662690	49127694.8	95985886
36	118738	4916886	15449972	47710761	47940874	48059150.4	92531001
37	111043	4551033	15505793	73056336	73320872	73268812.8	86058055
38	129623	4841384	15944279	66959305	66294295	67457140	99607387
39	129488	4670361	16037861	62689844	63772043	62170193	95148807
40	135597	4715017	16379206	77295042	77066074	77957741.2	89444272
41	127178	4900264	16341871	61717272	62517414	60808388.6	103511974
42	116822	3997742	15836066	63348598	62008432	63322348.7	98928105
43	139723	4877866	15342895	73361577	73387972	72816452.8	88898674
44	120666	4944038	15562800	62332527	62115545	63141985.1	101365284
45	128504	4816055	16109577	65168363	64414370	64189553.6	95213166
46	140005	4372855	15344016	74596710	75352110	75184653.3	110344324
47	110695	4620583	16386976	59105960	59672273	60101330.5	93144761
48	147164	4787428	15555470	45141149	44614677	44353681.9	92951151
49	113094	4054342	15422257	48671670	50458512	49657595.4	89113725
50	136205	5423839	16441689	68802719	68013089	68989898.2	98778862
51	128430	4227839	15691140	61799562	61438419	60546618	92508376
52	119271	4508447	15083992	58614677	58494651	58503666.1	83598297
53	122823	4968926	16235155	77382407	78056909	78758568.5	59209530
54	129401	4969141	16270618	64968134	64652519	63627992.8	18856779
55	135840	4620085	16346387	50007608	48925765	50027081.8	----
56	119747	5255463	16280134	----	----	----	----
57	140297	4654769	16147320	----	----	----	----
58	125556	4944490	16477952	----	----	----	----
59	144203	5258736	15868813	----	----	----	----
60	145479	4948741	16025350	----	----	----	----
Average	129800	4746514	16102262	64061262	64042585	64072362	92512407
StdDev	11122	405850	494382	8455071	8381870	8620429	14724351

ANNEXURE 11: WORKING CAPITAL VALUES FOR ACTUAL DEMAND AND ACTUAL PURCHASING CONDITIONS

Working capital values, actual demand, actual purchasing conditions							
Month	Payables	Receivables	RM	WIP	FG	Other stock	Daily Sales
1	49412211	69160160	17079509	21378289	17963029	9812874	1145640
2	63267415	58780684	16423391	18684713	22854410	6155172	1139516
3	35143031	46194424	16656688	18122921	23309087	7662988	1291394
4	38741584	46337331	17007387	12841580	22746671	6268397	1342112
5	30976314	51340937	15995352	12703314	20359761	8942417	1046232
6	46096760	54461640	16580186	16973772	24179918	5139662	872783
7	47643160	71670996	16761862	23315724	26220123	8450528	1269839
8	54299277	68568692	16467806	21955842	26706638	7208194	1367333
9	42380535	97494117	16228147	14951336	23855398	7374648	989484
10	36197637	92537311	16249430	17508282	21849421	5381501	853153
11	57137443	74565863	16146265	18184377	24810625	6939903	1207307
12	39254367	20395873	16377907	14684486	28577654	4945753	1278527
Average	45045811	62625669	16497828	17608720	23619394	7023503	1150277

ANNEXURE 12: WORKING CAPITAL VALUES FOR ACTUAL DEMAND AND EOQ PURCHASING CONDITIONS

Working capital values, actual demand, EOQ purchasing conditions							
Month	Payables	Receivables	RM	WIP	FG	Other stock	Daily Sales
1	42954512	69160160	132302	21378289	17963029	9812874	1145640
2	63945715	58780684	127631	18684713	22854410	6155172	1139516
3	36648597	46194424	119753	18122921	23309087	7662988	1291394
4	38991005	46337331	116025	12841580	22746671	6268397	1342112
5	30869536	51340937	124564	12703314	20359761	8942417	1046232
6	46265203	54461640	124299	16973772	24179918	5139662	872783
7	47179470	71670996	128258	23315724	26220123	8450528	1269839
8	53970386	68568692	120960	21955842	26706638	7208194	1367333
9	43331839	97494117	120205	14951336	23855398	7374648	989484
10	35951301	92537311	110887	17508282	21849421	5381501	853153
11	56925591	74565863	133713	18184377	24810625	6939903	1207307
12	----	20395873	----	----	----	----	1278527
Average	45184832	62625669	123509	17874559	23168644	7212389	1150277

ANNEXURE 13: WORKING CAPITAL VALUES FOR ACTUAL DEMAND AND ACTUAL PURCHASING CONDITIONS, WITHOUT SAFETY STOCKS

Working capital values, actual demand, actual purchasing conditions, no safety stock							
Month	Payables	Receivables	RM	WIP	FG	Other stock	Daily Sales
1	41905667	69160160	6224353	21378289	17963029	9812874	1145640
2	63035062	58780684	4068414	18684713	22854410	6155172	1139516
3	36596749	46194424	4567600	18122921	23309087	7662988	1291394
4	37446100	46337331	5340507	12841580	22746671	6268397	1342112
5	30951684	51340937	4205417	12703314	20359761	8942417	1046232
6	46892120	54461640	5510420	16973772	24179918	5139662	872783
7	47904370	71670996	5709699	23315724	26220123	8450528	1269839
8	53344354	68568692	5031971	21955842	26706638	7208194	1367333
9	42769466	97494117	4621931	14951336	23855398	7374648	989484
10	35074552	92537311	4085288	17508282	21849421	5381501	853153
11	57090241	74565863	4620668	18184377	24810625	6939903	1207307
12	40783795	20395873	5377908	14684486	28577654	4945753	1278527
Average	44482847	62625669	4947015	17608720	23619394	7023503	1150277

ANNEXURE 14: WORKING CAPITAL RATIOS FOR ACTUAL DEMAND AND ACTUAL PURCHASING CONDITIONS

WC ratios, actual demand, actual purchasing conditions					
Month	DPO	DSO	DRM	DI	DWC
1	43.1	60.4	14.9	57.8	75.1
2	55.5	51.6	14.4	56.3	52.3
3	27.2	35.8	12.9	50.9	59.5
4	28.9	34.5	12.7	43.9	49.5
5	29.6	49.1	15.3	55.4	74.9
6	52.8	62.4	19.0	72.0	81.6
7	37.5	56.4	13.2	58.9	77.8
8	39.7	50.1	12.0	52.9	63.3
9	42.8	98.5	16.4	63.1	118.8
10	42.4	108.5	19.0	71.5	137.5
11	47.3	61.8	13.4	54.7	69.2
12	30.7	16.0	12.8	50.5	35.8
Average	39.2	54.4	14.3	56.3	71.6

ANNEXURE 15: WORKING CAPITAL RATIOS FOR ACTUAL DEMAND AND EOQ PURCHASING CONDITIONS

WC ratios, actual demand, EOQ purchasing conditions					
Month	DPO	DSO	DRM	DI	DWC
1	37.5	60.4	0.1	43.0	65.9
2	56.1	51.6	0.1	42.0	37.4
3	28.4	35.8	0.1	38.1	45.5
4	29.1	34.5	0.1	31.3	36.7
5	29.5	49.1	0.1	40.3	59.8
6	53.0	62.4	0.1	53.2	62.6
7	37.2	56.4	0.1	45.8	65.1
8	39.5	50.1	0.1	40.9	51.6
9	43.8	98.5	0.1	46.8	101.5
10	42.1	108.5	0.1	52.6	118.9
11	47.2	61.8	0.1	41.5	56.1
12					
Average	39.3	54.4	0.1	42.1	57.2

ANNEXURE 16: WORKING CAPITAL VALUES FOR ACTUAL DEMAND AND ACTUAL PURCHASING CONDITIONS, WITHOUT SAFETY STOCKS

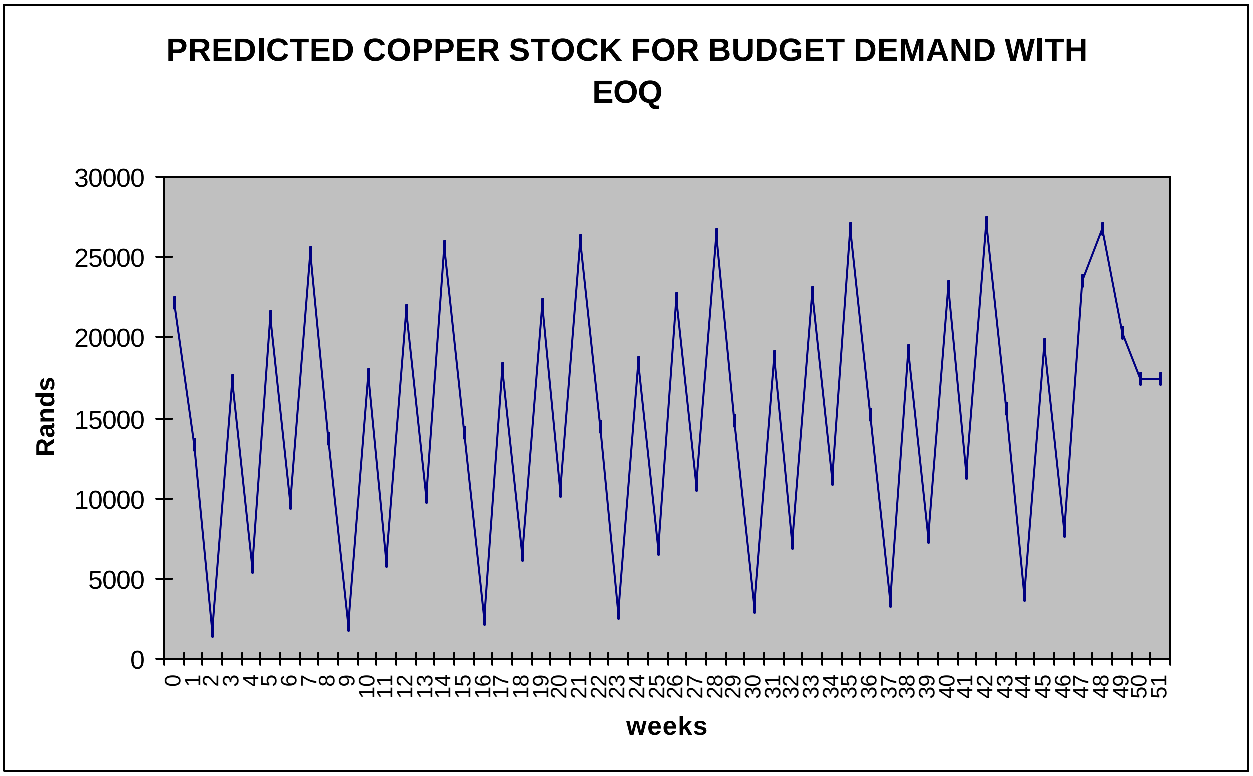
WC ratios, Act. Dem., act. purch. cond., no safety stock					
Month	DPO	DSO	DRM	DI	DWC
1	36.6	60.4	5.4	48.3	72.1
2	55.3	51.6	3.6	45.4	41.7
3	28.3	35.8	3.5	41.6	49.0
4	27.9	34.5	4.0	35.2	41.8
5	29.6	49.1	4.0	44.2	63.7
6	53.7	62.4	6.3	59.4	68.0
7	37.7	56.4	4.5	50.2	68.9
8	39.0	50.1	3.7	44.5	55.7
9	43.2	98.5	4.7	51.3	106.6
10	41.1	108.5	4.8	57.2	124.6
11	47.3	61.8	3.8	45.2	59.7
12	31.9	16.0	4.2	41.9	26.0
Average	38.7	54.4	4.3	46.2	62.0

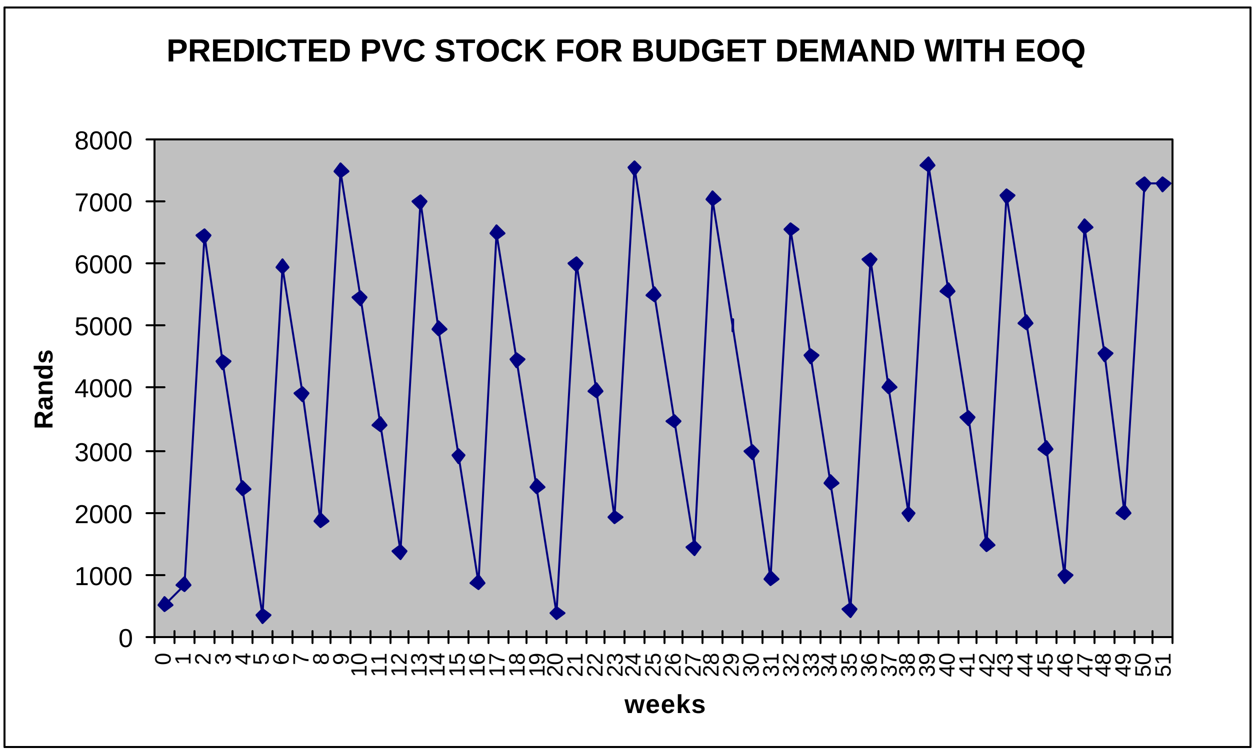
ANNEXURE 17: WORKING CAPITAL VALUES AND RATIOS FOR SIMULATED DEMAND AND DIFFERENT PURCHASING CONDITIONS

