بسم الله الرحمن الرحيم

قل اللهم إني تعبدك واحترم ما أعطيت من نعمة وكرسيت
المهاد إليه رحمة من هيك العلم يعكم وفؤادكم
فيهم لا أعطيتهم الله يطهيرم وما طلقوا منهم شريعة
قلم سلطه الله على مسلم وعمس لا نامسي فلهم

{ من هو الامام }
The souls of the military men who sacrificed themselves to the mother land SUDAN along the hard, old, past and future days. To those who are waiting ready to sacrifice.
To my wife Fatma Dilea and,
my children Ayman, Nazar, Nujud and Bassa.
PRODUCTION OPTIMIZATION OF EL SHAGARA
AMMUNITION FACTORY

"Study and evaluation of El Shagara Ammunition Factory’s organization, structure and production systems. Also alternative suggestions are developed to improve the overall performance of the factory."

A Thesis submitted to the University of Khartoum for master’s degree in Mechanical Engineering.

By

Brig. Eng. Mustafa A. Nagied Salih
B.Sc.
April 1987
PREFACE

The Ammunition factory of the Sudanese armed forces was established in 1960 to supply the army with the necessary ammunition requirement. It has continued to be the sole supplier of all types of ammunition in the country. It was also envisaged to play the secondary but very important role of providing additional services for its workforce, for the rest of the army and for the public at large.

The factory was faced with a number of bottlenecks affecting its performance. A number of problems are identified. These relate to input supply, improved quality, and reliability and reduced overall cost. But all these are organizational factors relating to the main domain of the system. For this reason several merger separation steps were taken within the army factory systems without any clear improvement.

This study looks at the issue in a strict scientific approach aiming to carefully scrutinize and analyze the system and highlight its shortcomings. It also suggests some executable policy recommendations for recovery.

The task was handled through the application of quantitative techniques. Control charts and control statistics being the major part of these techniques.
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GLOSSARY

ADJUTANT
An officer who assists the commanding officer and is responsible for correspondence and for ensuring that his orders are carried out.

ARSENAL
An establishment for the manufacture or storage of arms and military equipment.

BLANK STAR
A cartridge loaded with powder but no bullet.

GRIGLIDE
A large section of an army composed of a headquarters, several fighting units (e.g. infantry battalions or armoured regiments), and supporting units.

BULLET
A small round or elongated missile designed to be fired from a firearm.

CARTRIDGE
A tube of metal, paper etc. “Case” containing a complete charge, a primer, and often the bullet or shot for a firearm.

COMPANY
A unit of soldiers composed of a headquarters and 2 or more stations.
ACKNOWLEDGEMENT

I am particularly indebted to Dr. Elamin El Hussein and Sayed Ahmed El Amin Humaraid who have made my task immeasurably easier and more pleasant by undertaking the most unpleasant and tedious work of reading and checking the sheets and through their own wisdom and knowledge have suggested invaluable ideas.

This study is encouraged and facilitated by the Commanders of Arm HQ who gave leave of absence and to whom I am very much indebted.

It is difficult to select names from among a large number of colleagues and friends. But any list would have to include the factory staff of the Ammunition factory, Dr. Siddig A. Majid, Dr. Ahmed Hamid, Dr. Yahia Issawi, Dr. Mohamed Ali Mansour, Brig. (P.S.C.) Yabda El Zubeir, Managing Director (M.L.C) and the staff, Mrs. Fatuma Digna, Mr. Ali Osman Ali and the Staff of Civil aviation draughtmanship office.

Finally my thanks for typing this work go to Mrs. Mona Mosu.

Muzafa
CHAPTER (1)

INTRODUCTION
1.1 **HISTORICAL REVIEW**

The Ammunition Factory was established in November 17th 1960 as a nuclear for army manufacturing products. Work started as a one line basis of production. In 1964 the second line of production was established. By 1966 four lines of production were established. In 11th July 1970 anniversary day of Ammunition Factory the shot shell plant and training centre have been established which paved the way for the plant to become an independent unit functioning under the direct command of the Army Headquarters. By mid 1970 Osman Salih printing press has been confiscated and merged with Ammunition Factory. The new factory termed "Army Factories No. 69". In August 1972 Army Factories have been merged with the Ordnance Corps under the name "Ordnance Corps". However, in September 1972 the Army Factories no. 69 had been separated from the Ordnance Corps. Once again it was merged with army clothing and equipment stores, and Ordnance Corps.

Finally, in April 1982, Supreme Commander of the army has decided to form a unified army organization on commercial basis. The Ammunition Factory is one of the subsidiary units of the Military Economic Board. However, the factory has been subjected to merger separation practice to fulfill its objective efficiently.

For a large time, the Sudanese Armed Forces has had cooperative corporations. These corporations provide the military personnel
with basic and necessary human needs especially scarce consumer goods. The army also performs some public constructions, such as constructing and renewing roads and provide rescue at time of disaster. The army also provides other complementary services such as maintaining peace and security whenever the police failed to do so. Furthermore, the army participates in executing some development programmes. All this comes under what is called civic action to the civilian societies. Such practice is a norm among all scales of the world. The Ammunition factory as a part of the army is effectively sharing these activities.

The 1980 Factory convention defines the main duty of the Ammunition factory to 'produce different ammunition or varying calibres'. It is a monopoly firm for all types of ammunition. The following are the fundamental products:

- Small arms ammunition Cal. 7.62 x 51 mm.  
  Note: "Army Cal."

- Small arms ammunition Cal. 7.62 x 39 mm.  
  "Eastern" "Army Cal."

- Shot shell Cal. 12" for local market to cover civilian needs "Civilian Cal."

Different types of spare parts and other items for office equipments, hardware and furniture.

In addition, the factory provides some non-military services previously mentioned.
1.2 OBJECTIVE OF THE STUDY

Ammunition factory is the sole supplier of all calibres of ammunition for PAF and other discipline forces such as (police, prison, fire brigades and hunting and fisheries forces and other governmental units). The army invested heavily and introduced considerable incentives to develop the army factories, aiming to satisfy requirements for local consumption and to export finished products.

At present there are factors hindering the attainment of these objectives. For the attainment of these objective it is necessary to set up a system to ensure:

- Prompt and sufficient supply of raw material, parts, and accessories.
- Effective utilization of conversion resources and machines.
- Better product quality and quantity.
- Better machine reliability.
- Adequate information for decision making.
- Efficient coordination system for various production functional areas.
- Lower overall cost.
- Trained and skilled labour force

1.3 METHODOLOGY

This study project aims at finding ways and means of improving the performance of the army factories. This is hoped to be achieved by examining the following areas:-
Organization structure
- Factory location and plant layout
- Quality Control
- Inventory control and purchasing
- Maintenance procedures
- Information and coordination systems
- Cost Account

To identify the salient aspects that influence the production performance and to develop alternative strategies that can be recommended for the arm factories in general and ammunition factory in particular. The proposed new strategies are hoped to reduce the cost to the minimum level possible and enhance productivity.

The methodology followed in the preparation of the best alternatives set up systems for the factory workshops producing ammunition can be classified into several stages as follows:

- Information and data collection and analysis.
- Evaluation of managerial performance and current situation.
- Evaluation of fixed assets.

suggesting hierarchy for the best alternative seen from previous analysis and its suitability to achieve the factory objectives and to cope with the technological advances made in the field of industries and business.

1.4 DATA COLLECTION AND ANALYSIS

The data sets used in this study were of two kinds:
The reader might observe that some chapters are very long and treat diverse aspects of the factory's activities.

Quality control, inventory control and purchasing, maintenance and repair and costing are wide and closely related areas. Each of them is wide enough to deserve a complete and separate research study. Due to the lack of information - the defective data and in some cases show non-existence of basic data; some of our conclusion may lack sufficient statistical support. However, the author hopes that this study will be a fair contribution to the persistent efforts made by assigned supervisors in their pursuit of putting this scheme on the right track leading to success. The new set-up and the proposed systems covering all activities of the factory are necessary to guide individuals in the army factories towards systematic practices. A system must be flexible and adaptable to react with the environmental requirements.

1.6 EVALUATION OF FIXED ASSETS

1.6.1 MACHINERY

The evaluation of existing machinery was carried out taking into account the following factors:
- Date of installation;
- Initial price;
- Actual life;
- Total life;
- Inflation rate; and
- Machinery present condition "process
capability studies has been carried out to assess in machines evaluation.

The present value is estimated according to the following formula:

\[ V_p = V_0 \left(1 + \frac{i}{n}\right)^{n} - c \times \frac{N}{n} \]

When \( n = N \) the value of the machine will be assessed as a comparative figure to the salvage value of the machine.

where:

- \( V_p \): present value in Ls
- \( V_0 \): initial price in Ls
- \( i \): inflation rate per annum
- \( N \): total estimated life
- \( n \): actual life
- \( c \): capability factor taking into account the present condition of the machine and the technological advances as a measure for obsolescence. (Process capability study is covered widely in chapter four and conducted for the first time in the history of the factory within this study).

Inflation rate \( i \) is the sum of the international inflation of machinery prices plus local inflation indicated by the devaluation of the Sudanese pounds.

### 1.6.2 BUILDINGS

Existing buildings of the factory were evaluated at current rates according to the following formula:

\[ V_p = V_r \left(1 + \frac{i}{n}\right)^{n} \]

Where:

- \( V_p \): present value of the building
- \( V_r \): replacement value
- \( N \): total expected life
- \( n \): actual life
the reader may notice introduction of some statistical tools, control charts, process capability study and other advanced techniques.

Chapter five deals with establishing inventory control and purchasing system.
- Depots and stores categorization
- Determination and maintaining the level of stock.
- Introducing adequate forms and cards to control the stock and facilitate the procedures.
- Establishing job descriptions.

Chapter six deals with establishing maintenance department and a proposed approach to the maintenance problems in the factory.
- Organization of maintenance and repair wing.
- Introduction of planned maintenance system.
- Establishment of information systems by introducing adequate forms and cards.

Chapter seven deals with costing formula and records whether reflecting actual cost and being informative to production cost control. Incentive plan and operative training to reduce labour turnover.

As this was the first time in the history of the factory that no such study has been carried in the factory to ascertain per unit cost. Unfortunately, the outcome of the study revealed that the factory is working at a loss.
The number of units to be produced at B.E.P. should be:

**B.E.P. in units:**

\[
\text{B.E.P.} = \frac{\text{Fixed Overheads}}{\text{Selling price per unit} - \text{Variable cost per unit}}
\]

Or in sales value:

\[
\text{B.E.P.} = \frac{\text{F} \times \text{S}}{\text{S} - \text{V}}
\]

Where:

- \( S \) = Sales
- \( F \) = Total Fixed cost
- \( V \) = Variable Cost

In the case under study:
The selling price is less than the variable cost so under all circumstances the factory cannot break even unless either increasing the selling price or reducing the variable cost.

Chapter eight gives brief conclusions and recommendations. It also outlines the way these recommendations might be implemented, followed by references and appendices.
CHAPTER (2)

ORGANIZATION AND RE-ORGANIZATION OF AMMUNITION FACTORY
2.1 INTRODUCTION

The objective of this study is to derive an optimum organization structure to the Sudanese Armed Forces ammunition factory. The study consists of three sections, section one outlines the main features of the ammunition factory. This section describes and analyses the existing organization of the ammunition factory. To form a base for the suggested, improved and efficient organization. Section two discusses the previously approved organization. While section three presents the appropriate proposed organization.

Also, there was a proposed organization for the ammunition factory. This organization will also be studied from there a new and appropriate organization will be suggested.

2.2 THE AMMUNITION FACTORY OBJECTIVES

The main objectives of having an ammunition factory can be classified into two major groups; the primary and the secondary objectives.

2.2.1 PRIMARY OBJECTIVES

To maintain stable level of production rate, at the best economical level and adequate quality conform to the specification. The volume and the type of production are shown in the table below.
Type of small arms ammunition: remark

<table>
<thead>
<tr>
<th>Cal. 7.62 x 51 mm NATO</th>
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<th>used by PAP and other discipline forces</th>
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<td>Cal. 7.62 x 51 mm Russian</td>
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<tr>
<td>Shot shell Cal. 12&quot;</td>
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Main community and social obligations, such as:

The factory has to participate in military operations, internal security and daily guards.

The factory participates in social activities to the civilian community when ever it is necessary.

Protection and enhancement of the human and physical resources of society.

Satisfy personal objectives of the members of the factory such as:

Profits
Salaries and other compensation for executives "officers"
Wages and other compensation for employees "N.G.O.S."

To recruit and train highly qualified technicians.
To operate the factory efficiently.
2.2.2. SECONDARY OBJECTIVES

To provide some requirements of the P.A.F., other disciplined forces and other government organization with spare parts and some hardware industries.

Economy and effectiveness of operation in meeting the primary objectives.

From these objectives, a specification of necessary functions to accomplish these objectives was developed. These responsibilities are stated in the existing organization.

2.3. THE EXISTING ORGANIZATION

Ammunition factory is functioning under quarter-master general through logistic branch and Ordnance Corps command. Responsibilities assigned to each manager are specified as follows:

2.3.1 FACTORY MANAGER

Being responsible to the Ordnance Corps commander for commanding the factory.

To carry out the policies of ammunition factory as directed by H.O. quarter master general.

To train technical and military staff in the factory.

To ensure that the planned Training programs are carried out properly.

To establish factory defence project.

To execute any other responsibilities and duties as directed by high level of command.
2.3.2 **FACTORY DEPUTY MANAGER "2IC"

Carry on all factory manager's responsibilities in his absence.

Execute all responsibilities and duties as directed by the factory manager.

2.3.3 **OPERATION AND TRAINING ADJUTANT**

Being responsible to the factory manager for military operation and training activities.

To execute military operation and training programs as directed by H/O training and operation branches.