Avg. WC values, sim demand, actual purchasing conditions						
Payables	**Receivables**	**RM**	**WIP**	**FG**	**Other stock**	**Daily Sales**
63791788	92512407	16081570	17542872	24464326	6822901	1882078
Avg. WC values, sim demand, actual purchasing conditions, no safety stocks						
Payables	**Receivables**	**RM**	**WIP**	**FG**	**Other stock**	**Daily Sales**
63792714	92512407	4724331	16746679	24529470	6414701	1882078
Avg. WC values, sim demand, EOQ purchasing conditions						
Payables	**Receivables**	**RM**	**WIP**	**FG**	**Other stock**	**Daily Sales**
64061262	92512407	145479	17299424	24204397	6753702	1882078

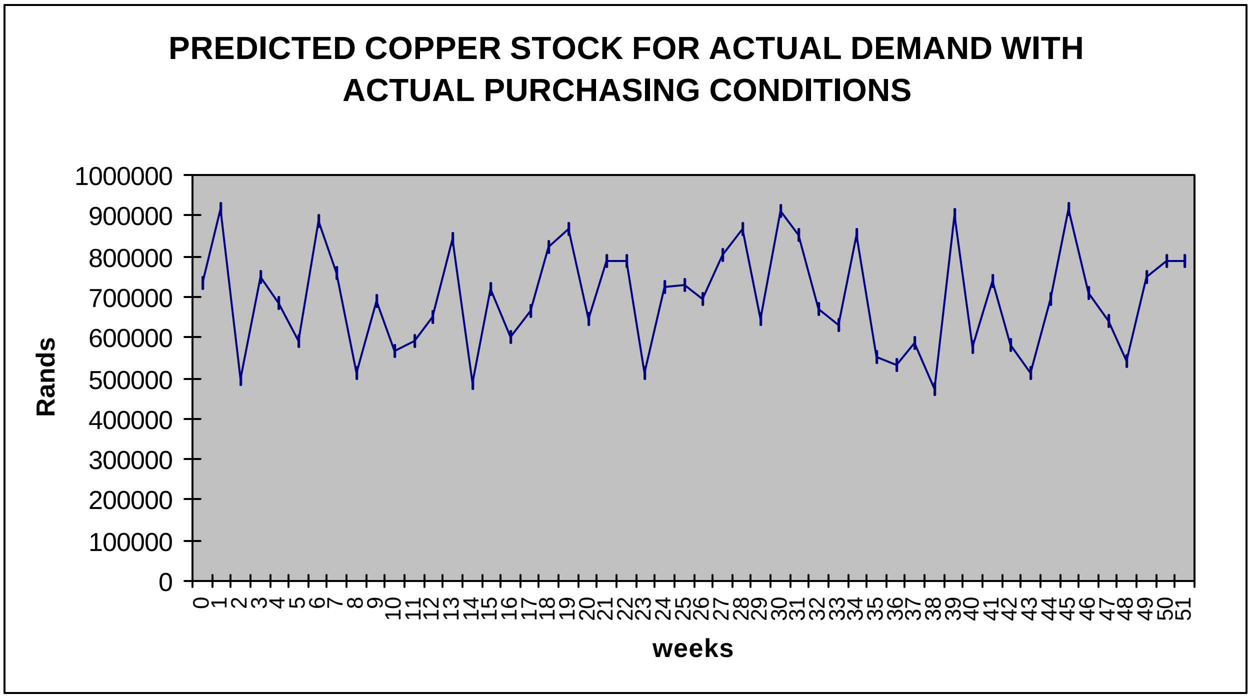
WC ratios, sim. demand, act. purch. cond.					
	DPO	**DSO**	**DRM**	**DI**	**DWC**
Average	33.9	49.2	8.5	34.5	49.7
WC ratios, sim. dem., act. purch. cond., no safety stocks					
	DPO	**DSO**	**DRM**	**DI**	**DWC**
Average	33.9	49.2	2.5	27.8	43.1
WC ratios, sim. dem., EOQ purch. cond.					
	DPO	**DSO**	**DRM**	**DI**	**DWC**
Average	33.9	49.2	0.1	25.7	40.8

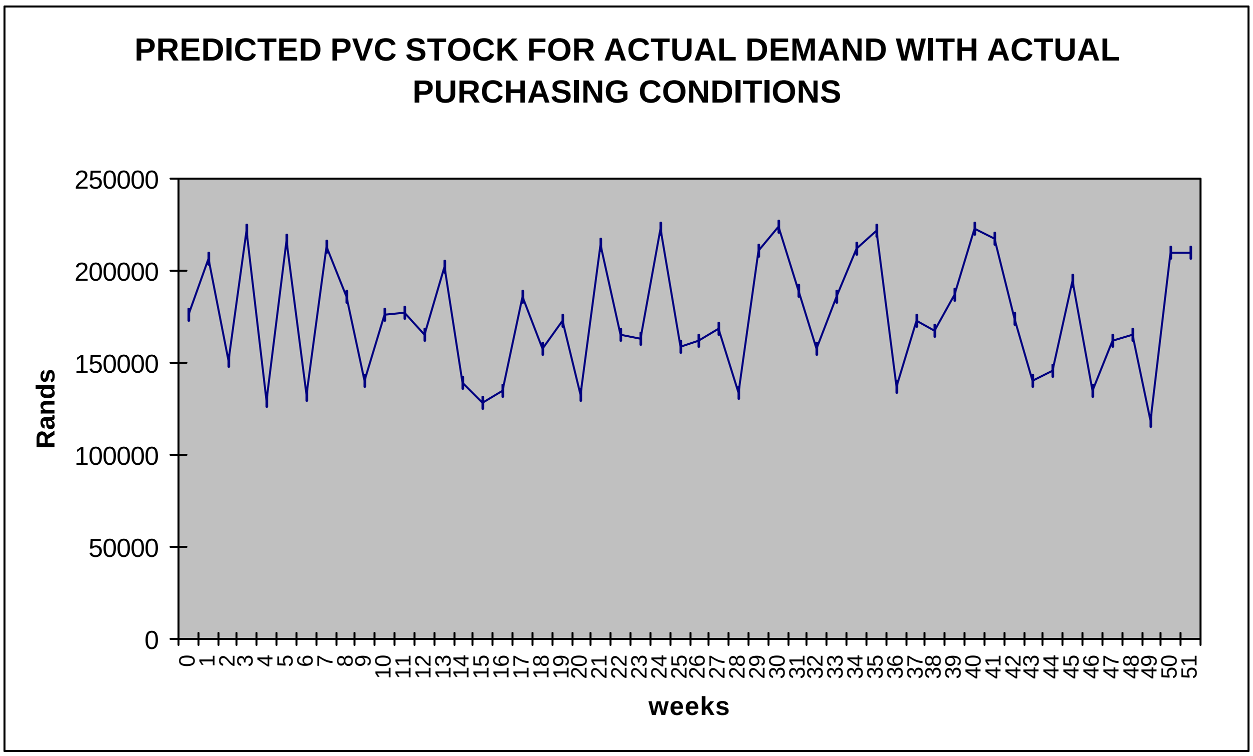
ANNEXURE 18: EXPECTED STOCK VALUES FOR COPPER AND PVC BASED ON BUDGET AND EOQ



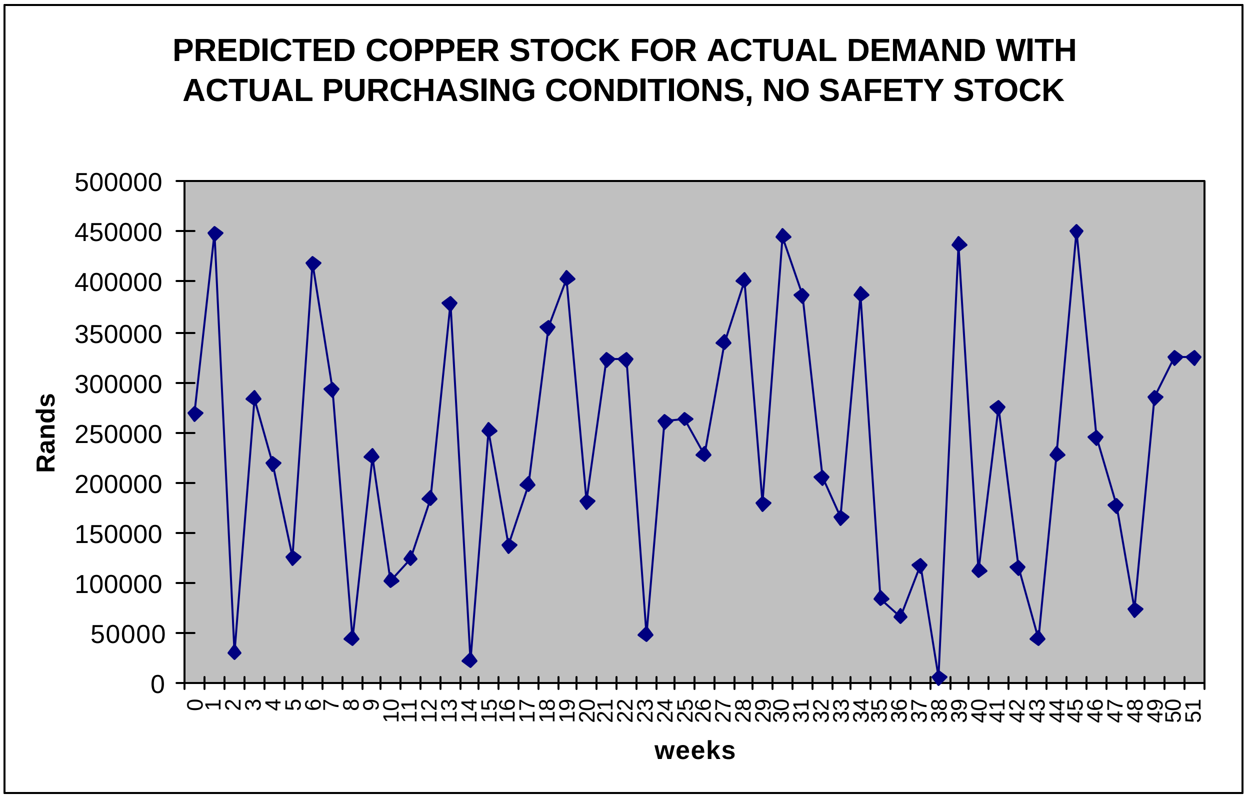


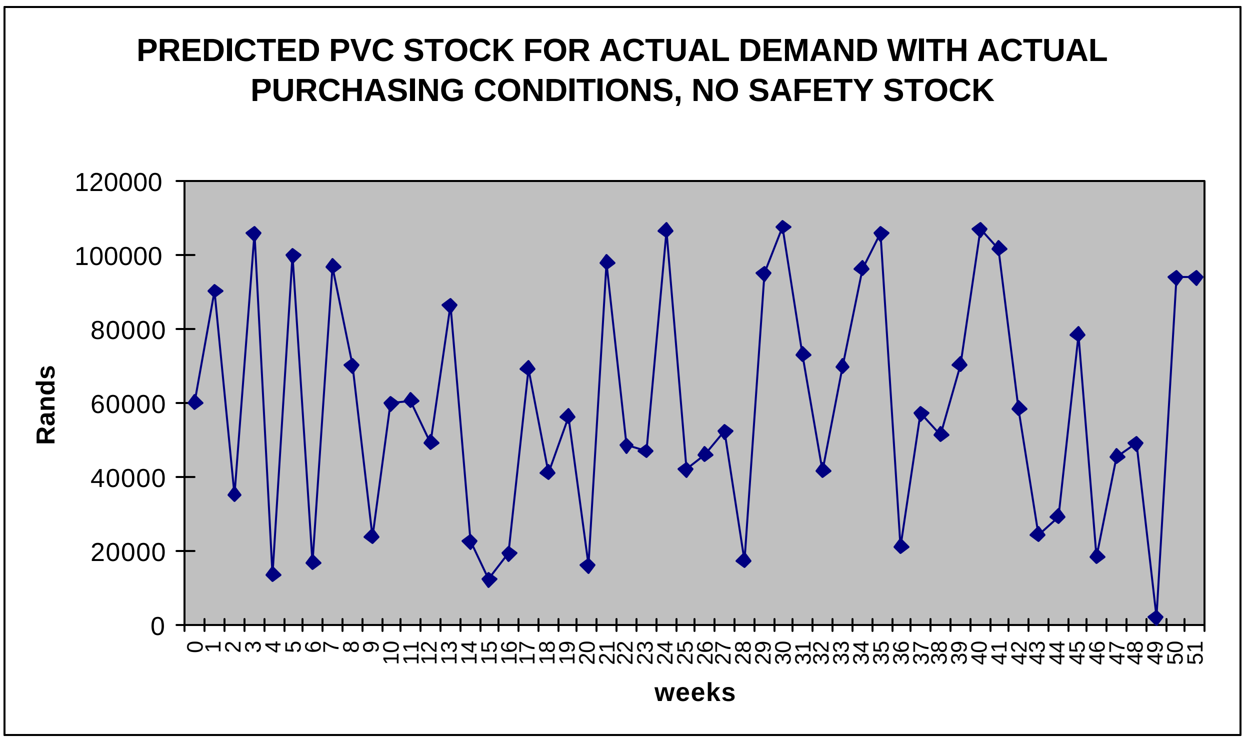
ANNEXURE 19: EXPECTED STOCK VALUES FOR COPPER AND PVC BASED ON ACTUAL DEMAND AND ACTUAL PURCHASING CONDITIONS



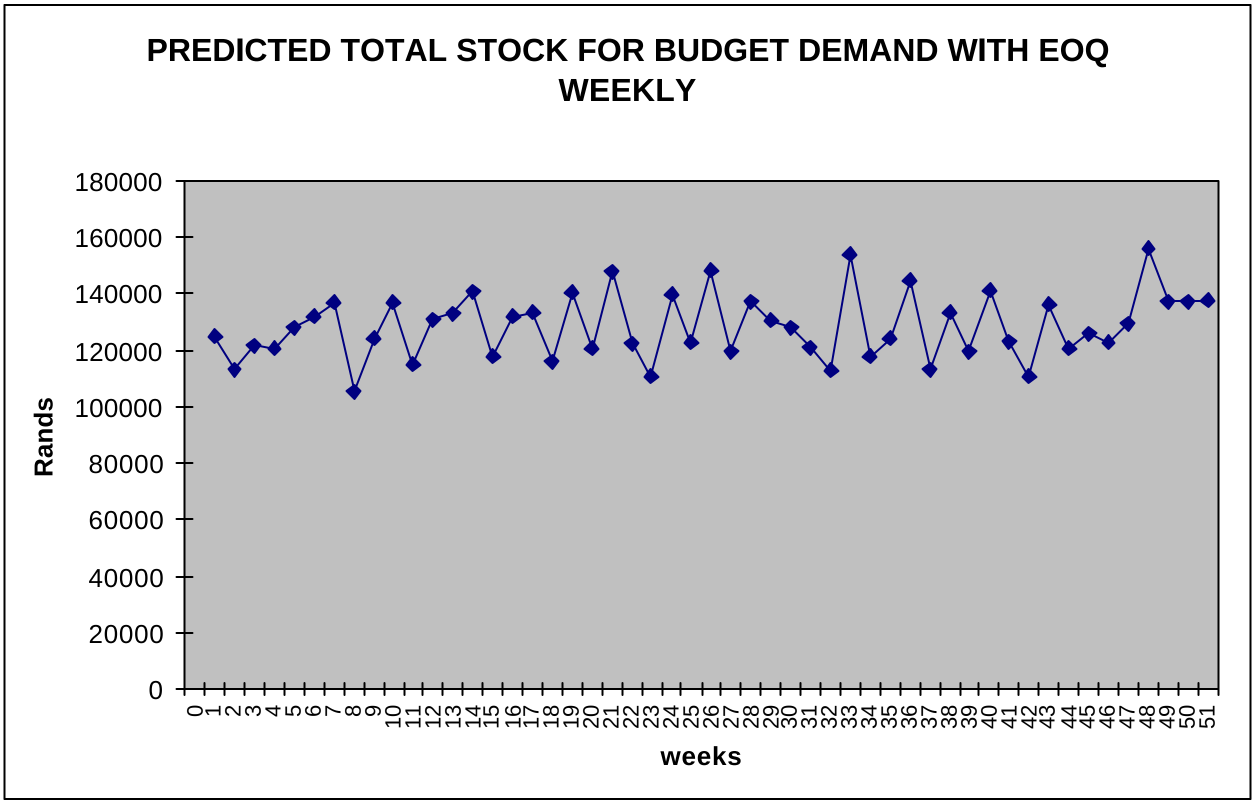


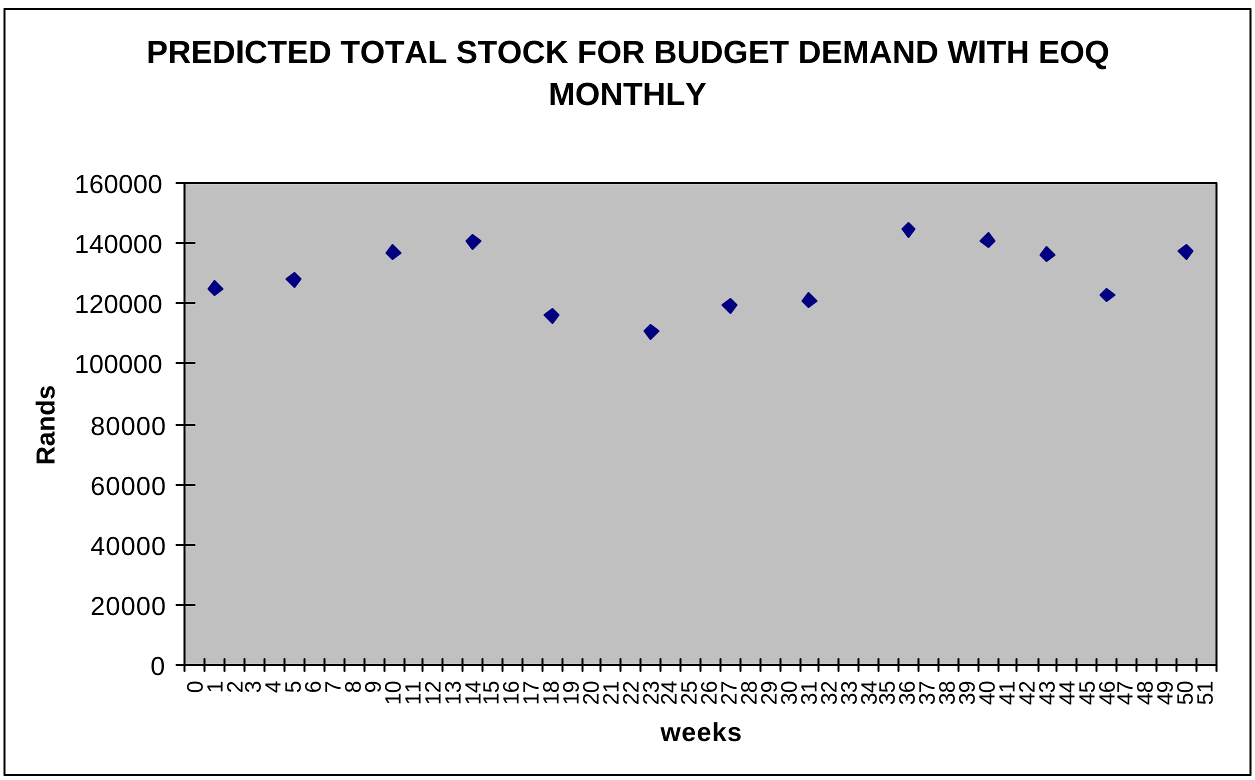
ANNEXURE 20: EXPECTED STOCK VALUES FOR COPPER AND PVC BASED ON ACTUAL DEMAND AND ACTUAL PURCHASING CONDITIONS WITHOUT SAFETY STOCKS