Prepare the annual proposal of operation and training programs.

Undertake procedure and routine work concerning nomination of officers and N.C.O.S.

Liaise with any other training institution to get specialized and technical courses.

2.3.4 **ADMINISTRATIVE AND SUPPLY ADJUTANT**

Responsible of clerical and routine work of the factory administration.

Responsible of ration of N.C.O.S. and soldiers and transport of factory force and supply.

Responsible of general management and services.

To report about all activities concerning boards of inquiry.

Supervision of canteen and H/O company activities.
2.3.5 **MORALE ORIENTATION ADJUTANT**

Create cultural cadres
Be responsible for religious lectures
Distribute H/C morale orientation publication.

2.3.6 **SECURITY OFFICER**

To establish a system capable to secure:-
Officers, N.C.O. S. and soldiers
buildings, assets and products
information and documents.
conferences
Supervision in foreigners and civilians visits to the factory.

**ASSISTANT MANAGER FOR PLANNING**

Be responsible to the factory manager for coordinating the activities of purchasing and stock control.

Liaise with the Headquarters procurement and financial affairs branches to receive the manufacturing requirements and supply.

Handle all depots problems.

Prepare the annual budget of the factory.

Advise on financial position of the factory.
Buying some raw materials, parts and other from the local market on behalf of the ammunition factory.

Keeps contract documents specifying type of items, quantities, quality, delivery equipment and other relevant factors.

2.3.8 ASSISTANT MANAGER FOR MANUFACTURING

be responsible to the factory manager for all activities of the factory production departments.

These departments include:-

2.3.9 TRAINING CENTRE

To examine nominees before and after attending training courses.

To create technical cadre to run the plants.

To establish technical courses to raise technical standards of the employees.

Held periodical examination to promote employees.

2.3.10 ELECTRICAL AND WATER SUPPLY WIND

Be responsible for power resources either generated from the stand by generator or supplied by national grid.

Be responsible for all wire connection inside the plant.

Repair electrical equipments on breakdown basis.
Connect and maintain all water supply connection.

Store all parts and other items concerning electrical and water supply.

Training of technical cadres in specialist fields for the interest of electrical wing and raise the standards of the specialists.

2.3.11 TOOL SHOPS

Produce tools and spare parts for the plants.

Repair the machines on breakdown basis.

Store the raw materials, tools, and other items concerning the tools shop.

Training of technical cadres in specialist fields for the interest of tool shop and raise the standards of the specialists.

2.3.12 QUALITY CONTROL AND LAB. WING

To ensure the quality of ammunition products.

To inspect the product at different stages of operation, processes before starting the production run.

To store all devices, chemicals and other items concerning quality control and lab. wing.

Training of technical cadres in specialist fields for the interest of quality control and lab. wing and raise the standards of specialists.
Report to the assistant manager for non-conformities and problems concerning quality.

Be responsible for cinema, photo-developing lab, pinocartridges and fire work section.

FACTORY PRODUCTION LINE WINDS

Produce small arms munitions of different types of calibres.

Repair the machines on breakdown basis.

Training of technical staff in specialist field for the interest of production lines and raise the standards of the specialists.

Store some parts and other items.

Appendix "A" fig. 2.1 and 2.2 show the existing organizational structure.

STUDY AND ANALYSIS OF THE ORGANIZATIONAL CHART

Ammunition Factory is functioning under quarter-master general through logistic branch and Ordnance Corps command. As shown in Appendix "A" fig. (2.1)

This vertical chain of communication is very complicated, rigid and slows the process of decision making. The Factory should function directly under the H/O command.

The existing organization consists of a deputy manager. It is worth mentioning
that deputy manager post in all organizations is not an important post and can be eliminated. Deputy manager post is redundant in a sense that he is functionless. Moreover, his role might lead to a great deal of personal conflict and clashes between him and the ranking manager. Any senior manager can act on as a manager in charge. In a nutshell, almost all over the world it is now a general practice to do without a post for "deputy manager".

In general, one would anticipate the organization of such a factory to include essential units such as:

- Statistic, research and development unit.
- Financial and sales unit.
- Inventory department and cost accounting.
- Purchase and procurement unit.
- Maintenance and repair unit.
- Legal advisor.

However, these units do not exist in the existing organization.

The depots which supply manufacturing inputs should have been separated from the assistant manager for planning department.

To produce ammunition efficiently, these depots can form a separate department.
With the exception of the production departments, the rest of the units serve as service units. However, in the last decade there has been an unproportional growth in the service department. That is, a horizontal expansion in the structure of the factory. The usual practice dictates that, the factory expenses allocated to production units should be comparatively higher than overheads. Afterwards, there has been no growth in the production department. On the other hand there has been an increase in the service units. This may increase the overheads, since the production level remains the same, this will result in increasing per unit cost. This horizontal expansion has the following implications:

It weakens the military command of the expanding forces.

Communication and coordination between various units become increasingly difficult to manage.

The growth in the service unit exhausts the limited financial resources of the factory.

The expansion of the service units exerts pressure on the logistics and the necessary inputs required for the productive plant. Hence, the per unit cost of production has increased tremendously. At the same time productivity declined.

The responsibilities of each department are, sometimes, not clearly defined. At
times, when broad functions are stated, there arises the duplication of activities. Moreover, some departments are over-burdened; for example, the logistics-inventory in the plant are handled by the planning department.

The job description is not consistent with the duties. For example, the job title should satisfy the employee in the high commanding level. The assistant manager for planning and production title should be changed to production manager.

The military ranking system is not flexible enough to attract the highly qualified "N.C.O.S.". Ammunition factory or any production plant requires technically-minded personnel to operate and to complement the ever - developing and sophisticated techniques. The factory organization allocates levels of responsibility and authority, and these can have a considerable effect upon one's status or social rank. Other sources of status would include seniority, associates, and education. One can tell much about a person's status in organization by observing such symbols as uniform, desks, rugs, paintings, office location and privileges accorded. If the personal objectives of all groups are not reasonably achieved, the basic objectives of the entire organization will suffer. Consideration of the nature and techniques of fulfilling many of these objectives constitutes a major portion of this research. However, efficiency requires some flexibility, that should be integrated in the organizational structure of the ammunition factory.
These efficiency criteria need to be identified and studied within the scope of this research.

Before discussing efficiency, one would like to elaborate in the historical development of the factory as discussed in the following section.

2.4 MILITARY INDUSTRIAL CORPORATION

**GENERAL**

The initiative came first from the previous deposed President of the Republic who took over as Defence Minister and Commander in Chief of the PAF in April 1982.

The main objectives in this structure was to use surplus resources in the army i.e. personnel and equipments. A study committee was ordered by the previous Supreme Chief of Staff to develop this concept. The organization to be formed should meet all needs of the PAF personnel. Efficiency dictates the full-utilization of surplus resources given the capacity utilization of the army. The organization should meet the following objectives:

1) To improve the economic and social well-being of the PAF personnel.

2) To compete in the local market to reduce prices and meet the increasing demand. To fulfill these objectives the Military Industrial Corporation derived certain objectives in conjunction with their companies and component units.
2.4.2 THE MAIN OBJECTIVES

Initiation and procurement of factories and other industrial establishments related to it, or promotion of joint ventures.

Achievement of self-sufficiency in industrial products for the PAF and general public at reasonable prices.

Surpluses to be exported.

Construction and ownership of buildings and establishments necessary to achieve the objectives of the corporation.

Training of technical cadres in specialised fields for the interest of the PAF and other government units.

Performing any other activities deemed in the interest of the corporation and for the execution of its operations or aid in protecting and preserving its assets.

2.4.3 STUDY AND ANALYSIS

Units and companies are shown in Appendix "A" Fig. 2.3 organizational charts.

The critical analysis of the existing ammunition factory which is decided to integrate with the other factories under the Military Industrial Corporation has been manipulated in the preceding section and the following section. Within the framework of the Military Industrial
organization, some observations will be highlighted:

It was the first time in the history of the Sudan that a military body indulged in the field of trade and commerce. This may weaken the army discipline which is the peculiarity of any military body.

The way in which some objectives are stated carries some discriminatory connotations like objective (I & II) previously mentioned.

This may create some unpleasant feeling between PAF personnel and civilians. Moreover, some words in the statement of the objectives are provocative and may widen the already existing gap between the army and the civilians.

The word surplus is stated vaguely and unclear, i.e. it is not quantifiable in terms of manpower, equipment and other facilities. Given the army, there is neither personnel nor equipment, surplus. Furthermore, no time limit for the use of this surplus is specified.

At the same time, the word does not relate to the fluctuation which are bound to take place during war and peace times.

After March-April revolution, it has been decided to revitalize the army. The author has been ordered to participate in reorganizing the factory along the new revitalization program.
After putting the existing organization into practice for many years, the system is now riddled with shortcomings and limitations. Empirically the system does not work up to the level of one expectation for the following:-

Plus the previously-mentioned shortcomings in the previously mentioned section under the heading (study and analysis of the organizational chart). Even when the ammunition factory in the approved organization which is not implemented yet. It is functioning directly under the Military Industrial Corporation. This may give it more flexibility and allow for maximum autonomy but on the other hand, it weakens the discipline by influencing in the field of trade and commerce.

The formation of the army factories is a true application of the words which had been stated in the previous constitution of the Sudan that, the PAF is one of the five forces of alliance of working people. The army is a productive unit and should add to the national product during peace time using all its resources to offset the expenses of the army budget.

For the above precedents, an attempt to improve the organization of the ammunition factory is shown in Appendix "A" fig. 2:4 to 2:7 - The proposed organizational chart for ammunition factory.
A PROPOSED ORGANIZATION FOR THE ARMY FACTORIES

Ammunition factory objectives and responsibilities are stated earlier.

The army factories consist of:
- Director General
- Operations and training directorate
- Administration directorate
- Planning, research, coordination and development directorate
- Technical affairs directorate
- The Integrated factories

Appendix "A" fig. 2:4 to 2:7 show the proposed organizations.

The proposed structure is based on the following concepts and principles:

To assure that the objectives are accomplished efficiently with a reasonable expenditure of money and effort.

To meet the defined responsibilities and security measures.

Proposed organization must minimize the cost of production.

Administrative units having similar tasks, duties "same nature of work" should function under one administrative department. "Similar functions grouped together". Blending the parts together into a unified whole that can operate effectively.
To ensure the ideal vertical and horizontal communication and to reduce the span of control.

To avoid shortcomings of the previous organization plans.

To plan for future growth and expansion.

Other principle applicable to responsibility are:

There should be no overlapping responsibilities, the same function should not be assigned to two or more persons.

Responsibility limits should be clearly defined.

There should be no gaps in responsibility.

Assignments work that should be done must be assigned to some person.

Responsibility should not be assigned for work that is unnecessary and does not contribute toward organization objectives.
3.1 INTRODUCTION

This chapter attempts to describe some of the better-developed analytical methods and discuss their specific application to the existing plant layout problems. They should be clarified in order to facilitate further discussion. The study has been made to provide with sufficient background and understanding of the existing layout with effective evaluation plan to highlight the factors that are most important in a given situation.

A survey of the existing buildings is made to ascertain facts regarding their construction, positionin of buildings and machines arrangement. The shortcomings that are arisen will be noted in the initial survey inorder that any such repair (remedy) can be completed along with the alterations that will take place when the new layout is installed in the future extension if any. the existing location and layout will not allow for radical change. However, it is not advisable to make changes in the existing arrangement of the lines and buildings.

EXISTING LOCATION AND SITE

The factory is located at Elshagaga area. It is surrounded, eastward by Jabal Aulia Highway, westward by Fisharies and research centre and the White Nile, southward by two residential area (Wad Agin and...
area is land from the north by the outskirts of the Shagura area. This site satisfies the best location conditions. A number of conditions can lead to the consideration of the plant location problem. These conditions are summarized in a comprehensive listing of factors that must be considered in selecting any plant site:

(i) Area
(ii) Provision for expansion
(iii) Communication and transportation
(iv) Human resources and wages
(v) Power supply
(vi) Climate and working conditions
(vii) Water and waste

3.2.1 AREA - PROVISION FOR EXPANSION

The total area allocated to the factory including future extensions is approximately 400 acres. The occupied area estimated as Acre 23. The site has been provided with wide open space and freedom to expand. There are possible, open land on all sides to allow for future expansion if desirable. Plant expansion will take place horizontally by adding a wing to any single story building, and it is possible to add a complete factory or more toward the north of the existing factory.

(Appendix "S" fig. 3.1 shows the factory layout).

3.2.2 COMMUNICATION AND TRANSPORTATION

The ammunition factory is an independent military entity. The finished product of the factory is delivered to Ordnance Corps. The Ordnance Corps is responsible
for distributing ammunition to the different army units. At the same time the Ordnance Corps provides the factories inputs such as raw material, spare parts and other accessories. These supply is obtained through long chain of arrangements. Starting from Ordnance Corps through procurement branch, logistic branch and quartermaster general.

In the proposed organization the ammunition factory and the other military factories shown in Appendix "A" fig. 2.3 are to be grouped together to form the army factories. The purpose is to ease supply arrangements and distribution strain.

Although some location factors, may be applicable, there is certain unique consideration, when implementing the proposed organization. The problem of dispersion has come to the front since the ammunition factory is a subunit of the army factories which lies in Khartoum north, Caduran, Karrari and other expected dispersed locations. This may complicate the communication and coordination between the different directorate and the subunits of the army factories. Otherwise El Shagara ammunition factory location is quite suitable.

The following transport facilities are available to the factory:

Railroads
The railway line is one km from the factory.
WATER CURRATURES

The factory is adjacent to the White Nile just about 200 meters east of it. However, this resource has not been fully utilized yet.

HIGHWAY

Gabel Awlia highway is one of the best paved roads in the national capital. Recently, it has been maintained by a Korean Construction Company.