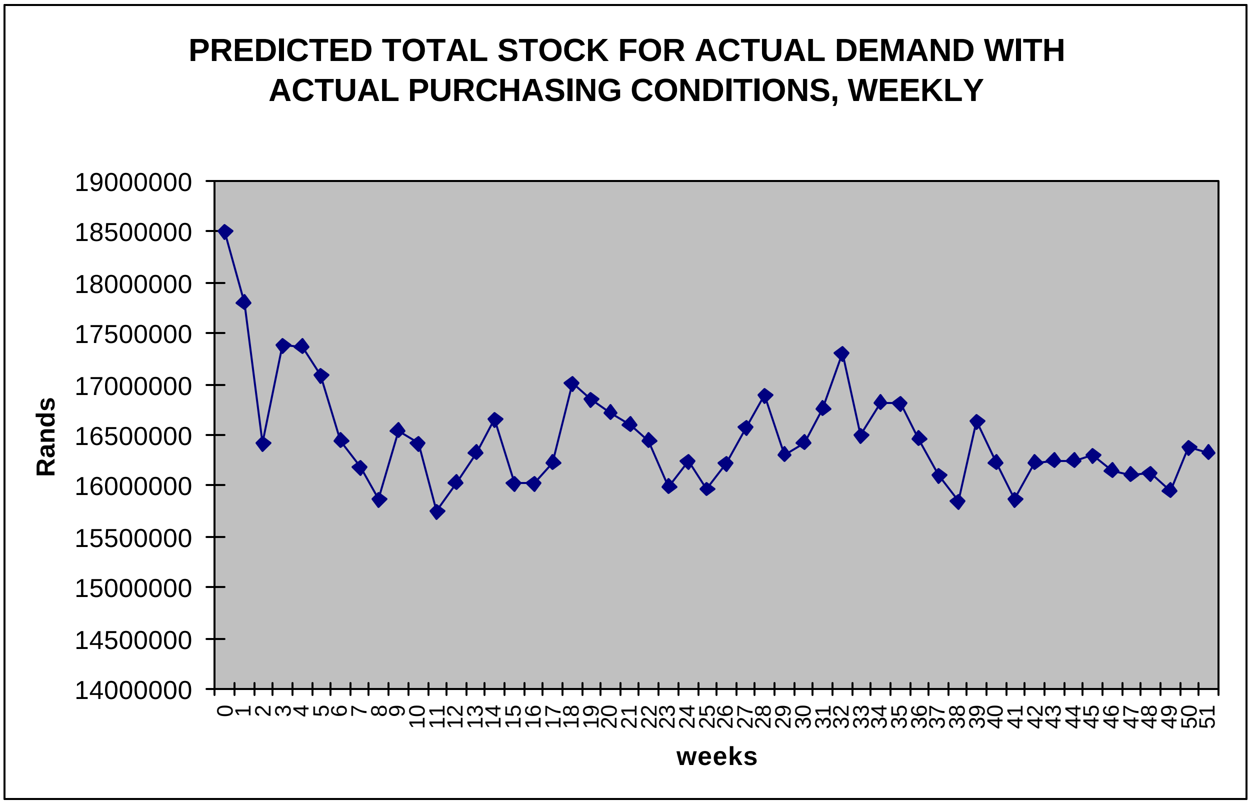


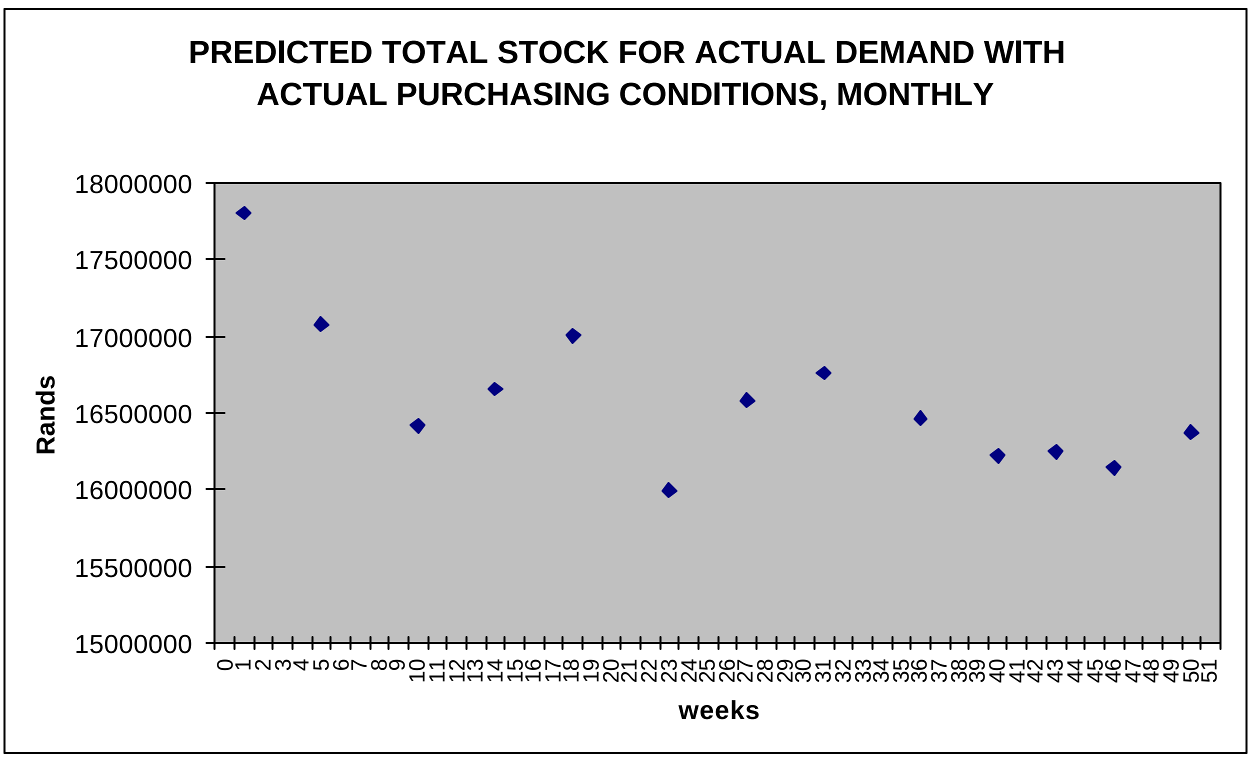
ANNEXURE 21: EXPECTED TOTAL STOCK VALUES BASED ON BUDGET AND EOQ



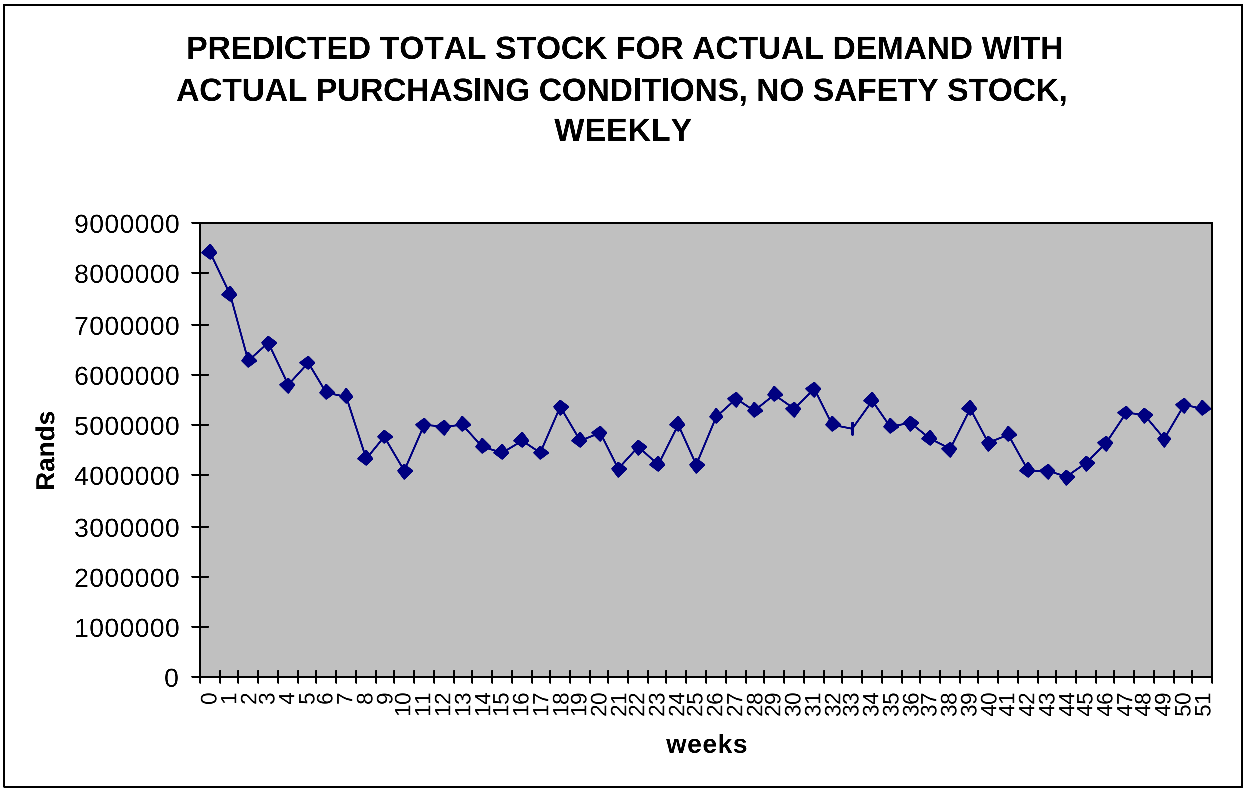


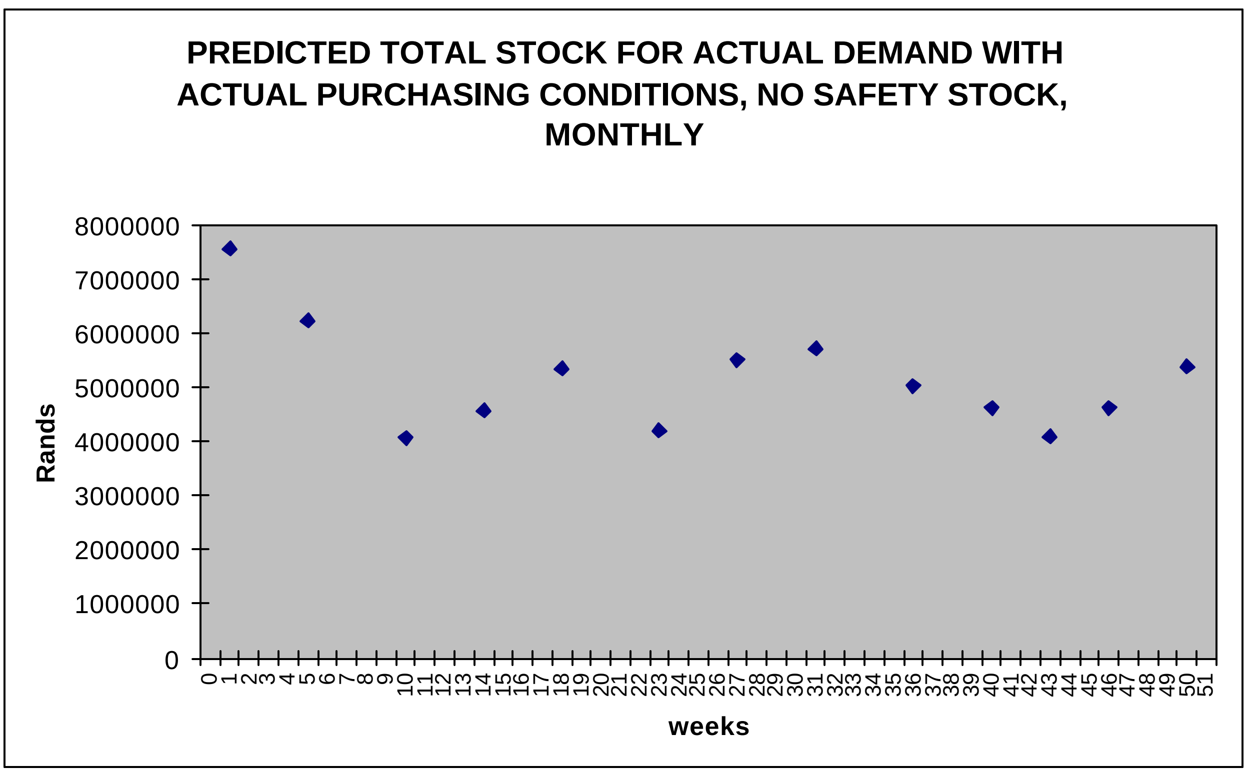
ANNEXURE 22: EXPECTED TOTAL STOCK VALUES BASED ON ACTUAL DEMAND AND ACTUAL PURCHASING CONDITIONS



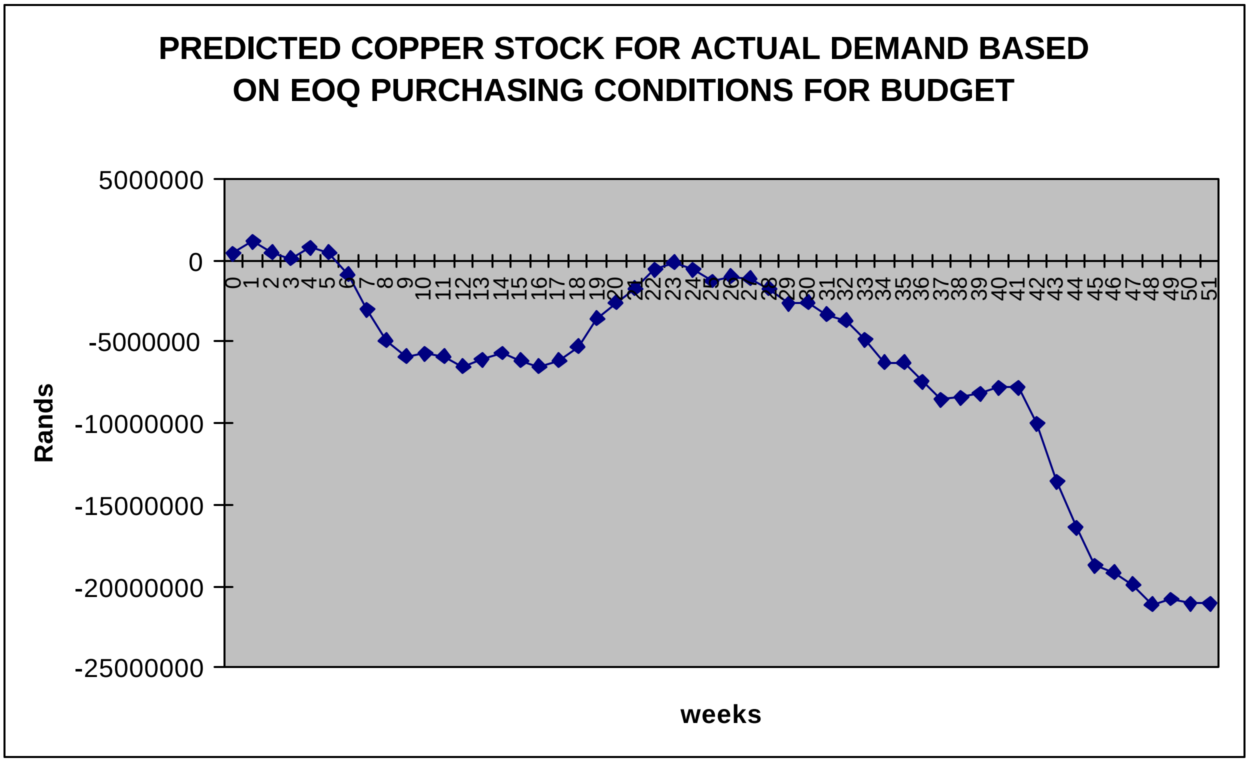


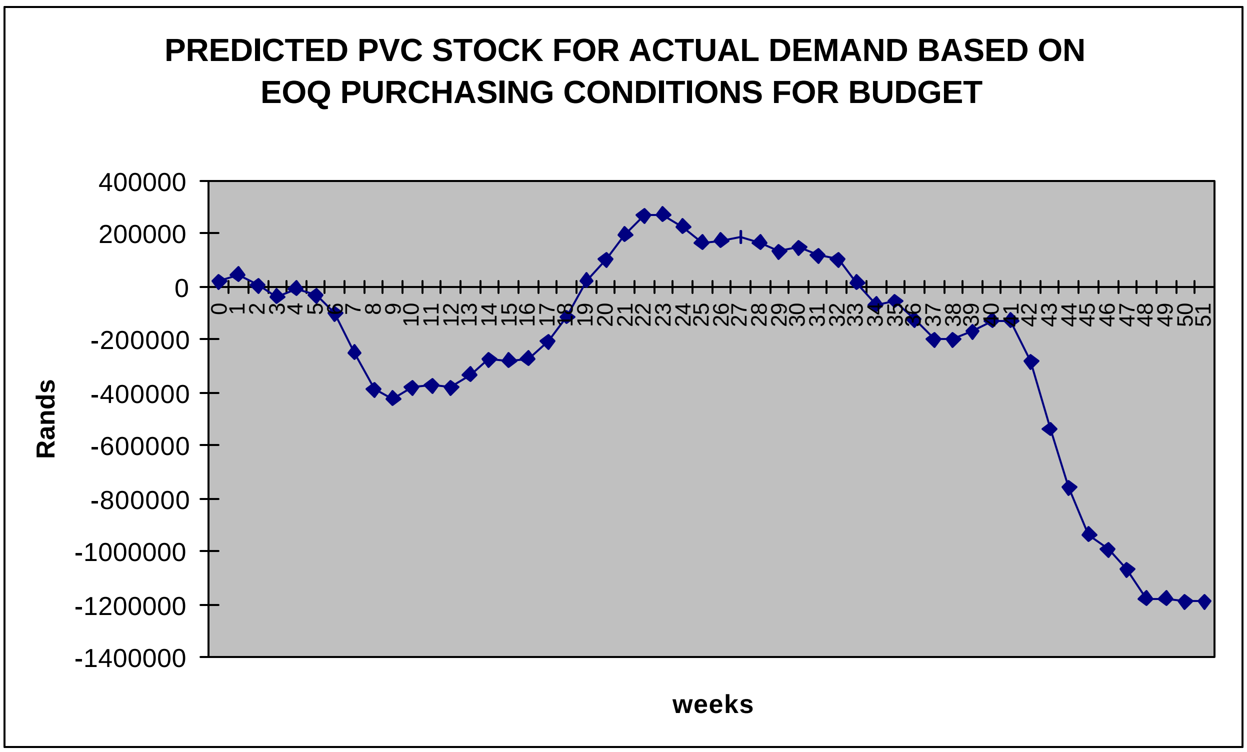
ANNEXURE 23: EXPECTED TOTAL STOCK VALUES BASED ON ACTUAL DEMAND AND ACTUAL PURCHASING CONDITIONS WITHOUT SAFETY STOCKS



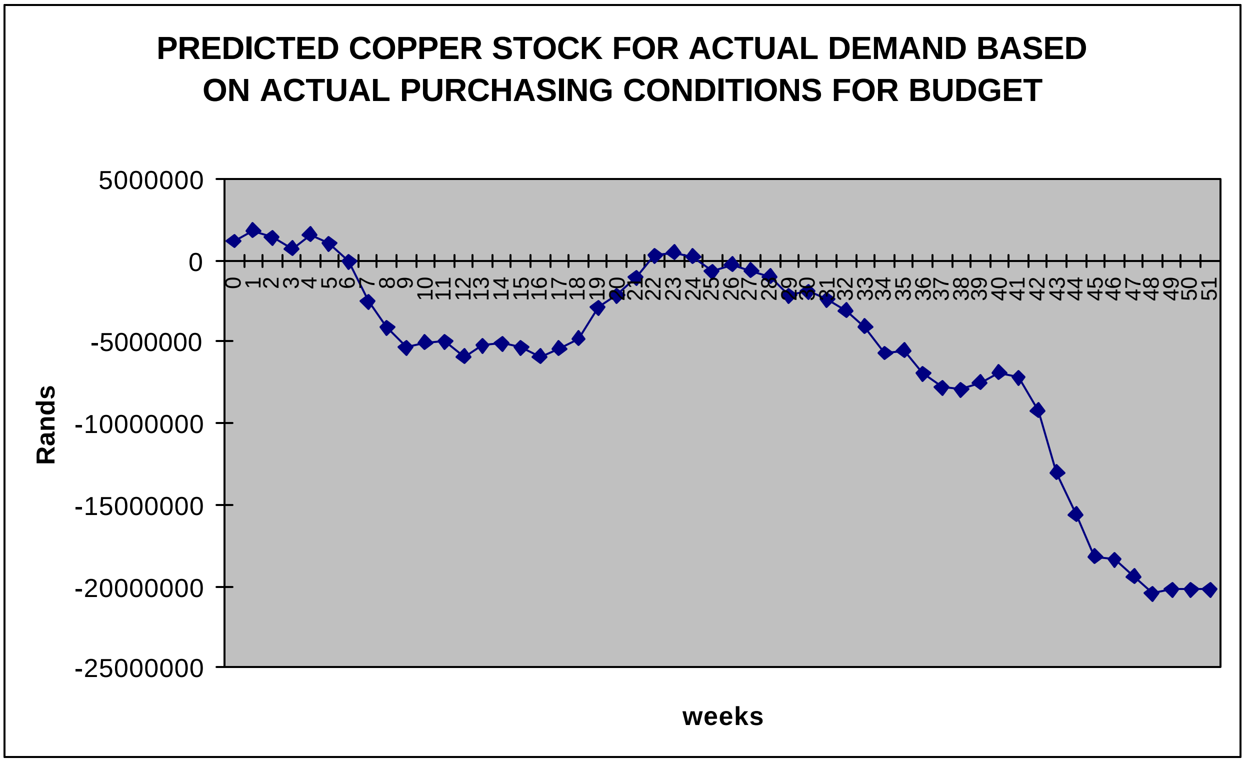


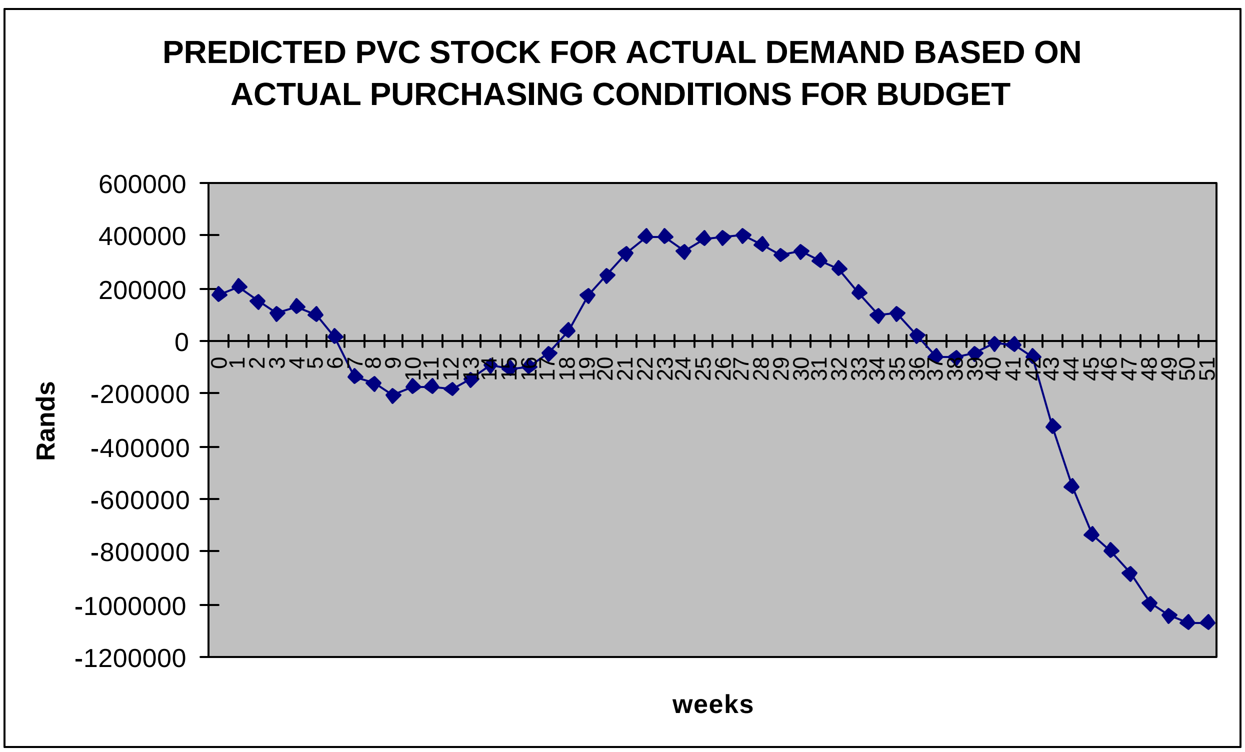
ANNEXURE 24: EXPECTED STOCK VALUES FOR COPPER AND PVC BASED ON BUDGET EOQ CALCULATION WITH ACTUAL DEMAND



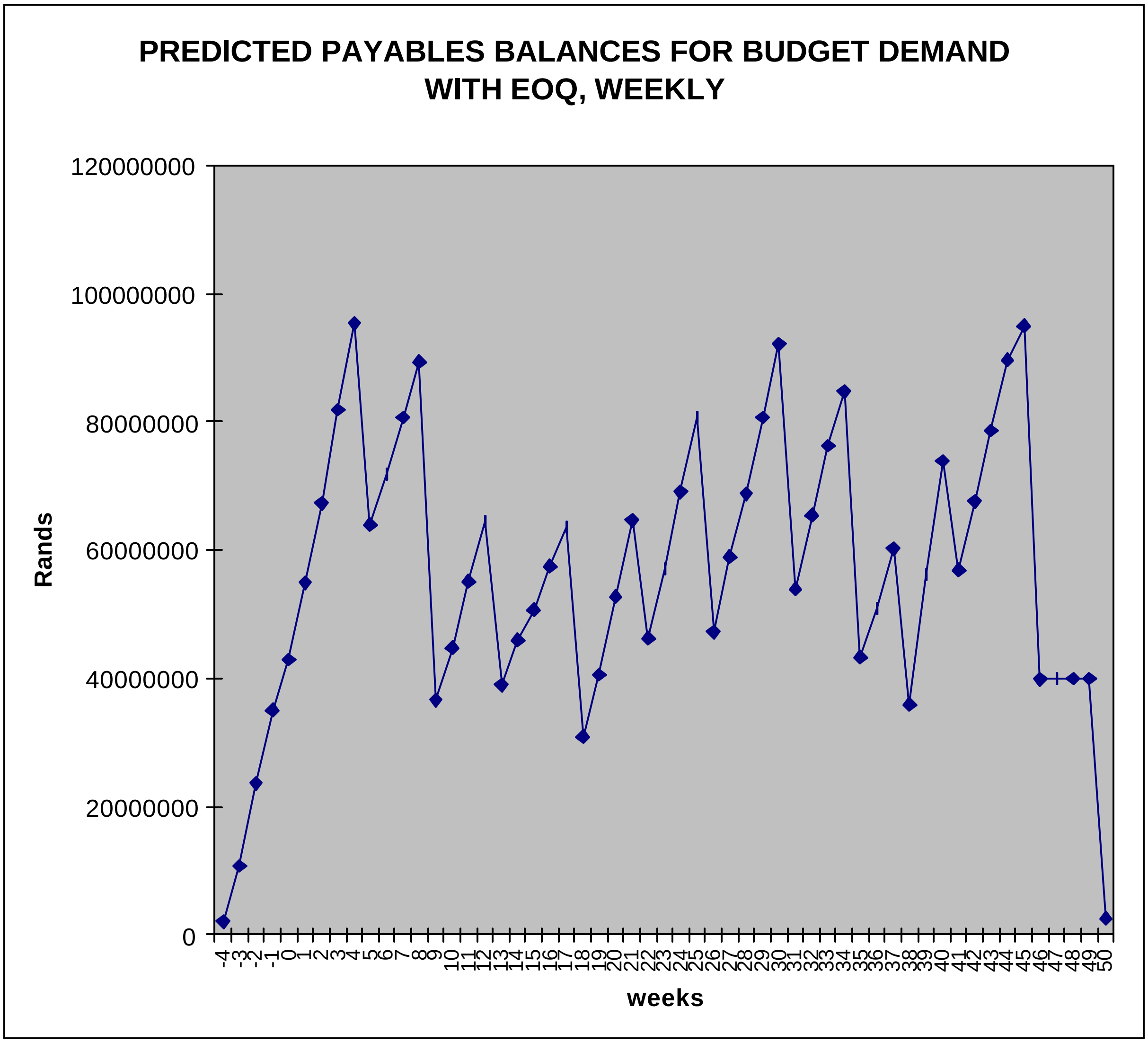


ANNEXURE 25: EXPECTED STOCK VALUES FOR COPPER AND PVC BASED ON BUDGET CALCULATIONS FOR ACTUAL PURCHASING CONDITIONS WITH ACTUAL DEMAND