AIR TRANSPORT

Khartoum airport is approximately 15 km away from the factory.

TELECOMMUNICATIONS

The factory is well connected with telephone lines, there is also an independent telephone system within the factory. This unit provides telephone services to factory through single corps microwave network.

The army headquarters provides other telecommunication services.

1.2.3 HUMAN RESOURCES AND WAGES

El amgara and Kalaklat are congested residential areas with the majority of the population in the lower income level. This represents a supply pool for potential labour force residing close to the plant. Moreover, rents are among the lowest areas in Khartoum three town with
all water, sewage, electricity and basic health needs available to residents. Hence, there is no problem in hiring unskilled workers at low wages. However, in such a case, the rate of labour turnover is likely to be high. The reader may recall from the previous chapter that one of the main objectives of this study is to minimise the cost of production at the best quality level.

3.7.4 POWER SUPPLY

All machines are electrically powered, until 1970 the main supply from the national electric grid was adequate. However, in the last decade there were frequent power cuts. This unreliable power source resulted frequently in machines breakdown and production stoppages. To avoid these troubles a 650 KVA stand by electric generator was installed in 1983. This generator’s capacity operates the existing plant only. For future expansion another power generator is to be supplied according to the future need.

3.2.5 CLIMATE AND WORKING CONDITIONS

Climate greatly influences human efficiency and behaviour. The climate effect the efficiency of equipment, as well. In the last five years the factory was equipped with three lines of production two for producing cartridges of calibre 7.62 x 51 mm "NATO" and one line for calibre 7.62 x 51 mm "Blankstar". The machines are precise and sensitive to temperature, dust, and humidity. Therefore the lines are installed in a controlled rooms.
However, the atmospheric condition for the working force might not be controllable. ElMaarga lies in a polluted air with dust, "Kinyiti" and mosquitos. These natural conditions create rhana and malaria for the labour and their families who reside in that area. The health problem is very important in the working conditions and the labour turnover.

3.2.6 WATER AND WASTE

600,000 gallons of water required to produce a ton of ammunition or approximately 100,000 pcs. This does not include water consumed by residents and offices in the military factory.

Fortunately, there is a main public water supply, 100 m away from the factory. The water supply is reliable and sufficient for the factory needs because of the following:

- In the last decade, the local public water supply was not enough and was running at low pressure. Ground water has been utilized by means of wells and pumps to reinforce and increase the water pressure inside the main pipelines.

- Provisions for sprinkler pressure, by exploiting a private ground water source of adequate quality and quantity inside the factory by means of pumps and gravity elevating tanks.

- The nearby White Nilo serves as a natural sewage system to the factory. The reader
may recall that the White Nile is less than one km. away from the factory. There is no pollution problem as far as the Nile is concerned. There is no unpleasant odor in that area. Nevertheless, sewage and fluid disposal requirements are properly met.

The above precedents have indicated that there are problems which require definition in order to solve them. However, a number of problems common to existing plant layout must be closely integrated with the plant buildings. These problems mainly are air pollution and unskilled labour.

Air pollution is closely related to the erected buildings. The existing buildings are discussed in the following part.

### 3.3 FACTORY BUILDINGS AND LAYOUT

The reader may recall from the previous chapter that the factory organization consists of the commander-in-chief, administration units, service units, and production units. These units are to be accommodated in a modern and efficient layout consistent with the organizational structure.

This part describes the general approach to the building problem, and also discusses the main factors that aid decision-making in planning and execution of the positioning of buildings.
3.3.1 BUILDINGS

The primary function of a building is to provide protection for men, machines, materials, products, or even factory secrets and classified documents. However, this protection is largely met in the existing buildings. It resists conditions or even theft.

3.3.3 BUILDINGS SHAPES

Monitor and gable roof type have been selected for a building of 50 m length, 30 m. width, 8 m height. Some buildings height is low, they are conditioned rooms, other are air cooled. All buildings are in suitable conditions. These buildings have been arranged together in such a way that associated departments are next to each other, and that the final shape produced can be conformed in a technically and economically convenient factory.

7.2.3 LAYOUT ON SITE

Once the structural formation has been established; and the organization chart illustrated (as shown in Appendix "A" fig. 2:4 to 2:7) which shows all different departments in the factory. Also if way in which they related administratively is defined; and the basic flow chart Appendix "B" fig. 3.2 & 3.3 is made in the shape of a network diagram to show production wings and storage and the way in which material flow between them. Then the next job is to plan the layout of the wings and departments on the site.
The following main aspects have been considered in the work:

"Layout for optimum material flow.
Layout for optimum administration.
Layout for minimum building cost.
Layout for maximum safety.
Position relative to roads.
Position relative to power and water supply and to sewers. *(2)
Orientation to suit climatic conditions."

The above mentioned factors affecting layout decisions. However, they are largely met in the existing layout with the best compromise.
CHAPTER (4)

THE QUALITY CONTROL
4.1 INTRODUCTION

There is no doubt that the quality of the ammunition produced is as important as the safety is for Sudan's security. It is very important a quality control system should be set up to minimize the losses, maximize the production rate and hence reducing the per unit cost. To achieve these factors that might lead to significantly effective ammunition, one should revise the total quality control system applied in the factory, and its suitability to achieve that factors and to cope with the technological advances made in the field of industry. Starting from the beginning of procuring the inputs up to the end product. This chapter therefore concentrate on the design control, incoming material control, product control and special process studies.

4.2 DESIGN CONTROL

The design of anti-personal weapons of the small arms ammunition has been justified and identified by Geneva convention under human rights act in 1900's. The Sudanese Ordnance Corps is the only authority has the right to observe, implement and design the ammunition as specified in the United Nation Human Rights Act. As decreed by chapter [IX] vol (v) of the Law of Sudan.
The basic problem facing the designer was to devise a means of testing the effects or "lethality" of the bullet against human tissue. A considerable quantity of data are available from medical sources on the observed effects of bullet strikes on the body and on the degree of incapacitation caused. Also data (extracted from an experiment conducted by the Royal Military Operational Research Course) reveal that both the velocity of the projectile and the mass of the projectile had an influence on its lethality. Subject to a minimum velocity of about 250 ft/sec. *(25)*. This minimum velocity is needed to penetrate the clothing and skin. This research has confirmed that the physical phenomena associated with wound and its formation are functions of the kinetic energy expended. A positive correlation has been established between the energy lost by a bullet in the target and the size of wound produced in human tissue.

Bullets are stabilized by the riffling in the barrel. However, the velocity of the bullet varies continuously along the trajectory under the effect of drag but is of interest at 3 points.

The initial, or muzzle, velocity, the impact velocity and the residual velocity, (at which it leaves the target).

The initial velocity is important to ensure an adequate impact velocity has a bearing on the severity of the wound and the residual velocity is a measure of the energy given up to the target.
Of particular interest is the quality of energy transferred to the target between 1 and 15 cm of penetration. Less than 1 cm is assumed to produce a superficial wound, greater than 15 cm represents energy wasted beyond the maximum depth needed to cause incapacitation.

According to the criteria used and experimental method employed, a variety of relationships have been derived between a small change in the energy \( \Delta E \) transferred to the target between 1 to 15 cm and the probability that a random hit will produce incapacitation. The result was abbreviated by designing a cartridge with specification implied in the specification shown in Appendix "D".

To produce ammunition conforming to that specification with an increased rate and a reasonable economical level, one should revise both jobs of i.m.c. and in process control "product control" and how; they have been practiced in the ammunition factory. Then an attempt should be made to improve a new set up to overcome all handicaps of the existing system which shows a high rate of reject reaches 40% or may be more.

4.3 **INCOMING MATERIAL CONTROL "I.M.C."**

4.3.1 **FACTORY PRACTICE TOWARD I.M.C.**

There are two phases in I.M.C., control on materials, tools and parts received from outside sources either, foreign or local supply.
The tool shop wing a part of the ammunition factory produces some tools and parts at a low rate. These tools and parts are much consumed during the flow process operations. The bulk of I.M is supplied from outside source. A German firm called Fritz-Werner (F.W) has been awarded a contract to install the factory equipments. Since 1960, two expatriates from F.W company were stationed in the factory between 1960 to 1984. They assumed the role of liaison officers. They also coordinated with the planning manager who prepares, holds, executes, audits the annual budget. The planning manager also prepares, requests, and receives the requirements and store them in the depots. The depots function under his command. These requirements "raw materials, parts, tools and accessories" had been received and stocked before inspection. Some of these requirements had been kept in oiled in the depots for 26 years in huge quantities without being inspected.

El Shazara factory practice toward I.M.C was depending entirely on the vendor trust. The outcome of this practice can be summarized as follows:

(i) A heap of piles of raw materials and parts: stagnated inside the depots.

(ii) Some units of a set of equipments of chromium plant were missing.

(iii) Great amounts of cups were exposed to humidity for long period. As a result these cups were found defective.
(iv) Other equipments and mounted apparatus left idle and neglected in the plant to the extent that authorities do not know about them.

(iv) No vendor certification has been confirmed by the factory top management.

(iv) No records keeping and follow-up. The end result has been mutually unsatisfactory vendor-purchaser incoming performance. Therefore a new improved set up is needed so that such shortcomings should be avoided. A proposal for I.M.C is discussed below.

4.1.2 A PROPOSED I.M.C.

The proposed system should be consistent with the new proposal organization Appendix "A" fig. 2.4 & 2.5. In the existing organization "as shown in appendix "A" fig. 2.2 " the planning manager responsibility is to prepare, request, receive, issue, and stock the materials, parts, and components. While in the proposed procedure, these requirements are being received, inspected, issued and stocked by the technical affair directorate.

The planning manager delineates purchase requirements, determines the quantity and the quality, specifies the requirements of ammunition factory, and other integrated units as well. These requirements are usually requested through procurement branch of the army headquarters through the destined military attache from different companies.
This procurement package follows a standard format to clarify requirements for prospective vendor and to assure that all vendors receive equal and fair chance of being recruited. The objective is to establish and maintain close and positive purchaser-vendor relationships which reflect the reality that each person's success is dependent upon the other. In this study the factory deals only with vendors whose quality standards and quality results fully and consistently meet factory requirements with best regard to the past relations practices and excellent quality reputation.

This part summarizes the procedures for ordering, accepting, and controlling parts, materials and equipments from vendors in the following manner:

(i) Requirements must be defined first, Then the materials and parts are requested, generally by the planning manager in establishing production schedules according to annual objectives of the arm factories.

(ii) Specifications and all necessary materials identification data are secured.

(iii) Vendor bids and offers are received and reviewed by a board consisting of:

Planning manager, purchase or technical affairs directorate rep., quality control rep., process control Engineer or such line, legal counsellor.
(iv) A purchase analysis must be initiated to determine the most suitable vendor or vendors. In the numerous cases where any factories policy requires multiple sources, the most suitable group of vendors. In all cases where a suitable "make or buy" evaluation of the material is made a part of the purchase analysis.

(v) Purchase inquiries are sent to, or invited from, several vendors. The procurement package provided to potential vendors will include a complete package of the relevant quality information.

With large procurements, and when appropriate, pre-contract award meetings are scheduled with suppliers to delineate all purchase requirements, including strong emphasis upon quality requirements.

(vi) Vendors are selected and contracts established or orders placed. Vendor quality assurance requirements are made. With major contracts and new suppliers, post - contract award meeting are scheduled with suppliers to confirm mutual understanding of all procedures are approved. Contracts are maintained with vendors while they are in the process of producing or securing the materials. Quality control officer is provided to the vendor when it is economical and appropriate. He is authorized to audit total quality control techniques and the certification approved and signed.
to specifications in accordance with
the I.M.C. plan. A team from
quality control wing provided, lab
facilities, statistical tools,
computer package, statistical
acceptance sampling tables and
quality control techniques are used.
Rapid, precise, chemical, and
physical measurements are being
made, using highly specialized
laboratory machines and apparatus.
Carry on some of the detailed test
specified by the quality program for
acceptance of I.M.C. and parts, the
measurements of a sample of cup
dimensions are carried out by go-no
go gauge. The record of sample
measurements with all data and
informations concerning quality
should be kept in quality control
wing, technical affair and planning
directorates. All these test with
others will be shown in Appendix D
to this chapter.

Material is disposed to the
production line if satisfactory, or
for corrective action if
unsatisfactory. This is done by
provision control section of
Tightness of production schedules on a certain part may make it necessary to accept, by sorting, if possible, some material to keep production lines in operation and rework unsatisfactory parts, to replace products recalled from the field. Or to retest and inspect rejected units.

Also out of fairness to the vendor, an account must be taken of the rejection causes disposed of at once.

This permits the use of relatively small area for the cage, and it reduces the danger of orange-tagged material "drifting deep into" the production lines.

(xi) Record Keeping and Follow-Up:

It is worth mentioning that in the Sudanese Ammunition Factory there are no proper records kept concerning all materials and parts which had been supplied before by various shipments.

The two available vendors are F.W. German company supplied NATO calibre and Belgium vendor providing the shot shell calibre. There are no occasional records and files concerning these vendors. However, such records must be maintained with minimum paperwork and clerical support. When the factory expands in the near future the number of vendors may also increase. Then, it will be desirable to design basis vendor rating, as practised in other factories. The recommended weighting factor - ratings are outlined below:

<table>
<thead>
<tr>
<th>Rating Category</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor Quality</td>
<td>40</td>
</tr>
<tr>
<td>Vendor Price</td>
<td>35</td>
</tr>
<tr>
<td>Vendor Service</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
</tbody>
</table>
This weighing scheme may be altered depending on the type of business. This plan may be used in the following fashion:

Its quality rating is based upon the function of total lots received that are acceptable for a given part. For example, if supplier "A" had 54 lots accepted out of a total of 60 lots delivered 94/60, or 90 percent, of the lots were accepted.

The quality rating would be 0.9 x 40 (weighting factors) = 36 points

On the pricing area, the vendor with the lowest net price may receive a full 35 points (or whatever weighting factor was chosen for price). If, for example, supplier B had the lowest net price of 93 cent per 100 prices, the rating on price would be 35 points. If B's price was $1.16 then supplier A's rating would be 0.93/1.16 x 35 = 0.8 x 35 = 28 points

The service rating can be based upon the percentage of promises kept. If supplier A kept 90 percent of his promises, his service rating would be 0.8 x 25 = 22.5 points.

Supplier A's total rating would therefore be:

| Quality  | 36 points |
| Price    | 28 points |
| Service  | 22.5 points |
| Total    | 96.5 points |

This rating can be compared with competing vendors on the basis of single-part number or catalog number. These comparisons are then taken as the basis for army factories in future purchase orders.
To maintain friendly business relations with selected vendor firm, one would develop the following actions:

- Occasional interchange of correspondence
- Periodic visit by some of the board members
- Insist on quality control to the vendor plant.

This will assist the factory effort to develop a total quality - control program and at the same time assures quality of the final output.

Establish ongoing vendor surveillance and vendor audit activities throughout the plant. After proceeding from one step to the next, it should be noted that it is dependent upon satisfactory product performance at each preceding "phase" in the development process. Phase one was the new design control, the first job of the T.O.C. which is well established according to the specification Appendix "D". The second job is the i.m.c. discussed earlier as outlined in suggested i.m.c. program which should be implemented with the next coming material supply.

After one secured the i.m.c., the next job is to inspect and secure the quality during operation process. Before the new improved set up one would revise the existing one.

THE AMMUNITION FACTORY PRACTICE TOWARDS PRODUCT CONTROL

The only updated form of production data available in the factory is the daily production rate chart. This chart is posted
in the general directorate office. However, production data are not analysed or used for any future reference other than day-to-day observation. It is unfortunate that the rejects are not plotted in the chart.

No other forms of quality chart are introduced in the factory.

Even in the absence of control charts, and documents, one would expect the continuing on-the-job skilled labour to maintain and practice a reasonable level of production. However, the factory failed to keep such veterans for the following reasons:

In the early sixties, the factory hired and trained soldiers and officers who have been trained in similar factory belonging to F.W. company in Germany. The training covers all areas of NATO ammunition manufacturing. These employees were gradually left. By late 80's only five percent of those skilled labour remained. During this long period they had known the equipments, machine tools well enough to be able to "nurse it along" in the production of satisfactory products. Their experiences have been consolidated in the form of "shop-practice". In other instances experience exists as "know-how" in the minds of veterans who had left the service. Further more, these five percent are expected to leave the service by the end of the current decade. There are no historical cards or documents identifying the nature and working conditions of the existing processing machines. As discussed in chapter two, there is no repair and maintenance wing in the existing organization.
Therefore no authority can identify the individual processing equipments, its historical background, its modification if any, its consumption rate, etc.

Attempts were made by the army to attract good soldiers and technical officers to replace the retired staff. However, the working conditions and the offers are not lucrative enough to convince high-calibre employees. As a result, the factory employed low-calibre unskilled soldiers. They were given short-term training periods locally. To improve their technical skills, soldiers are subjected to on-the-job training.

On-the-job training coupled with the absence of repair and maintenance wing affected the efficiency of the processing machines. This will finally lead to excessive variations in production and may result in manufacturing losses, in form of scrap and rejects that represent a ratio of as high as 20 to 40 percent and much more in some cases. These losses result because T.O.C. has been poorly applied, in-process control poorly monitored, lack of process study or machine capability, inadequate maintenance of the machines, lack of quality mindedness among plant employees, and above all lack of training. However, the factory practice shows that, the shop would suffer from the occurrence of such nonconformance

(i) An undersize or oversize length of the cartridges case, when all that was required was the proper-sized length. "The proper-sized length is 51.18 mm".

(ii) Damage during processing.

(iii) A missed operation.
(iv) Notes: countersunk on the wrong side of cartridges case or not deep enough.

(v) Bullet weight is heavier or lighter than specified "The required bullet weight is 9.45 gm."

(vi) Groove too deep or shallow.

(vii) Primer vent diameter too large or small. To minimize such nonconformances a proposal of an improved system of product control is discussed below.

4.5 SUGGESTED SYSTEM OF PRODUCT CONTROL

To eliminate defects of this sort, the shop complements its standard activity with an effective procedure for control during manufacture.

This procedure embraces major elements:

(i) Organizing for product control.

(ii) First-piece inspection—operators make their own process checks by gauges.

(iii) Acceptance sampling inspection of completed lots.

(iv) Control through data from final inspection.

(v) Quality audit by production line commander and quality control wing commander.

(vi) Follow through to gain corrective action from final inspection—control data and quality audits.
It is noted that these elements do not include process sampling or patrol inspection, which often characterize the preventive approach in a machine shop.

Before practicing this procedure for control during manufacture, process capability study should be conducted. This type of studies have never been conducted before. That is why a more complete study is needed.

4.1.1 PROCESS CAPABILITY STUDY

The facilities selected for manufacture of a part are an important determinant of the cost and quality of the resulting production. If the processing equipment selected is sufficiently accurate to meet the quality targets as established by drawing tolerances "as shown in "Appendix C fig. 4.1, 4.2, 4.4 & 4.5." reasonable costs and acceptable quality can be expected. If the processing equipment can not consistently meet the quality target, high costs, scrap, and reworked materials are inevitable outcomes.

Experienced manufacturing supervisors, operators, and foremen who have learnt from long experience to know about the capabilities of processing equipments left the service without proper replenishment being made. It is sometimes rare to have the required information about machines performance in such a form or document. Since such knowledge is essential to the proper functioning of a quality-control program, Ammunition
A process capability study should be conducted under normal operation conditions with a single set of factors making up the manufacturing process. A study should use a single batch "lot" of raw material, a single operator, and a single measure throughout the period during which data are being collected. The operator should avoid feeding "correction into the process or making adjustments during the study." Recalibration of the measuring equipment during this period should be avoided unless it is "normally" calibrated at frequent intervals. All these separate factors are subject to variation over long periods of time, so it is advisable to make several separate studies at widely separated intervals to determine the effects of normally varying factors on the process capability. The study should contain a sufficient number of measurement readings so that a representative sample is obtained.

For most operations, a minimum of 50 readings should be adequate, the order of
the readings should be preserved. Caution should be exercised in making rechecks to take into account possible changes that might occur with time i.e. change in dimensions due to a part dropping in temperature - decrease in moisture content, and so forth. Inspectors or process technicians are often well qualified for taking the data because of their training in measuring and data recording. The data are fed to the computer which aids in computing the process capability.

**METHOD OF CALCULATION** *(9)*

$$\text{Process capability} = \frac{6S}{\bar{x}} = 6\sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$$

where:

$S$ = standard deviation of sample population

$x_1, x_2, x_3$: individual measurements

$\bar{x}$ = arithmetic mean of individual measurements

$n$ = number of individual measurements

Computer application and electronic calculators may be effectively used for routine process capability evaluation. It is recommended that each production line commander be provided with one personal computer and desk calculator.

The micro stat package in the KAYPRO (II) MICRO-COMPUTER calculates descriptive statistics in its program "scatter plot and descriptive stat." It gives details or short list of the calculated parameter.
This package is used to calculate the following:

(i) The arithmetic mean and the standard deviation for use in the $\bar{X}$ chart.

(ii) The range for use in the $R$ chart.

(iii) The average and the standard deviation of proportion defective for use in the $P$ chart.

(iv) The standard deviation for the calculation of the process capability study "6σ". Since the package does not contain a quality control option, the statistics calculated above were manipulated for the construction of the different charts using a desk calculator.

It is advisable, whenever possible, that the process capability value does not exceed 75% of the total tolerance $4\bar{X}$. The process capability study is a powerful tool. Not only can it be easily computed, but its uses are many. It is recommended to make use of it. The applications can be considered in Ammunition factory include:

(i) Scheduling work to machines.

(ii) Selection of operators.

(iii) Setting up the machine for production run.

(iv) Establishing control limits for equipment that has a narrow process capability in comparison with the allowable tolerance band.

(v) New equipment needs will be highlighted when the present machines are not capable of producing the tolerances required by the design.
(vi) Before accepting the new piece of equipment, process capability studies should be conducted for assurance that the machine is adequate. The production line wing commander should also keep process capability studies up to date and analyses quality problems as they arise day to day. He may request help of the quality control wing commander, maintenance and repair wing commander, Electrical wing commander or bring other functional specialists to work on the problem if any.

The following table 4.1 is an example showing a result of study conducted under normal operation conditions in March 1980 in production line "A".

Most of the machines and many others are expected to be inadequate for the job to be performed. The reasons may be:

- Lack of spare parts
- Lack of veterans
- Lack of training
- Absence of Repair and Maintenance Wing.

By overcoming these handicaps and in so doing, one can proceed for product control as follows:
4.5.2 A PROPOSED PROCEDURE FOR PRODUCT CONTROL

4.5.3 ORGANIZATION OF PRODUCT CONTROL

Key individuals in the quality - control practices for product control are the N.C.O.S. and soldiers who actually produce the product. All practices are built around these employees and wing commanders because it is of and through them that the great bulk of product control activities must be carried out as recommended in the proposed organization.

The factory is fortunate to employ a young mechanical engineers. Part of their responsibilities are implementation of the product and process quality - control program and gathering the quality data. Practice shows that soldiers forge data. The reason that they forge data is because they feel that large number of rejects may be the cause of insult to them. Hence, it is recommended that production manager may train employees stressing the importance of statistics, meaning of quality control and that rejects are also machine faults. Furthermore, the best trained N.C.O.S. must be assigned to data collection.

4.6.2 SETTING UP A MACHINE FOR A PRODUCTION RUN

The shop-practice experience for setting up a machine for a production run is lying on the veteran production operators. They use to eliminate the
and effective both to set and maintain standards - through such means as tool and die control or process - capability studies with the help of maintenance and repair wing commander and tool shop commander, and to establish manufacturing control through such means as patrol inspection, process sampling or control charts. Since, the production line produces 7200 rounds per hour. It may be impractical and uneconomical to concentrate upon any techniques other than proper standards setting. After setting the machines and before production run, the first parts produced should be inspected first.

Pre Control

The procedure for using pre control is as follows:

If the first parts produced are inspected by using gauges and laboratory section equipments belonging to quality control wing. Then when 100 successive parts were sent to the plant laboratory for rigorous test and examination and the requirements shown in Appendix "D" the process setting is considered satisfactory and the process allowed to run.
Control is then exercised by checking single
In essence, modern process-control sampling techniques represent a better controlled and better planned form of patrol inspection. When actual readings are made, the measurements control chart has been carried on and introduced for the first time during all Ammunition factory age. When go and not-go inspection has been carried on, the percent defective or percent nonconforming control charts have been useful. Such application and sampling tables for process control are useful. These charts are attached in Appendix "B" fig. 4:17 to 4:18. The objective of this sort of process check is to provide a continuous picture of the quality of parts being produced. The process-sampling procedure used in production line shop has four major steps:

(i) The setup for each operation is made by the operator, when this operator is satisfied that it is correct, first-piece inspection is made by the process inspector "patrol inspector", when the piece is approved, the inspector punches a record card which is hung at each machine and the operator starts the production run.

(ii) The operator checks the work at regular intervals; every (5) min. If a defect is discovered, the process is corrected. The new setup must thereupon be approved by the process inspector.

(iii) At the intervals of "5 to 15 minutes " *(17) specified by the process-sampling table, the patrol inspector checks the required number of parts. "n = 5 " *(17). These parts may be chosen at random, if no rejects are found, the inspector segregates work that has been processed
since the last check, punches the record card O.K. and production continues.

LV. If defects are found by the inspector, the production line commander is notified to get the process corrected immediately. The production line commander may ask maintenance and repair commander's help if needed.

The parts that have accumulated since the last inspection are set aside for sorting. The inspector punches the reason for rejection on the record card. When the process is corrected, approval by the inspector must be obtained before production is allowed to continue.

A.3.5 FINAL INSPECTION

Final inspection of finished cases and bullets is required to ensure that acceptable work has been done and that the cartridges meet established requirements. Final inspection performed in the production line wing are more detailed and thorough since better facilities and equipment are available. Machine No. 7463 is an automatic machine with gauges and test equipment built in is available in the line. The machine automatically rejects the defective cases inside a container provided beneath the machine. Each container contains cases of the same defect to determine the machine responsible of the defect. Data from the proposed form "data sheet" Appendix "S", table 4:2 & 4:3 may show in the production line that two or three operations and two or three types of nonconformities are responsible for
will be accomplished on 100 percent of the parts processed to ensure that adequate quality protection is achieved. The production line controller should stress on final inspection which should be performed under his personal supervision. In addition he should regularly review the record cards taken from the machine. He should periodically conduct "P and C" charts and keep them in records on microtaped computer as recommended. Afterwards corrective action is decided upon, and as a result responsibilities are assigned to appropriate position.

In the section to come special process studies are reviewed and recommended as the final job of I.O.C.

To summarize, the discussed procedures are condensed in Appendix "C" Fig. 4:17. It shows the sequence followed in this procedure. The value the factory will gain from this procedure is due not only to these techniques but to the extensive program of quality education carried on in the plant.