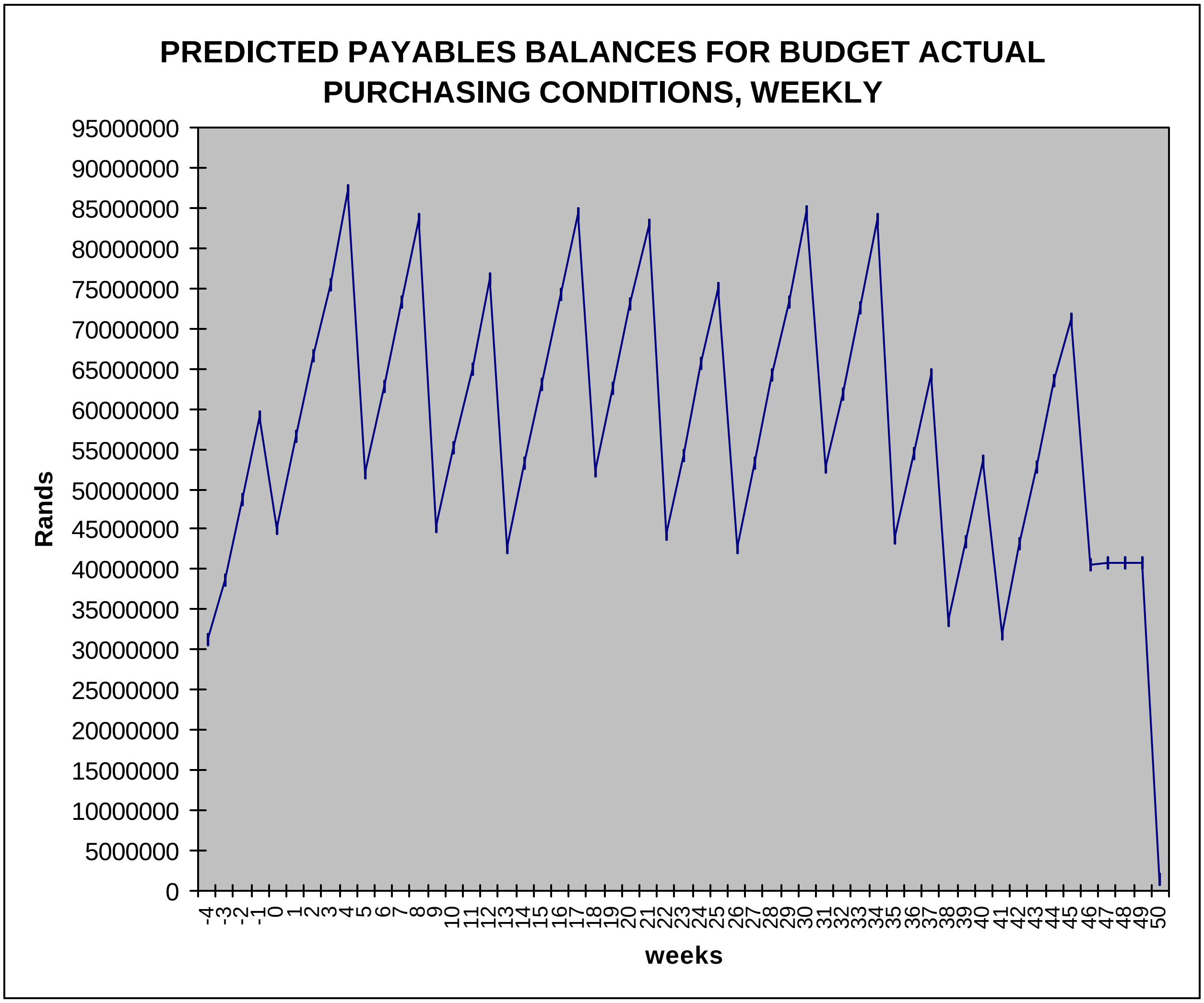




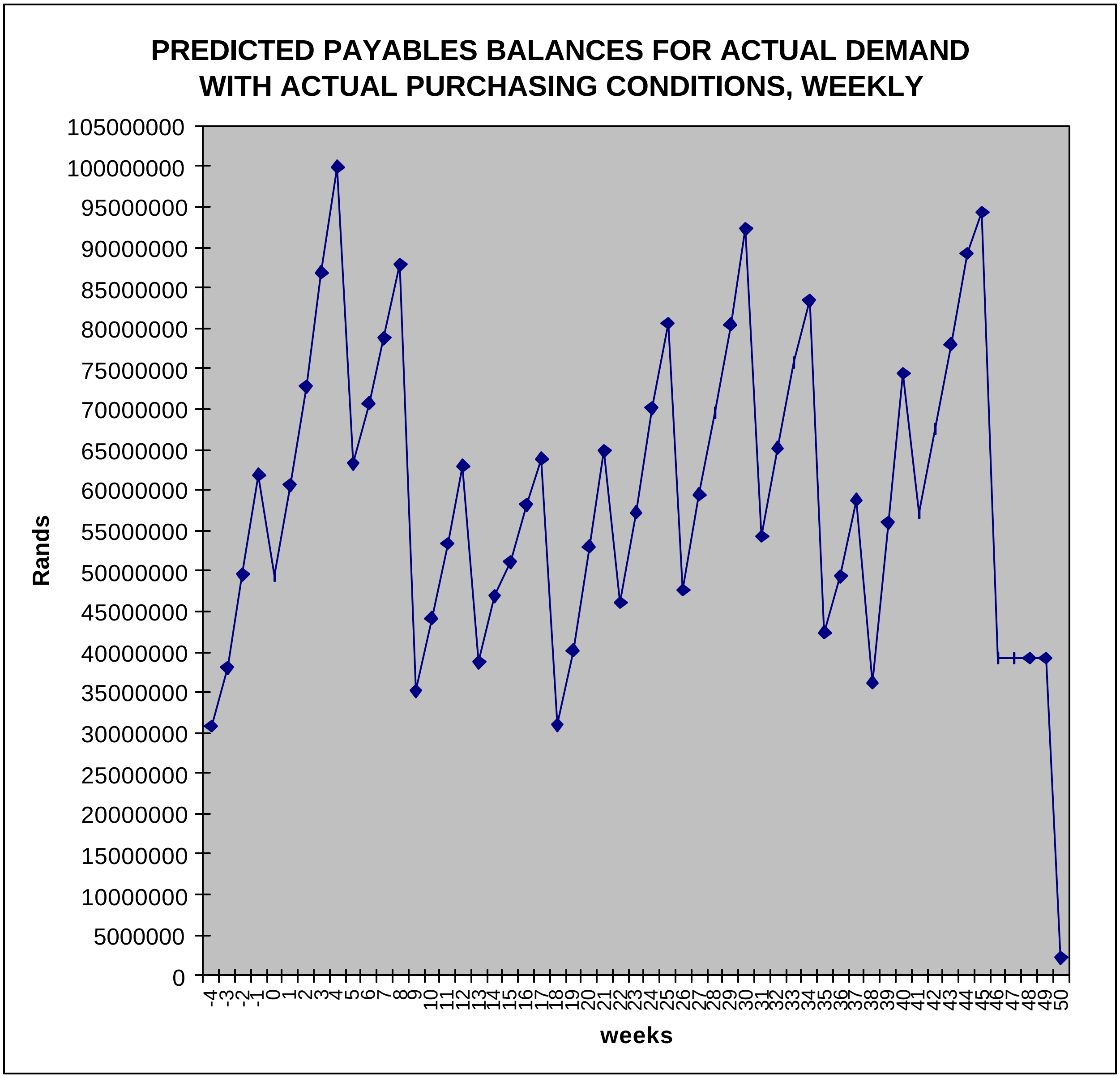
ANNEXURE 26: EXPECTED ACCOUNTS PAYABLE VALUES BASED ON BUDGET DEMAND AND EOQ



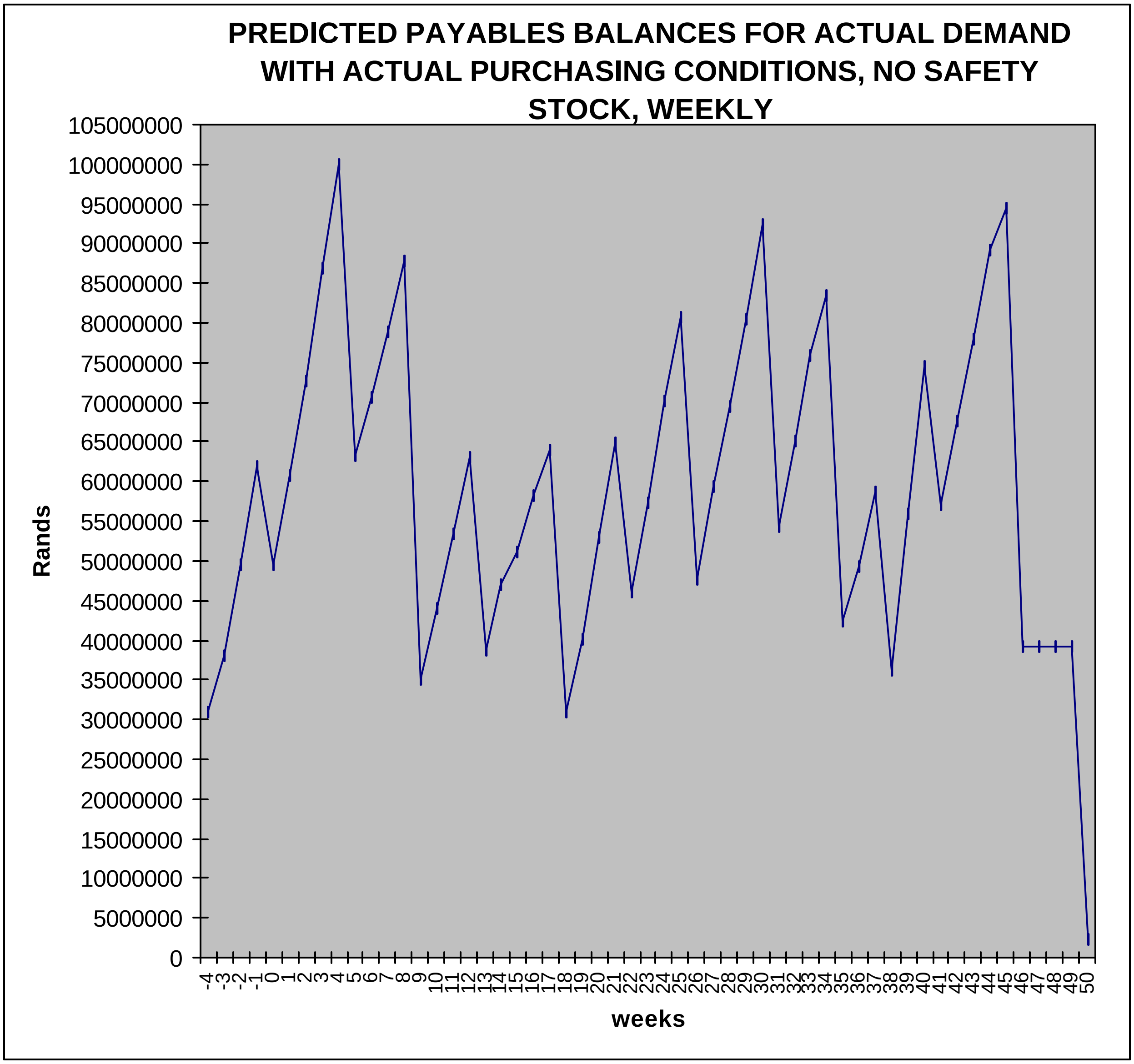
ANNEXURE 27: EXPECTED ACCOUNTS PAYABLE VALUES BASED ON BUDGET DEMAND AND ACTUAL PURCHASING CONDITIONS



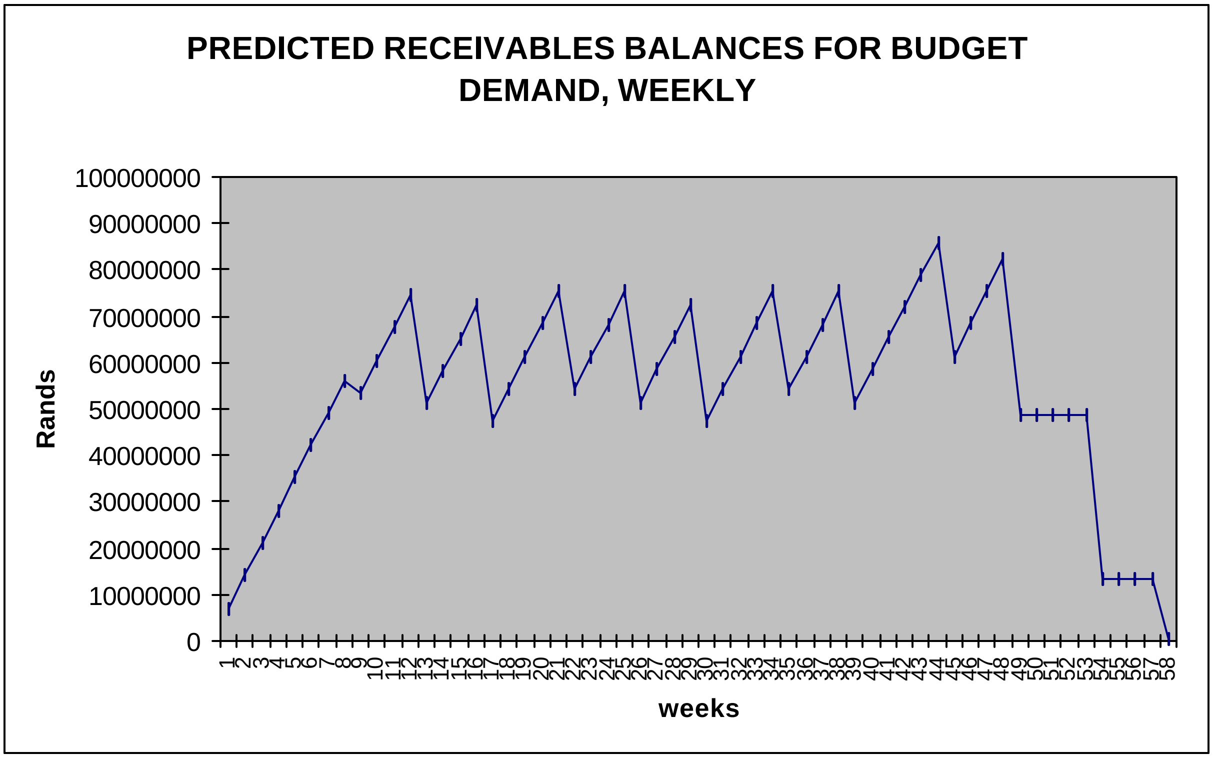
ANNEXURE 28: EXPECTED ACCOUNTS PAYABLE VALUES BASED ON ACTUAL DEMAND AND ACTUAL PURCHASING CONDITIONS

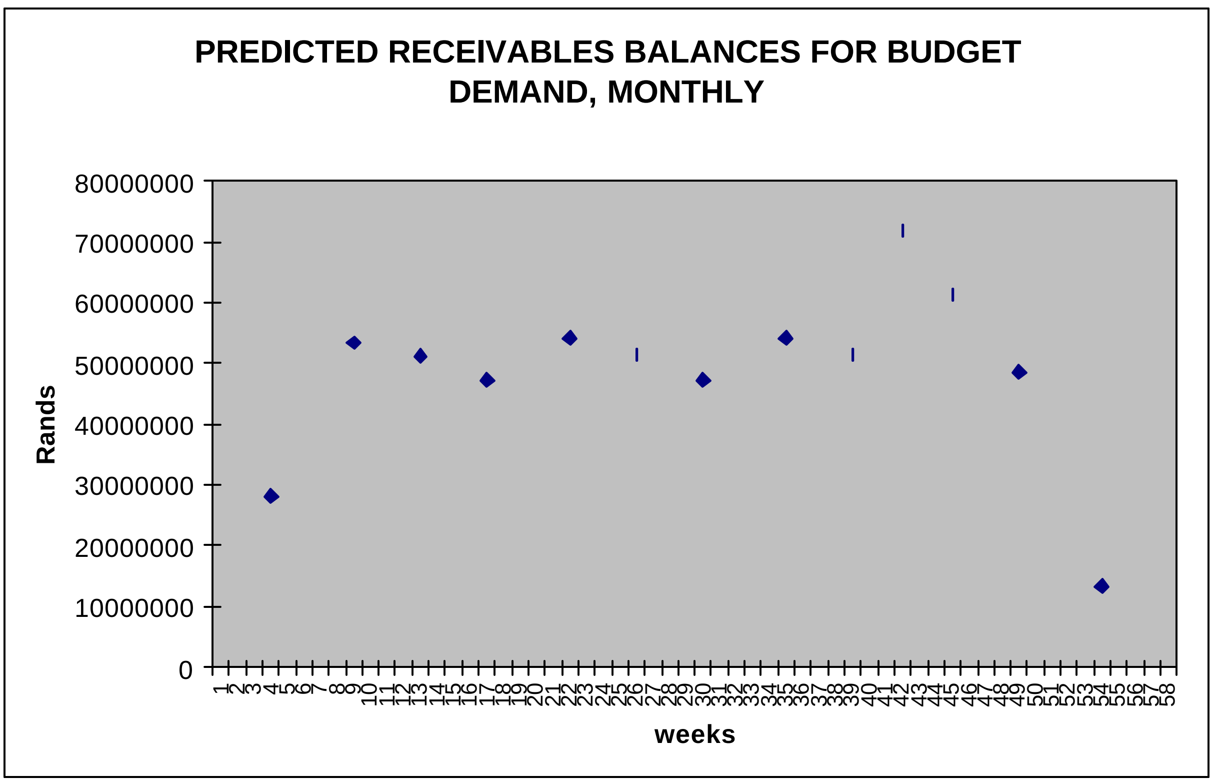


ANNEXURE 29: EXPECTED ACCOUNTS PAYABLE VALUES BASED ON ACTUAL DEMAND AND ACTUAL PURCHASING CONDITIONS WITHOUT SAFETY STOCKS