4.5.6 Quality Campaigns

Employee participation in better quality committees, periodic slogan and poster-campaign in the plant meeting hall "the cafeteria" and both preliminary and refresher training of operators are
examples of this educational activity. Top management may pay more attention to these activities. Specially the factory production-control system impairs shop morale by imposing an excessive rejects. So the results of the weekly analysis of the output, should be posted prominently in the cafeteria of the plant in the form of two charts. One chart shows the percentage of effective jobs for each operation. The second chart shows the percent nonconforming trend of all jobs passing through final inspection. Plant personnel may feel that they have gained considerable advantage from the activities of their shop. Among these advantages the plant may list:-

(i) Ease and economy of the operation of activity.
(ii) A complete analysis of shop quality.
(iii) A provision for continually monitoring.
(iv) An indication of the effects of corrective action.
(v) The fashion in which the activities point out these individuals - operators, or others who require further instruction.
(vi) The reductions in losses and increases in output that have accompanied operation of the activities.
(vii) The reductions in inspection time that have resulted from quality improvements developing from operation of the procedures.

4.6.7 QUALITY AUDIT AND VERIFICATION INSPECTION

It is very useful to select a small sample from the production output after all other
regular inspections and tests have been performed. It may be the basis for the release of the lot sampled; it may be conducted more rigorously than the regular inspections or tests; most quality audits point toward corrective action relating to equipment performance, operator skill, inspection efficiency and so on. It is recommended that quality audit and verification be conducted in the presence of Ordnance Corps representatives in order to certify the lot certification and sign.

It is essential to know that proof is destructive in nature. The quantity selected randomly for proof will normally be 500 rounds a (17) per lot which do not exceed 250,000. All tests are proof, discussed in appendix D.

4.4.7 DISPOSAL OF NON-COMFORMING PARTS

Because of the danger that rejected parts may, without approval, find their way back into the production process, particularly the small arms ammunition is highly demanded by some citizens for several purposes. Some operators took it for a gift, they used to take the rejected parts and assembled them outside the plant. This may cause danger of using faulty ammunition. It also may affect security precautions i.e. violating arms law. It is important that procedures be available for rapid disposition of such parts. These procedures will involve a rigid system of tagging "holding for disposition", and routing. They will include a quality control- component sponsored review for disposition of those parts.
4.6.0 COMPLAINT ANALYSIS

In a very important sense the customer "user" is the final "control station" for factory product control activity.

Records and analysis of users' "field brigades" and units' "complaint reports from the field to the Ordnance Corps. Finally, these reports raised to Army factories commander. These reports furnish useful product - control information "feed back information". While usually a considerable time lag exists between these reports and current production, they nonetheless both reflect the effectiveness of control programs and highlight those non-conformities upon which more aggressive corrective action must be initiated.

The factory management must encourage brigade commanders "users" to inform immediately about any nonconformities.

Besides, the Ordnance Corps should conduct annual scheduled program concerning inspection visits to the field brigades and units for field inspection. It is recommended that "A.T.O.S" belonging to Ordnance Corps should send a copy report resulting from the annual inspection visits.

4.6.0 CONTROL OF QUALITY IN PACKING AND TRANSPORT

Although control of quality during manufacture may have been excellent, these remain subsequent points for control.

The importance of packing and transportation are also essential. Storage is normally long term storage. For
product container and placement by "transport".

6.7 SPECIAL PROCESS STUDIES

These process studies, known as the task job of T.O.C., provide the T.O.C. medium through which basic product - quality problems can be effectively faced and rapidly solved.

Special process studies involve investigation and tests to locate the causes of nonconforming products, to determine the possibility of improving quality characteristics, and to ensure that improvement and corrective action are permanent and complete.

Ammunition factory practice showed that, when a major quality problem arises, for example the assignable cause assigned to operation 7R77 "punch or flash hole" as shown in Fig. 4 flow process chart. The quality problem usually discussed and analyzed by production line commander, tool shop commander, quality control wing commander and electrical wing commander. Usually members of the panel tend to shift the blame on others. To avoid this conflict and discrepancy, responsibilities should be well-defined and to carry out various steps required in the investigation.
Maintenance and repair wing commander, tool shop commander, electrical wing commander and production line commander must constitute the technical board. The board is to be chaired by the production manager. The outcome of the analysis must immediately diagnose the prescribed solution to the problem. In a nutshell, the mission of this board is simply analyzing problems, examining causes, and prescribe solutions. Coordination of efforts are essential ingredients to fulfill this mission properly. Corrective steps that must be taken to bring this solution to reality must be assigned to appropriate personnel under the command of maintenance and repair wing commander.
CHAPTER (5)

PURCHASING AND INVENTORY CONTROL
5.1 INTRODUCTION

Supply and stock control, are the areas that enhance manufacturing processing enterprises need to pay very special attention to. One of the major problems is the severe shortage of foreign exchange resources to procure raw material, spare parts, machines, equipment, coupled with a lack of adequate supplies and appropriate stock control.

This chapter therefore concentrates on needs for adequate control of stock, needs for appropriate system of purchasing.

5.2 NEED FOR PROPER PURCHASING PROCEDURE AND ADEQUATE CONTROL OF STOCK

5.2.1 GENERAL PROCEDURE

Refer to chapter two "Study and analysis of the organizational chart. Some units are totally absent, those which are not included in the existing organization are:-

"Statistics, research and development unit, financial and marketing unit, costing department, stock management and accounting, purchasing and procurement unit, maintenance, repair and safety unit, and legal advisor".

Ammunition factory practices towards those areas are:-
The planning manager prepares the budget annually in March. Before that, he addresses the production manager to raise all annual production requirements.

Such as, raw materials, tools parts equipments, etc. Accordingly, the production manager gives the instructions to the following commanders to prepare their requirements.

(i) Electrical and Water supply wing commander.
(ii) Quality control and lab wing commander.
(iii) Production lines wing commanders.
(iv) Tool shops commander.

Moreover, the latter is asked to forecast the amount of tools and parts he may produce through the year. The planning manager used to collect all annual requirements lists. These lists are haphazardly raised without even knowing a defined objective or a clear target for the concerned year. Then the planning manager checks the residual stock in depots whose stores keepers are functioning under his direct command.

The planning manager makes personal contacts with procurement branch directorate of the army headquarters to find out the items prices. Due to that, the proposal of the annual requirements is converted in terms of money. Usually, the planning manager attends a meeting held in Ordnance Corps headquarters to discuss proposal of the annual budget.

The result of the meeting will be the final proposal collectively with the other proposals of the Ordnance units.
raised to the Army Headquarters.

Normally, 80% of the total budget will be approved. Finally the approved budget is sent back to the planning manager who follows up and liaises with procurement branch directorate through the year. By the end of the year, usually, the planning manager receives 33% of the approved supply. Sometimes, some vital and essential items in running the production flow are not found among the received supply.

The storekeeper enters details of stock records "ledgers" shown in Appendix "G" without examining delivery documents for incoming parts or raw materials. Then he issues orders when the wing commanders issue requisition forms attached Appendix "G" and adjust stock records accordingly. This is applied in case of foreign supply. Concerning local supply, the procedure is as follows:

The ammunition factory commander selects a committee of the concerned members. The committee chairman submits his report to the commander, who agrees to the opinion, accordingly the storekeeper issues the purchase order form "the form attached Appendix "G". Finally he enters details in stocks records "ledgers" and so on...

It can be noticed that the only documents which are in use are:

(i) proposed and approved annual requirement lists.

(ii) Ledger, requisition form and local purchase form
These forms are attached in Appendix 8.

5.5.7 THE EXISTING DEPOTS

Aircraft ammunition factory, stocks fall into the following categories:

(i) General stores
(ii) Plant and machinery spares
(iii) Raw materials "Special Stores"
(iv) Packing materials,
(v) Miscellaneous
(vi) Finished products
(vii) Other - process stocks.

Note: No salvage unit is in existence.

Stores No. (ii) are managed by Headquarters company commander. They contain clothing, webbing, footwear, fuel, oil, personal arms and ammunition, stationery.

Stores No. (iii) plant and machinery spares:
These are mechanical parts held by planning manager and electrical parts held by Electric and Water Supply wing commander.

No. (iii), (iv) and (vii) are managed by planning manager.

One part of no. (v) is managed by Quality control wing commander. The second part is managed by planning manager, and the third is managed by Electrical wing commander.

Concerning no. (vii) which is the worst case that it is managed by Production line commander who is functioning under the production manager command i.e. - produce and stock - which is organizationally wrong.

Note: Some items in store No. (iii) and (v) were purchased in very large quantities 20 years ago. Still they are available.
It is necessary to keep stocks of various kinds to act as a cushion between supply and demand. Both of which under normal conditions will fluctuate.

The holding of stocks therefore has two advantages:

1. It enables orders to be met.
2. It facilitates steady and efficient plant production.

The desirability of holding stock is that, it costs money as an investment. It may be required, not only in the stock but also in the stores to house the stock. The problem with stocks is that:

- Too low stocks may result in too high production costs or loss of orders.
- Too high stocks may tie up too much capital on which there is no direct return.

The essence of stock control is in finding the happy mean between these two conditions. This can be stated in another way: the level of stock that is held should be such that total costs are minimized or total profit maximised. To balance operating cost, see 5.1 annual cost of buying may be useful.

Technical affairs directorate, the recommended unit in the proposed organization should follow that technique to determine minimum cost quantity.

In determining the stock level to be maintained many closely related problems arise such an...
FIGURE 5.1 ANNUAL COST OF BUYING, MOVING, AND STORING ITEMS COMPARED WITH REORDER QUANTITY

\[ X = \sqrt{\frac{IAS}{L}} \]

SEE HAGUE AND BODDAM, PRODUCTION PLANNING AND INVENTORY CONTROL, FOR A DERIVATION OF MIN COST ORDER SIZE FORMULAS
Demand, supply, production planning may have to be taken into account for which a ready-made solution to every situation in ammunition factory is not available. Demand or usage characteristics which strongly influence the production and inventory control system is uncertain in Shapera Ammunition Factory. Fluctuation stocks exist basically because forecasts are not accurate. Thus the inventory problems are directly related to its inability to forecast demand with precision. This does not mean that lack of precise demand forecasts is an excuse for the factory sloppy control. In such case, it is recommended that the plant should operate at a maximum rate of production because Ammunition of different calibers is highly demanded in Sudan. Concerning other products and of other factories, records in future should be kept and analyzing the data as a basis for forecasting in anticipation of future demand. Then it can be easily planned for production and supply.

The present system of purchasing and stock control via ammunition factory at Shapera, does not lend itself to efficient procurement and supply. It is therefore necessary for an early change to be made. To allow the army factories directorate to perform its duties efficiently, it should retain itself autonomy to give technical affairs department "see proposed organizational chart" more flexibility in procurement and supply. It will then be necessary to establish all absent units early mentioned and recommended in chapter two.
6.1 THEORETICAL CONSIDERATION

6.1.1 GENERAL

Weighting factor vendor ratings, present sources of supply, record prices, lists lead time needed, maximum and reorder stock levels, per unit cost etc., can be established. Technical affair directors should apply these techniques to balance its stocks of a list of varieties of items among integrated units through a system of centralization i.e. centralized inventory control. Previously mentioned that, some items were purchased in very large quantities. It is common practice to buy raw materials in relatively large quantities to obtain quantity price discounts, to keep shipping costs in balance, and to hold down clerical costs connected with making out requisitions, checking receipts, and handling account payable. These quantities act as a buffer "reserve" stock. The amount of reserved stock required is a function consisting principally of the following aspects:

(i) The ability to forecast demand accurately.
(ii) The length of the lead time
(iii) The ability to forecast or control lead time accurately.
(iv) The size of the order quantity.
(v) The service level desired.

6.3.2 BUFFER STOCK CALCULATION

A statistical technique which satisfactorily handles the calculation of buffer stock to give a desired service
level is the statistical concept, inherent in the normal distribution. The characteristic of the normal distribution that is important to the concept of service level in stock control is that the total distribution is encompassed by 6 standard deviations "6σ". (16) Three on either side of the mean.

From the statistics of probability the chance of having a product available over the long term to satisfy random demands if no buffer stock is maintained is 50%. Therefore if no buffer stock is available over the long term a 50% customer service could be given. If one standard deviation of reserve stock is held then the service level expected would be 84%, and if 2 standard deviations of reserve stock were held, the service level expected would be 98%. This attainment of a 98% service level is the level that any factories naturally aspire to.

IV.1. PRINCIPAL COMPONENT OF STOCK

The chief questions are:
(1) What to order?
(11) How much to order at a time?
(111) When to order?

The total stock may generally be regarded as consisting of:
(i) Active stock (fast-moving).
(ii) Buffer stock (physical minimum).
(iii) Occasionally there is a third component policy or strategic stock.

To answer these questions, one may refer to the equation:

\[ \text{reorder level} = \text{the buffer stock} + \text{the expected lead time demand} \]
Having determined the size of the buffer stock required to give the desired service level the determination of the order point is greatly simplified. If the lead time and the demand were certain, there would be no need for buffer stock, but this rarely happens.

5.3.4 THE OPTIMUM LEVEL OF STOCK

To set up the optimum level of stock these points should be considered.

(i) Cost of ordering and receiving supplies.
(ii) Cost of holding stock (storage cost).
(iii) Cost of manufacturing finished stock (or unit price).
(iv) Cost of running out of stock.

It is recommended that the economic ordering quantity can be found using the formula.

\[ x = \sqrt{\frac{2AS}{i}} \]  

Where \( x \) = quantity to be obtained on each order.
\( A \) = Cost of placing or getting an order.
\( S \) = Annual usage in units.
\( i \) = Annual cost of holding on unit in stock one year.

1.4.5 ORDERING TABLES

It is not necessary to compute the order quantity individually for each item. Ordering tables can be used to short-cut the work of computing minimum cost order quantities, using the previous formula,

\[ x = \sqrt{\frac{2AS}{i}} \times \sqrt{s} \]
Figure 5.2 Pattern of Inventory Balance

<table>
<thead>
<tr>
<th>Total Cost of Annual Consumption L.S.</th>
<th>Value of Min. Order Quantity X L.S.</th>
<th>No. of Orders Per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 50</td>
<td>All</td>
<td>1</td>
</tr>
<tr>
<td>75</td>
<td>45</td>
<td>2</td>
</tr>
<tr>
<td>100</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td>300</td>
<td>75</td>
<td>3</td>
</tr>
<tr>
<td>500</td>
<td>125</td>
<td>4</td>
</tr>
<tr>
<td>750</td>
<td>150</td>
<td>5</td>
</tr>
<tr>
<td>1000</td>
<td>175</td>
<td>5</td>
</tr>
<tr>
<td>2000</td>
<td>250</td>
<td>8</td>
</tr>
<tr>
<td>5,000 - Above</td>
<td>400</td>
<td>12</td>
</tr>
</tbody>
</table>

Table 5.1 Recommended Ordering Table
It is necessary to use the same units when using this formula i.e. pounds if costs are in terms of money, or units of annual consumption and order quantity are given in numbers. The following is the ordering table. It is recommended to be placed in the physical store and kept by the stores accountant together with:

(i) Quantity ordered and balance on order.
(ii) Quantity received and balance on hand.
(iii) Reorder level. * (16)
(iv) Average cost price of each item.

4.7.6 Setting Physical Minimum and Physical Maximum and Reorder Point * (175)

If we use the following example i.e. \( x = 200 \). Annual consumption 1200 units, the working year is 300 days, lead time is 4 months. Thus daily consumption = \( \frac{1200}{300} = 4 \) units. Therefore 200 units are consumed in 2 months "25 days per month". If lead time is 4 months, consumption in lead time = 400 units. Assume physical minimum is 2 months consumption (200 units).

Then an order must be made when stock reaches physical minimum + lead time consumption i.e.

\[ 400 + 200 = 600 \] units.

This point is called "Reorder point".

Physical maximum = physical minimum + lead time consumption + \( x \)
\[ = 200 + 400 + 200 = 800 \]
units.

This pattern is recommended to be followed inorder to balance inventory in army factory’s central depot.
Table 5.1 is introduced and recommended by
commission on a high level in its report on
government storage system review.

5.1.7 **CLASSIFICATION OF STOCKS BY VALUE**

One of the most universal concepts of
business is called the "Pareto Effect".
The "Pareto Effect" states that 80 (13) about
20% of occurrences account for 80% of the
results.

Or about 20% of the people in the country
have about 80% of the wealth.

Or about 20% of the company's customers
account for about 80% of its sales.

Or about 20% of the stock items account for
about 80% of the cost of the stock.

**A.B.C. CLASSIFICATION**

When applied to inventories, this concept is
called the A.B.C. classification. Any
inventory can be separated into three
distinct classes.

(i) **Class A Items**
(ii) **Class B Items**
(iii) **Class C Items**

(i) **Class A Items**
Class A items are the very high value items. i.e. those
relatively few items account for 75% - 80% of the
total value of the stock. Class A
items will generally represent 15% - 20% of
the total stock.

(ii) **Class B Items**
Class B items are medium value items. These
items usually represent 30% - 40% of the
total stock, and about 15% of the value of
stocks.
Figure 3. A-B-C Classification of Stock Items
III. Class C Items

Class C items are low value items. These items usually represent the bulk of the stock about 40 - 50% of the total items of stock, and accounting for 3% - 10% of the value of the stock.

The breakdown into A.S.C. items is of course arbitrary and within these groups, the A.S.C. classification will exist. The A.S.C. classification of stock items can be shown graphically as depicted in figure 5.3.

S.4.4 Stock Control Unit Responsibilities

(a) General

This is the function of ensuring that goods required in stock, to meet manufacturing needs, are made available.

Stock control will be responsible for maintaining accurate stock records and will record movement from:

(i) Goods received notes for purchased items.
(ii) Material issue requisitions.
(iii) Progress record cards for parts manufactured in the workshop.

By this means the balance of all stock items will be readily established.

All depots and stores with different categories should be merged and managed by the technical affairs directorate. It may allow planning, research and fellow director to perform his real task.
5.5 PURCHASING

The primary function of the purchasing department is to obtain the required materials and parts at the time required, in the correct quantity, at the correct price. It must also be able to advise on prices and deliveries on potential material from suppliers.

5.5.1 DUTIES

(i) Finding and approving suppliers.
(ii) Purchasing, supplies at the least cost to the army factories.
(iii) Ensuring delivery of goods is made at the right time by progressing all orders.
(iv) Warning all concerned if delivery promises are not going to be met.
(v) Keeping adequate order and supplier records and hold price index cards for all standard products.
(vi) Analyse the service provided by suppliers taking into account:

- Percentage of orders delivered on time or late.
- Percentage of reject or scrap supplies obtained from suppliers if any.
- Weighing factor vendor rating.

By doing this it is possible to establish, good and bad suppliers "vendors" and thus order supplies accordingly.

With the introduction of stock control, the effectiveness of the purchasing department is critical, maximum, minimum
and reorder levels of stock will require to be set. Lead times for the procurement of materials and parts will require to be established. To reduce this time to a minimum, the time spent obtaining quotations and placing orders for supplies must also be reduced to a minimum.

By having suppliers' records and price index cards, inquiries for supplies can be dispatched without delay. When quotations are received, by knowing the price previously paid, an immediate cost comparison will be possible.

Having established the good suppliers from the analysis, this information can be used when placing orders. In some instances, when the delivery time is not critical, price and quality can take precedence. In other instances - however, the delivery time takes priority over price, especially in ammunition production in some situations.

When goods are received, they should be recorded into stock as soon as possible. Early inspection of goods received and location in their respective storage areas is essential.

To establish and set up a new system of inventory control in the recommended organization forms attached in Appendix "F" should be introduced so as to enhance griped control.

**FORM INSTRUCTION**

A form instruction is provided for each form that will be introduced. The purpose is to clearly define the reason for the form, how it is used by each department or wing.
concerned and how the individual staff members will prepare and process the forms to completion.

To ensure systems and procedures operate effectively, it is necessary to formalise the presentation of information, to make certain that essential data is fed to the departments wings concerned.

System changes by wings commander should not be allowed. All requests for changes either of the system or forms used, should be discussed by a select committee, to ensure that all aspects of the procedure are taken into account to ascertain the effect changes in one wing or department will have in another.
CHAPTER (6)

MAINTENANCE MANAGEMENT
A.1 INTRODUCTION

Most of the machines in the ammunition factory are very old. They are not reliable in resisting Sudan climate and environmental working conditions (high temperature, air pollution with dust, unskilled labour, machines abuse, lack of adequate supply of spare parts), unless an adequate maintenance system is adopted.

This chapter therefore concentrates on need for appropriate system of maintenance management.
Figure 6.1 Classification of Maintenance
done by equipment operators themselves in each production line wing. Electrical wing commander used to repair electrical faults when called for.

Breakdowns and emergency maintenance are the basis of maintenance exercised in all wings and departments of ammunition factory. Sometimes they are involved in a corrective maintenance.

No planned preventive scheduled maintenance, or shutdown maintenance are conducted before. Obviously, forms, cards, and records are not used completely to organize the maintenance activities. Except only one form (Army form 0.1.3 attached in Appendix “g”). It is used as a requisition form to receive spare parts needed for repair.

Imported spare parts and tools are scarce in the depots especially when lead-time is very long. A maintenance workshop is one of the vital backup services to the maintenance of production line equipment, i.e. tool shop wing containing "very old lathes, milling machines, drills, etc.," to produce some of spare parts. These machines are installed since 26 years. They become inefficient to produce adequate spare parts to conform
to the required specification. Even these tool shops may not be fully utilized due to lack of working tools and skilled labour. The result, all wings and departments are practicing quantization to keep the plant running. This finally will lead to bitter ends. There are obvious deficiencies in the conduct of the maintenance function in all wings of the factory. The result, it is claimed that downtime is excessively high, causing low output. Evidently it has been ascribed the low output to excessive downtime.

When the production manager raises his report of the machine operator as to the exact causes of the breakdown have been established, conferences with the supervisor and production line wing commander establish responsibility. In order to assign causes, these questions arise:

Was the stoppage caused by:

(i) The condition of the machine.
(ii) The result of overloading
(iii) Bad engineering workmanship due to:
- unskilled labour
- inaccuracy precision of machines
(iv) Inadequate supply of spare parts.
(v) Operator mistake or machine abuse.

This may initially be controversial, but even if concessions are at first made by then, it is essential that these classification are established by maintenance and repair wing commander when proper management information system will be established.
A proper system should be introduced using forms, cards Appendix "h", as the records start to be accumulated and analysed many clues as to future action will become evident. This is the start of a scheduled maintenance application, to set up preventive maintenance programmes on the most appropriate base.

Maintenance is an essential activity to assist production and preserve assets. However, haphazard maintenance and waiting for a machine to breakdown before it is maintained is harmful to the machine and can be very costly and sometimes catastrophic to ammunition production situation. In ammunition plant breakdown can occur during the peak demand this will disrupt the military operations and may lead to disaster. These effects may be greater in developing countries, where machines are imported, foreign currencies are scarce and importing spare parts takes a very long time. Inevitably, an appropriate system of planned preventive maintenance is needed to minimize breakdown.

Planned maintenance is an organised attempt to prevent sudden breakdown in equipments and emergency shutdown for repair- a defined programme for periodic cleaning, servicing, inspection and replacement of critical parts before they fail, this can reduce downtime to a minimum, since most high machine rates make downtime very costly "production rate is 7200 rounds per hour in each machine in the line".
Figure 8.2 Maintenance Cost
6.3 THEORETICAL CONSIDERATION

In order to provide a satisfactory maintenance service to all wing equipments at minimum cost, consideration must be given to two basic needs:

(i) All equipment must be inspected, lubricated and adjusted at regular intervals either in accordance with manufacturers' instructions or by experience to reduce excessive wear or damage.

(ii) Selected spare parts must be held in stock, to enable worn or broken parts to be renewed when required.

To achieve this, considerable preparation, recording of maintenance information, analysis etc., is required. From this analysis, which must be carried out on a regular basis, realistic maintenance plans can be prepared and introduced.

In order to introduce systematic planned maintenance it will be necessary to provide a number of basic forms and procedures.

These will be used to issue instruction, collect and distribute information, to enable effective maintenance to be applied and control over expenditure to be imposed.

Certain criteria are necessary to ensure that information is correctly distributed and actioned by the various departments and wings in the factory.

1.9.1 PLANT REGISTER

Before any form of planned maintenance can
FIG. 6.3 THE MAJOR PLANNING STEPS

- PLANT REGISTER
- LIST OF ALL ITEMS

- ITEM HISTORY RECORD
- LIST INFORMATION
- TECHNICAL DATA

- SERVICE INSTRUCTIONS
- ROUTINE ACTIVITY

- EXAMINE EACH ITEM THOROUGHLY
- MANUFACTURER'S LITERATURE

- DECIDE WHICH ITEMS TO MAINTAIN AND AT WHAT FREQUENCY

- ITEMS TO BE PLANNED FOR

- MAINTENANCE LIFESPAN
  FOR EACH OF THE ACTIVITIES

- ITEM TO BE MAINTAINED ON BREAK-DOWN BASIS

- MASTER PLAN
  SCHEDULE ALL THE ACTIVITIES

- MAINTENANCE SCHEDULE
  I.E. TO COVER A YEAR PERIOD
operate in the factory, it is necessary first to identify each item of plant and to allocate to it a code number as shown in Appendix "A", fig. 3.1. This code number will be used always to refer to the item, whenever work is carried out on it, or material or spare repairs of the item. It will be necessary, first, to obtain a layout of the plant concerned. "Reference to Appendix "A", fig. 3.7 & 3.1. From this layout, which will identify each building and its contents, a comprehensive list of each piece of equipment housed in the building will be prepared. Each item is thoroughly examined to identify the components which require maintenance.

Using manufacturer recommendation and the experience of the veteran, frequency of maintaining each component can be established temporarily, until forms, records and new set up are introduced to reduce the frequencies.

- Non-critical items on those which are going to be replaced can be separated and maintained on breakdown basis.
- Related items "i.e. production line" are to be grouped together.
- Daily activities may be considered as services and routine work - to be allocated directly. Other activities are to be planned.

4.7.5 ITEM HISTORY RECORD

A record is prepared for each item containing its technical data and manufacturer/suppliers. It is used for recording the item's history. A card for each task containing brief and concise
Instruction explaining how the activity should be carried out. Weekly activities can be grouped and given to the foreman to plan for them. In every instance, it is imperative that records are kept of maintenance work done which includes:

(i) Details of work done.
(ii) Sequence of operations
(iii) Trade involved.
(iv) Time taken.
(v) Spares, materials used.

This information is the basis for planning future work and is the basis for improvement of maintenance programmes and work methods.

When maintenance record cards have been prepared for all plant and equipment, the maintenance and repair wing commander will be required to establish maintenance schedules for each to cover:

(a) (i) Lubrication
    (ii) Inspection
    (iii) Scheduled maintenance.

(b) Indicating the type of work which can be done by the production line operators.

SCHEDULED MAINTENANCE

It is necessary for the maintenance and repair wing commander to establish the various routine maintenance activities and their frequencies. This can be derived from:

(i) Recommendations and technical data, provided by F.M. company or other manufacturer's instruction books.

(ii) Historic data which will be recorded on the recommended maintenance record cards.
(11.) Veterans experience.

The latter two are not available, hence the information can be used to re-assess the frequencies also are not available. The period of regular lubrication, inspection and maintenance may be extended or reduced. Initially, these inspired guesses may not be very accurate, however, as historic data is recorded on the maintenance record cards, this information can be used to re-assess the frequencies. Eventually, a satisfactory compromise will be reached between providing excessive or insufficient scheduled maintenance. This can only be achieved however, by carefully analyzing the maintenance records which should be held for each item of plant or equipment.