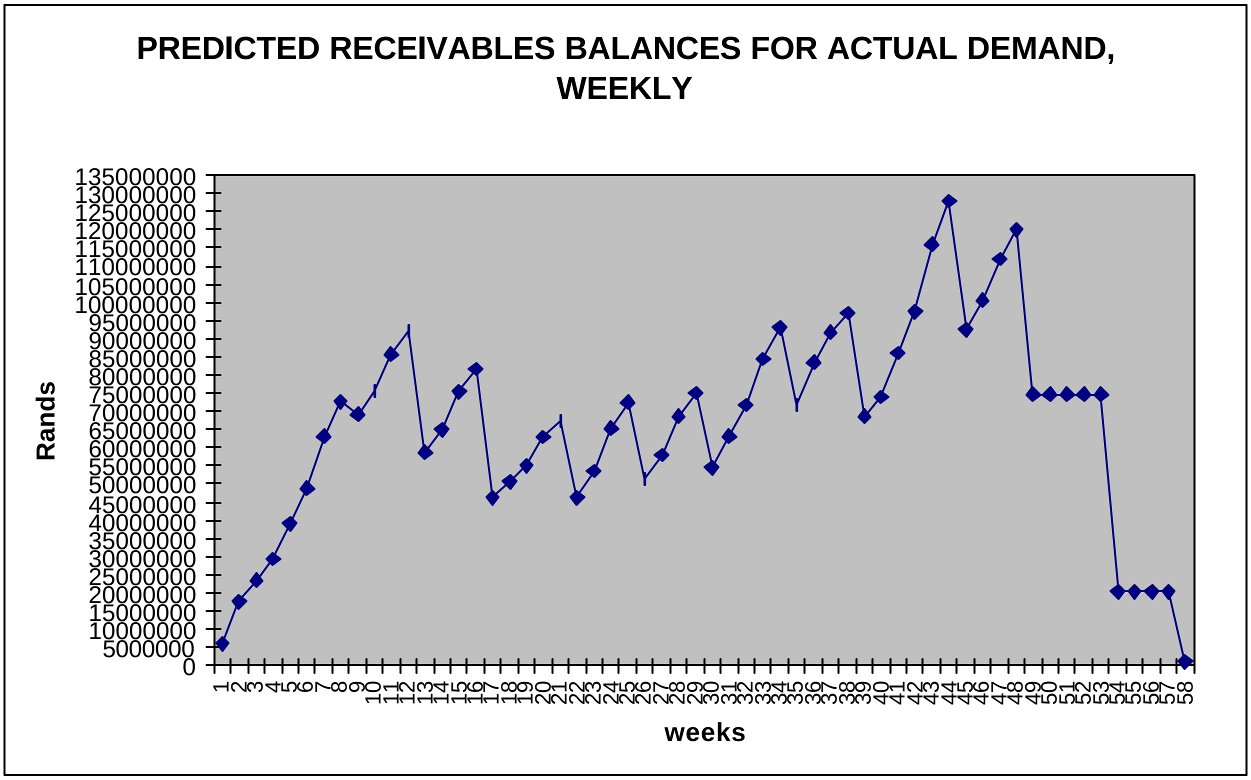


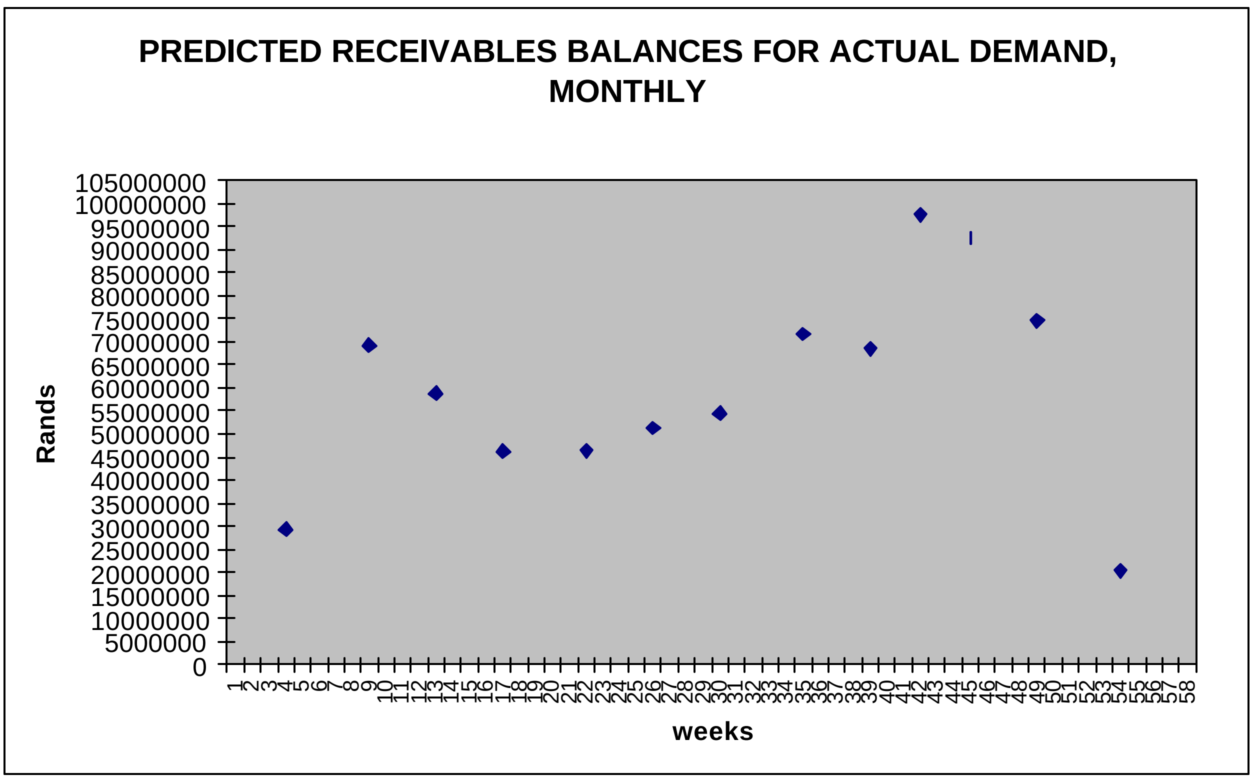
ANNEXURE 30: EXPECTED ACCOUNTS RECEIVABLE VALUES BASED ON BUDGET DEMAND



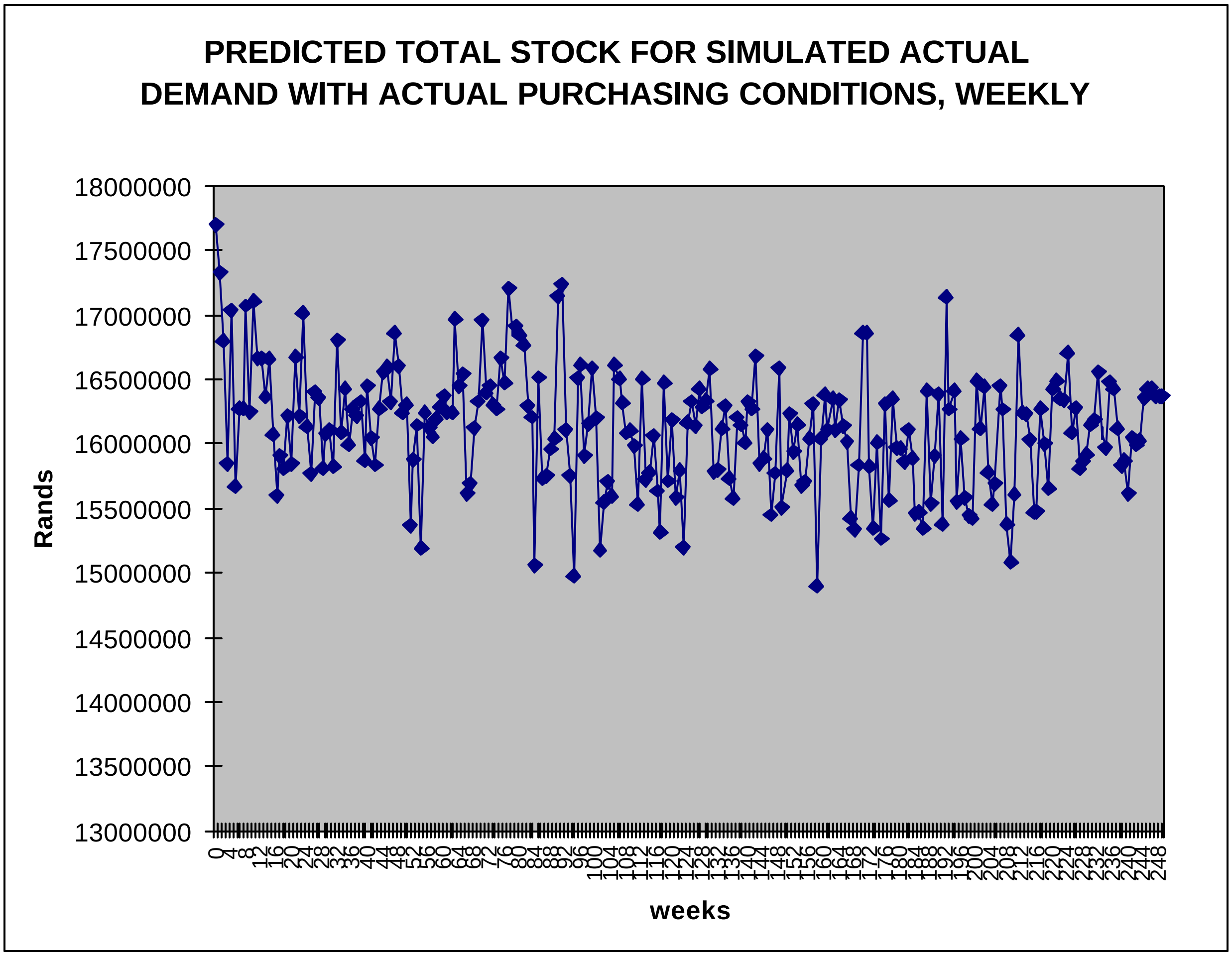


ANNEXURE 31: EXPECTED ACCOUNTS RECEIVABLE VALUES BASED ON ACTUAL DEMAND

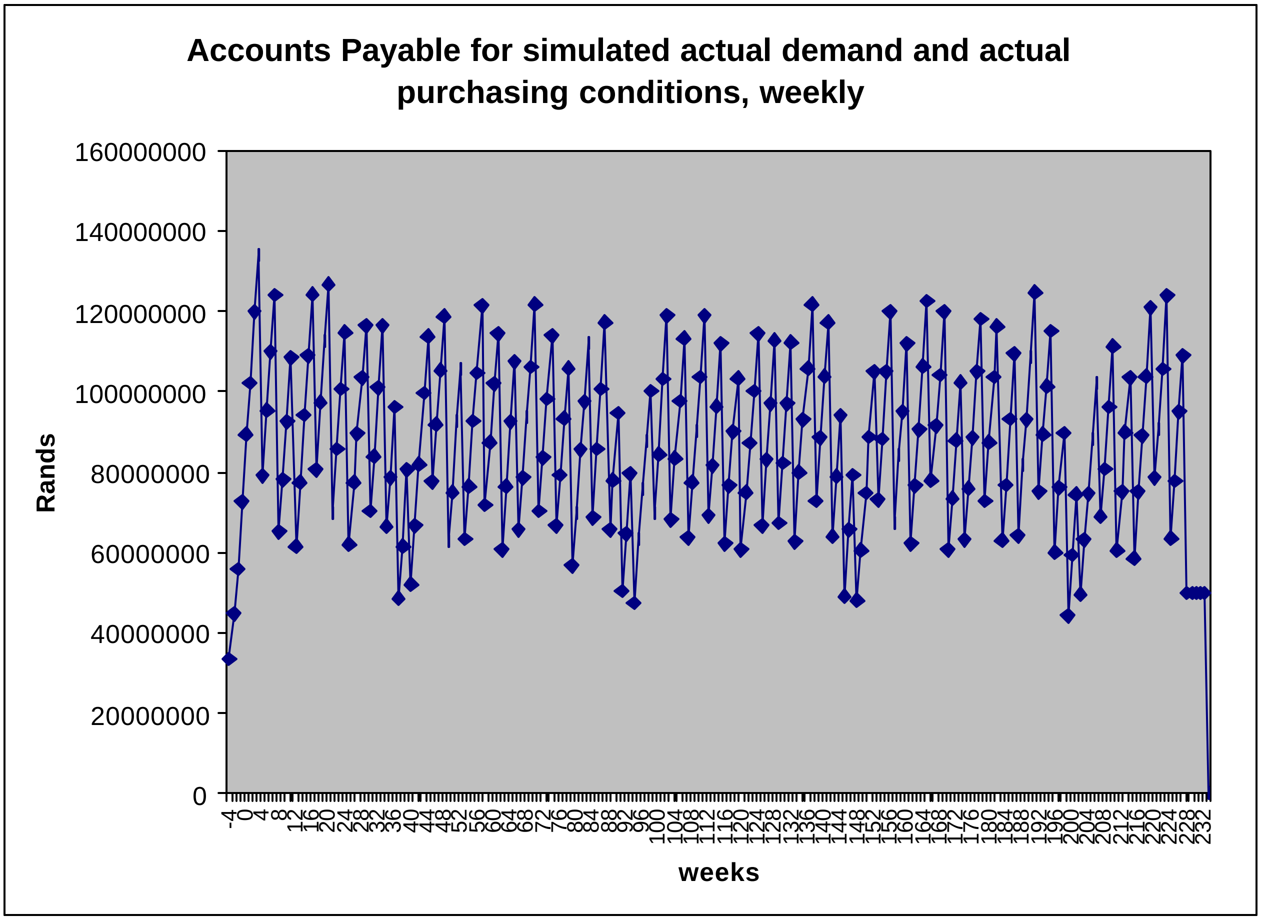




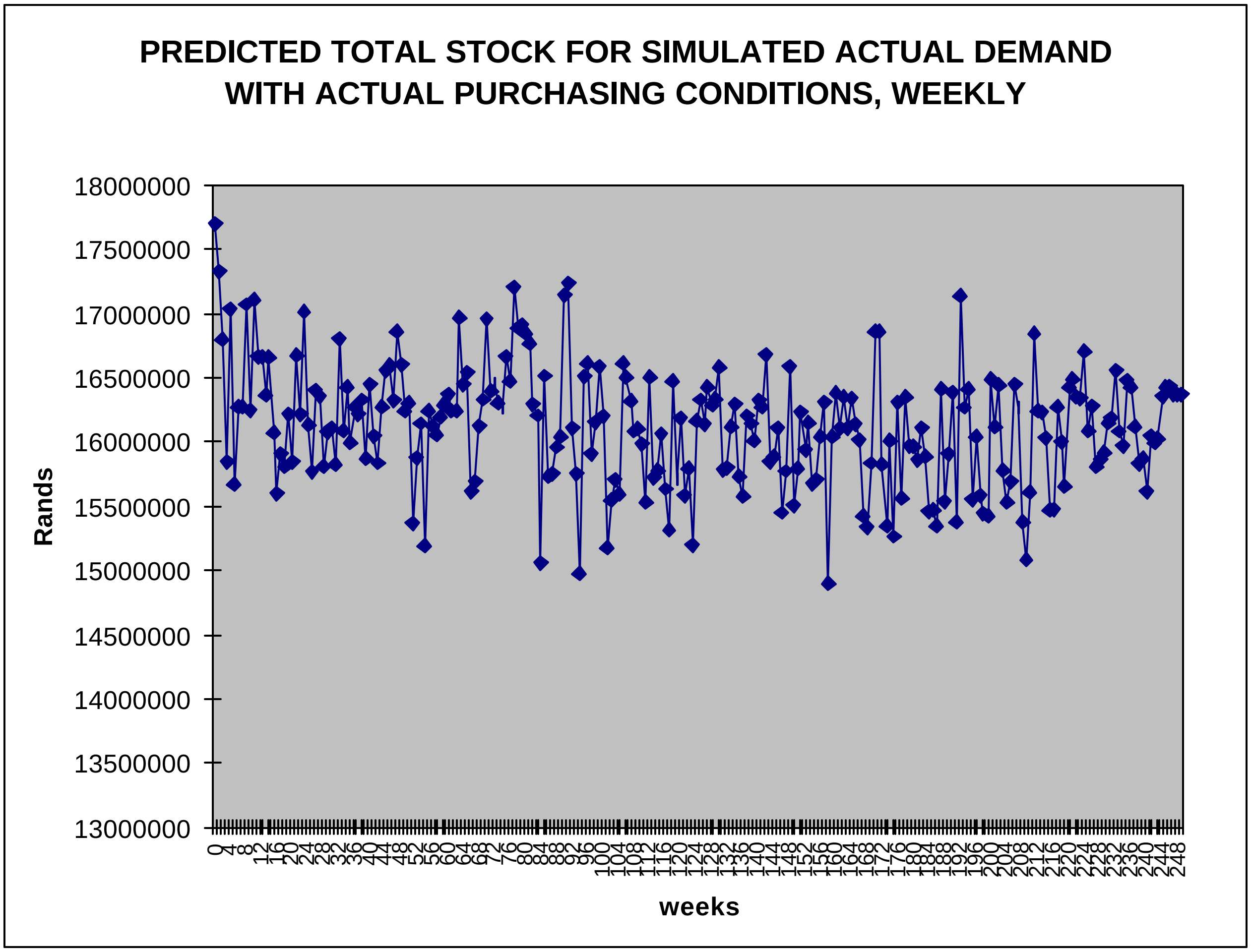
ANNEXURE 32: EXPECTED TOTAL STOCK VALUES BASED ON SIMULATED ACTUAL DEMAND AND ACTUAL PURCHASING CONDITIONS