Maintenance and repair wing commanders should regularly scrutinize records and adjust inspection and maintenance schedules if necessary.

5.3 BREAKDOWN MAINTENANCE

This is unscheduled work which occurs irregularly and usually has to be dealt with immediately. Breakdown maintenance is the only type exercised by all wings of the factory. The frequency with which breakdown occurs is excessively high. Evidently, it can reflect lack of the scheduled maintenance work.

When the maintenance and repair wing will be established, the recommended scheduled and maintenance system will be set up and implemented. Accordingly, this will improve the maintenance work in the factory and one may expect downtime to be minimized.
6.6 PLANT SHUTDOWN MAINTENANCE

This type of maintenance is not applied in ammunition factories. With continuous process plants, it may be recommended that:

1. Certain sections of plant will be shut down for a fixed period of time during which predetermined maintenance work and general repair will be carried out. Maintenance and repair wing commander should coordinate with production line commander to determine that period after getting production manager approval.

2.1 Sometimes, the planning director after consulting the arm factories director approval may close down the plant for a definite period, during which time general maintenance and repair are carried out if necessary.

3. In all cases technical affair director should be informed to cater for spare parts and tools.

7.7 PLAN EXECUTION AND INFORMATION FLOW:

The most important factor for defect reduction is that the planned maintenance team should learn every bit about defects found during carrying out the normal plan. Also greater care should be taken during inspection work. This will link all faults related to each other. In order to handle the mechanical work involved in carrying out the functions of the maintenance and repair wing, an adequate skilled labour force "veteran" provide
## FIG. 6-3 MAINTENANCE SCHEDULE

<table>
<thead>
<tr>
<th>LINE NO.</th>
<th>MACHINE NO.</th>
<th>WEEK NO.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>51</th>
<th>52</th>
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<tr>
<td></td>
<td></td>
<td>TASK NO.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## FIG. 6-4 INFORMATION FOR SPARE PARTS ASSESSMENT

<table>
<thead>
<tr>
<th>SPARE PART NO.</th>
<th>PART NO.</th>
<th>ANNUAL USAGE</th>
<th>QUANTITY</th>
<th>ORDERING</th>
<th>MAKING OR BUY</th>
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</thead>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ITEM</td>
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<td>LOCATION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>----</td>
<td>----------</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**MANUFACTURER**

**SUPPLIER**

<table>
<thead>
<tr>
<th>PLATE NO</th>
<th>SIZE</th>
<th>MODEL</th>
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</thead>
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<table>
<thead>
<tr>
<th>PURCHASE DATE</th>
<th>ATTACHMENT</th>
<th>OTHER NATURES</th>
<th>NO OF INSTRUCTION CARDS</th>
<th>FREQUENCY</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FOR NEARLY</td>
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<td></td>
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<td></td>
<td>MONTHLY</td>
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<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DATE</th>
<th>TYPE OF MAINTENANCE</th>
<th>DESCRIPTION</th>
<th>COST</th>
<th>MATERIAL</th>
<th>LABOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PLANNED BREAK DOWN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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</table>
### FIG 6.10 TIME SHEET

<table>
<thead>
<tr>
<th>TASK NO</th>
<th>WORKING</th>
<th>WORK DONE</th>
<th>MATERIALS</th>
<th>TIME</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

<table>
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<tr>
<th>START</th>
<th>FINISH</th>
</tr>
</thead>
<tbody>
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</table>

### FIG 6.11 MAINTENANCE SUMMARY SHEET

<table>
<thead>
<tr>
<th>TASK NO</th>
<th>WORKING</th>
<th>WORK DONE</th>
<th>MATERIALS USED</th>
<th>VALUE</th>
<th>TIME</th>
</tr>
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<tbody>
<tr>
<td></td>
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<table>
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<tr>
<th>ALLOW</th>
<th>TAKEN</th>
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</table>
Want to maintain the reliability of the machines. Quality control personnel want the end product to conform to the required standard and the precision of technology put into use. Accurate and continuous flow of information lead to a happy media between all the functions.

Early notification of a change of plan in one area enables the other party to make the necessary adjustment to suit the change.

Awareness of each one's difficulties leads to appreciation and coordination. In addition, clear definition of areas of responsibility is of major importance. "Job specification Appendix "I".

The allocation of some maintenance staff, quality control patrol inspectors to various production lines may be helpful. It develops a better production, maintenance and quality relationship, minimises downtime, rejects or losses and allows correct and fast feed back to the main sections.
CHAPTER (7)

COSTING OF PRODUCTION
7.1 INTRODUCTION

The ammunition factory, like the rest of the government producing units, suffers from the cost negligence syndrome. No attempts have been made in the history of this factory to operate economically. There is no statement in all the factory's documents to address or even identify the objective function of such producing firm. Scientific analysis requires specification of objective function. Given that objective function, an efficient manager will try to optimize that objective function subject to the operational and other technical constraints. Consequently, resources in that firm will be allocated optimally. This is as far as optimization can go.

We wish that such a procedure has been adopted once in the history of the factory.

If that scientific procedure has been a tradition, one would have simply update and revise the cost scheme of producing bullets. Further, a reader may recall from chapter two that the sufficient condition for data base does not exist in the past as well as the current organization. However, a sketchy and very preliminary estimates to evaluate the cost of one type of various products that is "slug-shell" has been roughly outlined. That estimate does not even identify realistically the itemized fixed and running costs of the shell. Therefore, the task is not only to estimate the cost of producing a bullet, but to establish a pioneering costing system to achieve the advantages below:
However, the following are the chief advantages:

7.1.1 ADVANTAGES OF COST ANALYSIS

(i) A costing system will enable first to measure the efficiency and then to maintain and improve it. This is done by comparing cost per unit in one period with that in another or actual cost with the standard.

(ii) Costing will reveal activities which bring profits and those that result in losses.

(iii) Costing helps management to plan the various activities. This is because under a proper costing system, full information about production facilities will be maintained.

(iv) Information about availability of various stores and materials helps in planning work and in detecting unnecessary losses.

(v) Some of the important decision - for example, whether or not to replace men by machines or the decision to make an article or buy it from the market - can not be made without proper costing information.

(vi) Exact causes of profits or losses will be revealed.

(vii) Costing inculcates the habit of making calculation before taking a decision.

(viii) A good system of costing affords an independent and most reliable check on
the accuracy of financial accounts. The check operates through reconciliation of profits shown by costing and financial accounts.

7.1.2 COST FUNCTION

Usually, optimizers can either minimize the cost of production for a given engineering production function, or maximize output subject to a given cost.

However, the factory is far from such schemes. It may be recommended to start from scratch by first establishing a realistic and scientific cost scheme. The technical optimization procedure can be carried by future interested researchers after evaluating this cost scheme.

Depending upon the nature of industry, there are many methods used in costing department. Process costs is recommended to be the applicable one to suit Ammunition factory.

7.2 CLASSIFICATION OF EXPENDITURE AND ELEMENT OF COST: *(12)*

Direct and indirect expenditure consists of:

(i) Direct material: The total of all the three
(ii) Direct labour: is known as prime cost or charged.
(iii) Direct expenses: flat cost.

Indirect expenses is usually
classified into:

(iv) Work of factory expenses i.e. indirect expenses incurred of goods and services;

(v) Office and administrative expenses i.e. expenses incurred for general administration; and

(vi) Selling and distributive expenses i.e. expenses incurred for effecting sales.

Items (ii) to (vi) are known as elements of costs or primary costs. When costing information is presented, it should be the duty of the cost account to enter information. Cost accountant should present information for each of the six elements clearly and distinctly, with the help of forms, cards, and records they are recommended to be used, the reader is referred to "Appendix 91" and Appendix 92.

Works cost or
Manufacturing Cost = Prime Cost + Factory expenses.

Office cost or
Cost of production = works cost + office expenses.

Cost of sales = Cost of production + selling expenses

Selling price = Cost of Sales + profit (+loss)

Cost of conversion = manufacturing cost - cost of direct material
7.2.1 DIRECT MATERIAL

GENERAL

Materials always form a substantial portion of the total cost and hence utmost care should be taken to see that there is no unnecessary loss or wastage on account of materials.

Methods for pricing issues of stores:
As explained earlier, "chapter 3" stores requisition orders are sent to accounts department. It is the duty of the Accountant to enter the rate and amount on the requisition order. For calculating the amount of requisition orders or of the materials issued, there are various methods: *[12]

(i) First in first out or FIFO
(ii) Last in first out or LIFO
(iii) Weighted averaged method.
(iv) Market price.
(v) Fixed price.
(vi) Inflated price.

The issue of goods must always be done on the basis of FIFO i.e. the issue must be out of the earliest consignment on hand. FIFO is the recommended method to be used by army factories.

If methods of pricing materials issues were introduced earlier to the army factories, one would simply update and revise the cost of the material used. For example - instead of importing finished parts, a sheet of the same material can be imported and processed
locally to produce the finished cups of the same quality. It is clear that a considerable amount of foreign exchange may be saved. Manufacturing the cups locally will definitely save a substantial amount of foreign exchange resources simply by eliminating the intermediate cost. The intermediate cost involves price of labour, marginal efficiency of capital and transport cost. All these would have been paid if the cups are imported in a finished form.

7.2.2 RECORDING

For each type of expenses there are certain records which may form the basis for cost reading.

(i) Equipment - for the equipment the most appropriate media is the invoice or job order detailing and expense on the particular equipment.

(ii) Supplies - the records suitable in this case are store requisition.

(iii) Labour - the conventional form consist of time cards and job cards.

(iv) Maintenance overhead - these are recorded on the base of departmental centre established according to a criteria representing the amount of cost proportional to the share of the department in the source received.

(v) Plant overhead - this is uncertain according to the accounting procedure.

It is essential that every group of activities should be treated with equal importance like
any other activities through an order
system to carry out the work, comprising
a consistent interaction between the
various records and forms authorised
earlier.

The following forms attached in Appendix
"C"
- Goods received note.
- Requisition order.
- Bin Card.
- Stores ledger.
- Job card.
- Piece work card.
- Wages abstract "the normal pay sheet
Forms."

7.7.3 DIRECT LABOUR

(i) GENERAL

Direct labour means that labour which
can be conveniently allocated to various
jobs or products. Workers whose time
can not be allocated to individual jobs
or products are known as indirect
labour.

(ii) ATTENDANCE

Is usually recorded in one of the
following ways:-

(i) By recording attendance in
register.

(ii) By allotting a number to each
worker and by asking the worker to
drop a metal token of the same
number in a box every time he
enters the factory.

By making out a card for each
worker and by asking the worker
to get the time of arrival and departure recorded on the card through insertion in a time-recording clock. However, the factory as a unit following the military regime has an independent check on the time keeping to discourage lolling. Moreover, the recommended recording system will be appropriate to provide adequate time utilized record.

(iii) ANALYSIS OF TIME OF DIRECT WORKERS

It is necessary to know how much time has been devoted by various workers to a job. This is necessary not only for purpose of finding out the cost of a job but also for controlling wasteful or idle time. The analysis is done on job cards.

(iv) METHODS OF WAGE PAYMENT

The time honoured systems are:

Time and piece basis, of which wages on time basis in older.

In case of time basis wages are calculated on the basis of number of hours or days spent in the factory. Output as such is not taken into account. In this case, the worker will take good care of quality and will be careful in the use of materials and machinery. But he has no incentive at all to increase the output; on the other hand, output may decline. If it declines, wages per unit as well as fixed expenses per unit will increase.
To remedy the defects of the time system of wages, piece basis has been introduced. Higher output means lower fixed expenses per unit. Quality is generally ignored by the worker, he may also take no care of tools, machines, and himself in his anxiety to produce more.

**Incentive Plans** *(15)*

Two plans of wage payment have been developed with the object of encouraging efficient workers.

The plans are:

- The Halney plan and the Rowan system. There are certain common features of both these:
  - Wages on time basis are guaranteed to all.
  - Standard time is fixed for work to be done.
  - A bonus is given to those workers who save time in addition to wages on time basis for actual hours worked.

The two systems differ only in the calculation of the bonus.

(i) Halney bonus = \( \frac{1}{3} (H_a - H_s) \cdot R_h \)

(ii) Rowan bonus = \( \frac{(H_a - H_s) \cdot H_s}{H_a} \cdot R_h \)

(iii) Weir bonus = \( \frac{1}{2} (H_a - H_s) \cdot R_h \)

Where:

- \( H_a \) = hours allowed or standard time
- \( H_s \) = actual time on job
- \( R_h \) = workmen’s rate/hour

(iv) Wages under scientific management.

Taylor, the founder of scientific management.
proposed the system of "Taylor's differential piece rate system" *(1). This system is rather harsh because no guarantee of wages on time basis is given.

Two of Taylor's associates, Gantt and Emerson, developed methods of their own. Gantt's task and Bonus plan and Emerson efficiency plan *(1). The two systems have certain common features:
- Wages on time basis are guaranteed;
- Efficiency is measured for each worker; and
- Bonus is given to those who achieve a certain level of efficiency.

There is another plan - "Bedeaux plan" under this method also, time wages are assured and wages for time saved are divided 3/4 to worker and 1/4 to management.

**Maslow's Need Hierarchy** *(1)

The needs hierarchy proposed by Abraham Maslow, suggests the following order of priority of fundamental needs *(1):

(i) Basic physiological needs.
(ii) Safety and security.
(iii) Love
(iv) Esteem
(v) Self - actualization

**Labour Turnover**

The ammunition factory, like the rest of the Sudan institution suffers from high labour turnover rate in the last decade.
Labour Turnover = A + S  \[1\]

Where:
A = no. of employees who joined during a given period.
S = no. of employees who left.
E = the average no. of employees during the period.