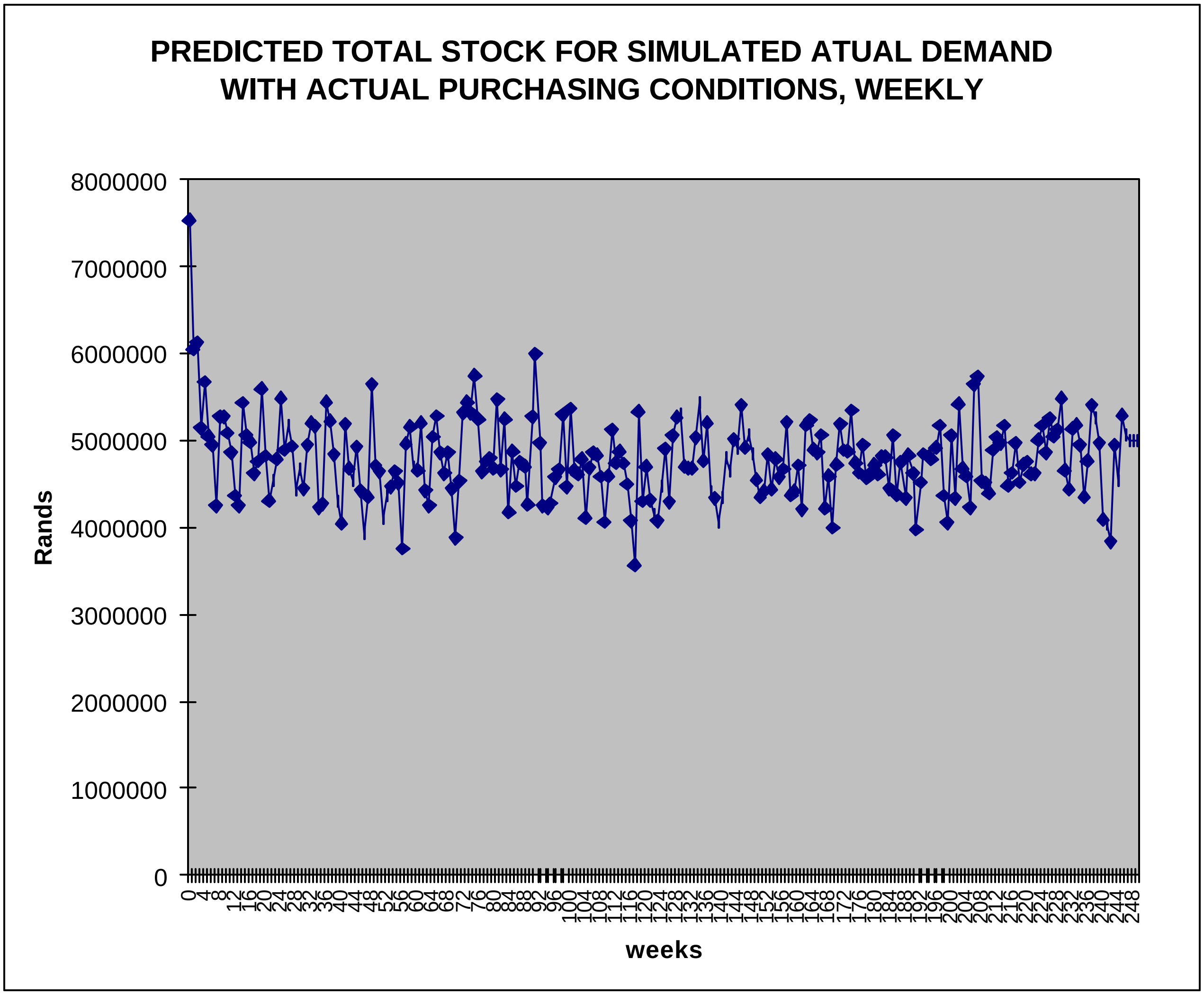
ANNEXURE 33: EXPECTED ACCOUNTS PAYABLE VALUES BASED ON SIMULATED ACTUAL DEMAND AND ACTUAL PURCHASING CONDITIONS



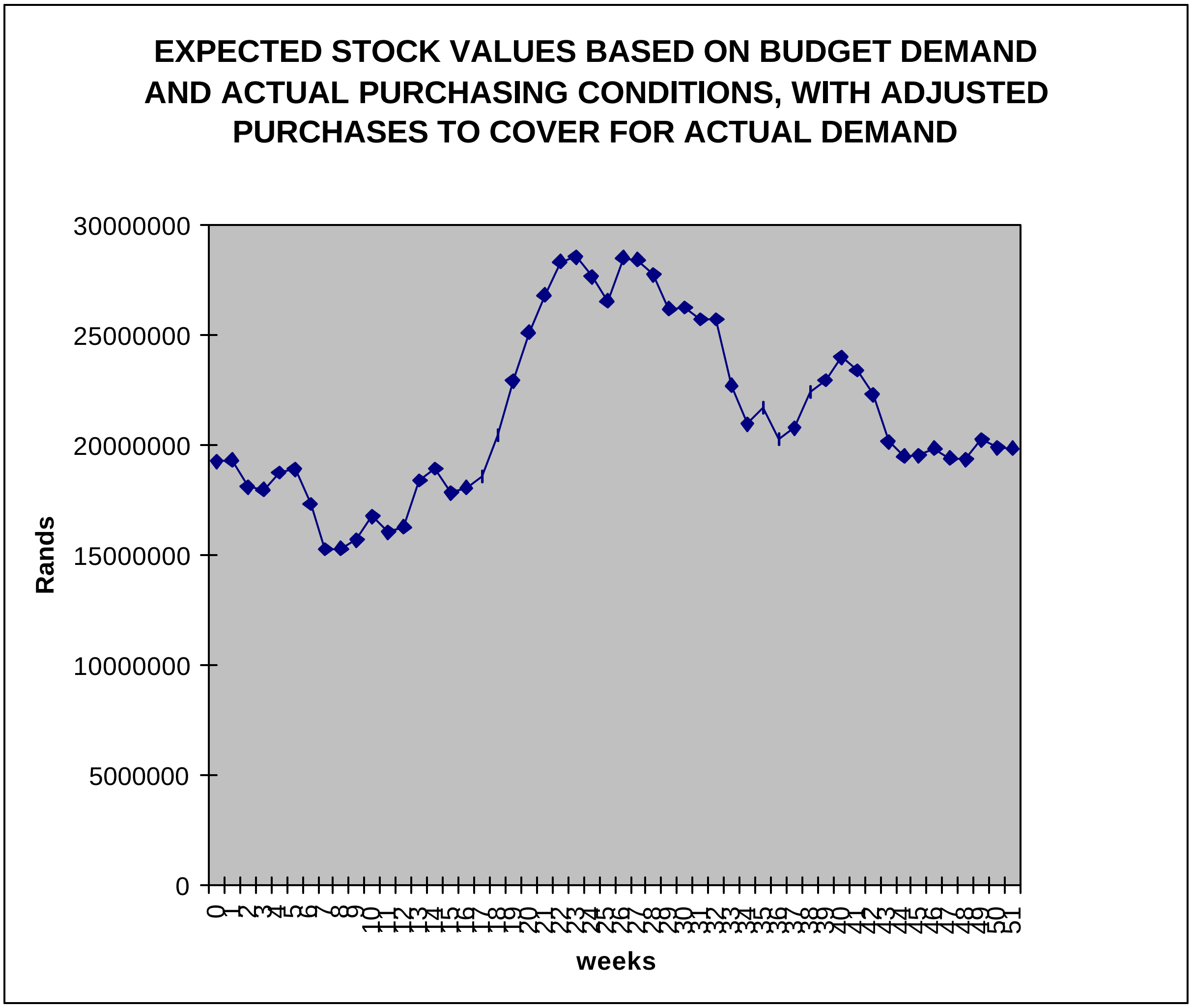
ANNEXURE 34: EXPECTED ACCOUNTS RECEIVABLE VALUES BASED ON SIMULATED ACTUAL DEMAND AND ACTUAL PURCHASING CONDITIONS



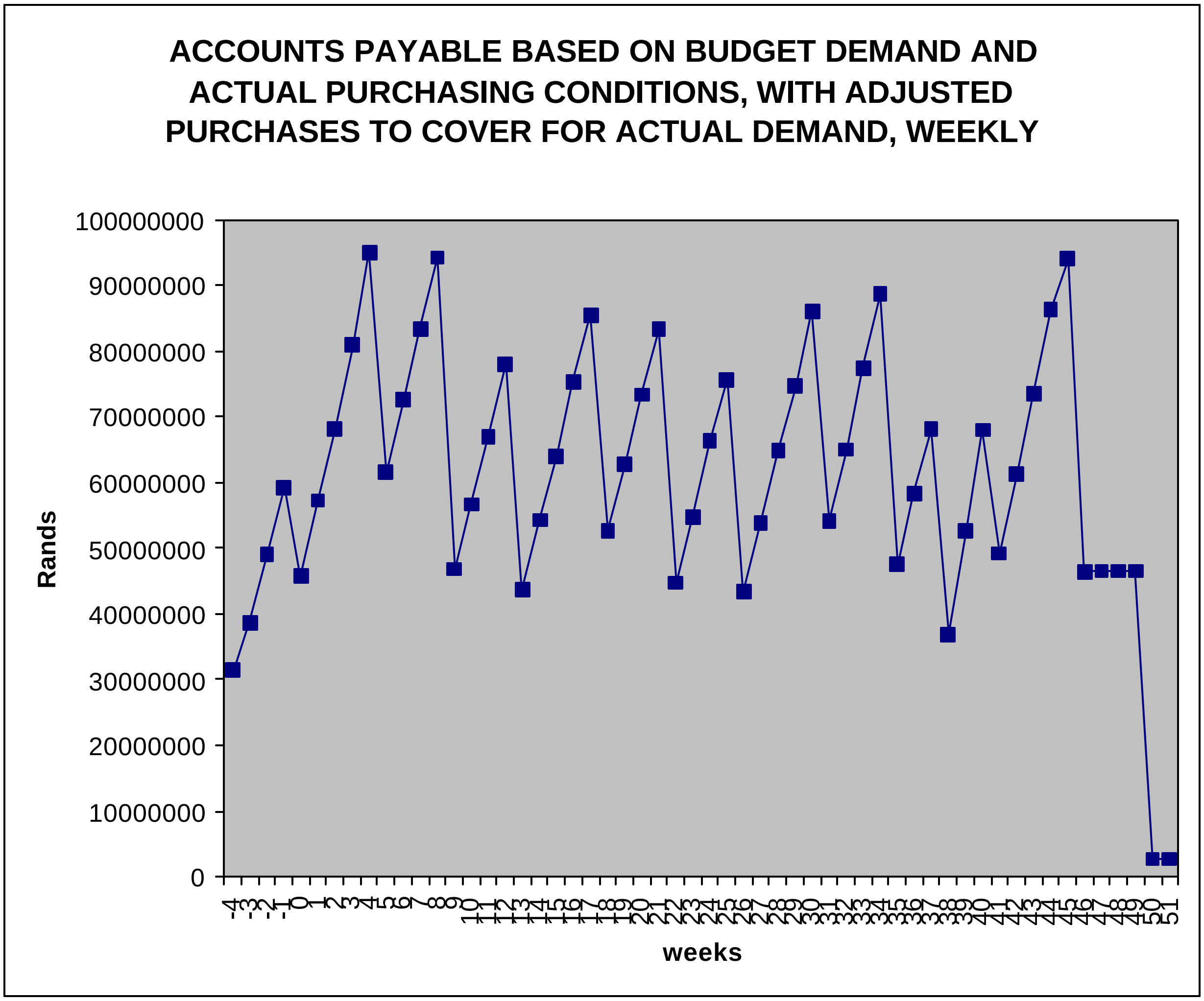
ANNEXURE 35: EXPECTED STOCK VALUES BASED ON SIMULATED ACTUAL DEMAND AND ACTUAL PURCHASING CONDITIONS WITHOUT SAFETY STOCKS



ANNEXURE 36: EXPECTED STOCK VALUES BASED ON BUDGET DEMAND AND ACTUAL PURCHASING CONDITIONS, WITH ADJUSTED PURCHASES TO COVER FOR ACTUAL DEMAND



ANNEXURE 37: EXPECTED ACCOUNTS PAYABLE VALUES BASED ON BUDGET DEMAND AND ACTUAL PURCHASING CONDITIONS, WITH ADJUSTED PURCHASES TO COVER FOR ACTUAL DEMAND


ACCOUNTS PAYABLE BASED ON BUDGET DEMAND AND ACTUAL PURCHASING CONDITIONS, WITH ADJUSTED PURCHASES TO COVER FOR ACTUAL DEMAND, WEEKLY
Rands
weeks
0
10000000
20000000
30000000
40000000
50000000
60000000
70000000
80000000
90000000
100000000