Usually high turnover is not a healthy phenomenon and add directly to the factory’s expenses as new and turned staff is to be prepared.

Employees leave because, employees fault; firm fault; and unavoidable. 75% \[1\] of reasons can be avoided - for example - inconvenient environment, disapproving job, current, incompetent management, low wages, shop morale is impaired by lack of material and spare parts, lack of training, market value of labour - compared with wage structure in nearby countries particularly, the Gulf oil countries etc..

With scientific management practice, turnover can be kept as low as possible. However, employees will become “turned on” to their job if, the work is meaningful; the worker has knowledge of operating results and the worker is personally responsible for these results.

(VIII) OPERATIVE TRAINING

Training should be a continuous process as:
- On the job training;
- Vocational school;
- Apprenticeship; and
- Special courses or abroad for higher skills.
Training should not be for the job only, but should be extended to training on the job. Considering the conventional methods of training adopted so far, attention should be given to the following factors:

- Savings in learning time;
- Amount of immediate learning; and
- Long-term retention.

With providing automatic machines in the new lines and the consequent upgrading of skill level, the development of operative training calls for specific increase in skill and will receive a much greater degree of emphasis in the future. So the availability of economic resources that can be allocated to training and education becomes a must.

**Recommendation**

People are never completely satisfied on any need level, but a reasonable amount of gratification of first-priority needs be forthcoming whenever it can be possible. The army headquarters in the high level always tends to substantiate this concept of need perception. Men's motives are generally governed by his economic status. It may be recommended:

(i) To provide the best possible working conditions and strongly secure the employee's economic status.

(ii) Availability of economic resources that can be allotted to train and promote employees.

(iii) Occupational safety and health and trade unionism laws are not applied organizationally in the army regime, but they are largely met and observed.
in reality with military commanding system through chain of commanding report - periodic meeting with all level of command - morale orientation - periodic slogan and poster campaign in the plant cafeteria - etc.

However, it may be recommended to assign the commander of arsenal and fire prevention platoon to be nominated to attend a training cause in occupational safety and Health Institute. That commander should be responsible for safety and health among the employees in addition to his conventional duty.

(41) Ammunition factory's employees should be classified to be put in a high category level among all employees of P.A.P. because beside the military task, they are responsible for technical task, consequently this will need a certain calibre of qualification. Moreover, they are scarce in the market.

(47) Time rate is unsuitable, the most suitable incentive plan recommended is the Rowan plan because it links work and time with productivity, the bonus is that proportion of actual hours that the time saved bears to the standard time. All additional output gained by worker, hence overhead reduced due to additional output. Moreover it ensures labour turnover.

7.3.4 DIRECT EXPENSES

In addition to direct materials and direct wages, some expenditure may be incurred
for only a particular job or particular product. Such expenditure is direct to the
job. Instances are:-

(i) Special hire of machinery required for a
job.
(ii) Royalty paid on the basis of production
for use of a patent.
(iii) Travelling expenses incurred for a job
only.
(iv) Special designs or experiments for a
job.
(v) Cost of units spoiled during trial runs.

7.2.5 WORKS OR FACTORY EXPENSES.

(i) Wages paid to indirect workers such as
repair men;
(ii) Works manager's and supervisors salaries
and fees to technical directors;
(iii) Workers' welfare expenses;
(iv) Contribution to social security schemes
including provident funds contribution
made by the employer.
(v) Carriage inward on materials purchased;
(vi) Materials of small value "national";
(vii) Buying and storekeeping expenses;
(viii) Normal lodges (of time and material);
(ix) Factory rent and rates (even the
premises are owned by the firm);
(x) Insurance of factory premises, plant,
etc. -
(xi) Power and fuel;
(xii) Factory lighting;
(xiii) Depreciation of plant and machinery,
tools and factory premises; and
(xiv) Works stationary, works telephone and
works clerical charges.
If any money has been realized by sale of scrap material or wastage, it should be credited to the manufacturing accounts or deducted from factory expenses.

7.2.6 OFFICE AND ADMINISTRATIVE EXPENSES

(i) Rent, insurance and lighting of office premises;
(ii) Salaries to general manager, secretary, finance manager, office manager, accountant and cost accountant and their staff.
(iii) Stationary used in office and postage and telephone;
(iv) Depreciation, repair and insurance of office equipment and power required to run it;
(v) Bank charges;
(vi) Audit fees;
(vii) Legal charges (except in connection with sales or production).

7.3.7 SELLING AND DISTRIBUTION EXPENSES

(i) Salaries of the sales manager and his staff including his office staff and salesmen;
(ii) Travelling expenses and commission payable to sale men;
(iii) Advertising and show room expenses;
(iv) Printing of catalogues, price lists and stationery;
(v) Rent and repairs and insurance of finished goods;
(vi) Bad debts;
(vii) Packing and carriage outwards and insurance in transit;
(viii) Fees to valued directors;
(ix) Telephone and postage;
(xi) Entertainment expenses;
(xl) Legal charges for recovery of debts; and
(xii) Subscriptions to trade journals.

7.3 ESTIMATION OF INDIRECT EXPENSES

7.3.1 GENERAL

It is necessary to find out the cost of product or a job as soon as the work is finished. This will involve making an estimate of indirect expenses for a period even before the period begins. This is because the factory cannot afford to wait till actual information is available. So it may be recommended to make a valid estimate in the long run because it will be made naturally on the basis of figures of some previous period which is not available now.

7.3.2 EXPENSES CATEGORIES

To make a valid estimate, the expenses have to be divided into the following categories:

(i) Fixed expenses, that are not affected by changes in output or sales such as rent, salaries etc.

(ii) Variable expenses, that is, expenses that change in the same direction in which output changes, for example - power consumed, indirect materials, insurance in transit, carriage outwards etc.
Semi-variable expenses, that is expenses that change but not in the same ratio. For example, depreciation is not doubled if output is doubled. Semi-variable expenses are partly fixed and partly variable.

7.4 DEPRECIATION METHODS

GENERAL

Depreciation accounting is a system of accounting which aims to distribute the cost of fixed assets over the estimated useful life of the unit in a systematic and rational manner.

The factors that cause depreciation are:

(i) Wear and tear due to actual use;
(ii) Efflux of time — mere passage of time will cause a fall in the value of an asset even if it is not used;
(iii) Obsolescence — a new invention or a permanent change in demand may render the asset useless;
(iv) Accidents; and
(v) Fall in market price.

THE BASIC FACTORS

For calculating depreciation, the basic factors are:

(i) The cost of the asset;
(ii) The estimated residual or scrap value at the end of its life; and
(iii) The estimated number of years of its life (not the actual but the number of years it is likely to be used by the firm).
There are various methods of calculating the depreciation:

(i) Fixed percentage on original cost or fixed instalment or straight line method;

(ii) Fixed percentage on diminishing balance or reducing instalment method;

(iii) Sum of the digits method;

(iv) Annuity method;

(v) Depreciation fund method;

(vi) Insurance policy method;

(vii) Revaluation method;

(viii) Depletion method;

(ix) Machine hour rate method; and

(x) Repair provision method.

The following method has been adapted by Industrial, Research and Consultancy Centre for providing depreciation. This method may be recommended to be used by many factories in providing depreciation rate.

MACHINERY AND EQUIPMENT

For machinery and equipment the most essential factors in machine assessment taken in consideration are:

(i) Initial purchase value;

(ii) Date of purchase;

(iii) Working time;

(iv) Estimated life of machine in the industry;

(v) Timing of expenditure; and

(vi) Assessed condition of the machine.

These factors were embodied in the following empirical formula:
\[ V_p = \frac{V_o i(1 + n)C}{N} \] *(18)*

Where:
- \( V_p \) = present value
- \( V_o \) = initial value
- \( i \) = rate of inflation
- \( n \) = actual working time
- \( N \) = useful life of machine
- \( C \) = assessed machine condition

Note:
Depreciation should be calculated for each machine separately *(18)*

7.6.1 **RECOMMENDED METHOD OF CALCULATION**

Machines, vehicles and equipment:
The amount to be written off every year is arrived at as under:

\[ \text{PRESENT VALUE MINUS ESTIMATED SCRAP} \]
\[ \text{ESTIMATED LIFE} \] *(18)*

(iii) Buildings
Depreciation rate amount to 2\% of the premises value. *(19)*

(iii) Building Rent
Annual standard rent amount to 12\% of the total cost of the premises at the time of construction plus 6\% of the land cost *(20)*

(iv) 33\% of the factory expenses are deducted as military expenses, i.e. the production lines incurred 67\% of the factory expenses.
7.5 **DISTRIBUTION OF COST**

These charges which can be attributed -

(i) The process - equipment;

(ii) Buildings;

(iii) Services; and

(iv) Utilities, can be charged accordingly.

Indirect charges which cannot be readily attributed to any of the above directly are allocated on one of the following basis:

(i) Pounds spent;

(ii) Manpower used;

(iii) Floor space;

(iv) Power consumption; and

(iv) Value of equipment.

7.5 **COST SHEET INFORMATIONS**

The following details are extracted from some records and estimate of producing ammunitions of different calibres and shot shells for the year ended 31st December 1987.

Direct materials used were purchased in D.M, $, £ and L.S. in several years (total for production line a, b & c) amount to L.S 1267748.

Direct labour amount to L.S 644425.

Direct expenses amount to L.S 423664.

Indirect salaries and wages amount to L.S 1773118.

Welfare expenses L.S 4020.

Carriage inward & fuel L.S 115319.

Indirect material L.S 407376.

Electric power L.S 35194.

Stationary & Sundry L.S 56397.

Machines and equipment were purchased in D.M, $, £ in several years (total for
<table>
<thead>
<tr>
<th>Item</th>
<th>% Time Inc. in Production</th>
<th>% Time Inc. in Production</th>
<th>% Time Inc. in Production</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>Note 1</td>
</tr>
<tr>
<td>Item 2</td>
<td>15%</td>
<td>25%</td>
<td>35%</td>
<td>Note 2</td>
</tr>
<tr>
<td>Item 3</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
<td>Note 3</td>
</tr>
</tbody>
</table>

**TABLE 1.1**

**APPROPRIATION OF EXPENSES**

- Depreciation of fixed assets
- Rent and other charges
- Interest on borrowed capital
- Salaries and wages
- Materials
- Indirect labor and other expenses
- Direct materials, labor and other expenses
- Depreciation of property, plant and equipment
- Unaccounted for

**Remarks**

- Note 1: Details...
- Note 2: Details...
- Note 3: Details...
all plants) amount to L.s 377655222
Vehicles were purchased in D.M. 8 and L.s in several years amount to L.s 32665111
Buildings were constructed in 1956, 1970 and 1984 amount to L.s 4553571
Line A production amount to 15800000000000 cartridges,
Cal. 7.62 x 51 (NATO)
Line B production amount to 92400000000000 cartridges Cal. 7.62 x 39 (Eastern)
Line C production amount to 30500000000000 shell
According to price list of Ordnance Corps, the selling price of product A, B and C are L.s 0.3, L.s 0.3 and L.s 0.815 successively.
### COST SHEET OF PRODUCING A CARTRIDGE CAL. 7.62 x 51 NATO FOR 1985

**PRODUCTION LINE "A"**

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Total  Rs</th>
<th>Percentage to total cost %</th>
<th>Per Unit cost Rs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct material</td>
<td>820509</td>
<td>24.6</td>
<td>0.442</td>
</tr>
<tr>
<td>Direct labour</td>
<td>270587</td>
<td>8.3</td>
<td>0.149</td>
</tr>
<tr>
<td>Direct expenses</td>
<td>192911</td>
<td>5.8</td>
<td>0.104</td>
</tr>
<tr>
<td>Prime Cost</td>
<td>1291407</td>
<td>39.7</td>
<td>0.695</td>
</tr>
<tr>
<td>Salaries &amp; wages</td>
<td>576440</td>
<td>20.1</td>
<td>0.364</td>
</tr>
<tr>
<td>Welfare expenses</td>
<td>1729</td>
<td>0.5</td>
<td>0.001</td>
</tr>
<tr>
<td>Carriage inward &amp; fuel</td>
<td>76906</td>
<td>2.3</td>
<td>0.041</td>
</tr>
<tr>
<td>Indirect material</td>
<td>263484</td>
<td>7.9</td>
<td>0.142</td>
</tr>
<tr>
<td>Electric power</td>
<td>23158</td>
<td>0.69</td>
<td>0.012</td>
</tr>
<tr>
<td>Stationary &amp; Sundry</td>
<td>18382</td>
<td>0.56</td>
<td>0.007</td>
</tr>
<tr>
<td>Machines &amp; equipment</td>
<td>755628</td>
<td>22.7</td>
<td>0.397</td>
</tr>
<tr>
<td>Depreciation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicles depreciation</td>
<td>71129</td>
<td>2.13</td>
<td>0.033</td>
</tr>
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</table>

**contd...**
<table>
<thead>
<tr>
<th>Cost per Unit</th>
<th>Cost of Production</th>
<th>Factory Overheads</th>
<th>Factory Rent</th>
<th>Rent, Depreciation of Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
<td>3.33</td>
<td>0.1</td>
<td>0.05</td>
<td>0.03</td>
</tr>
<tr>
<td>0.05</td>
<td>3.33</td>
<td>0.1</td>
<td>0.05</td>
<td>0.03</td>
</tr>
<tr>
<td>0.05</td>
<td>3.33</td>
<td>0.1</td>
<td>0.05</td>
<td>0.03</td>
</tr>
<tr>
<td>Product</td>
<td>Cost per Unit</td>
<td>Sales Price</td>
<td>Markup</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>---------------</td>
<td>-------------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>Item A</td>
<td>$5.00</td>
<td>$10.00</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>Item B</td>
<td>$7.50</td>
<td>$15.00</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>Item C</td>
<td>$10.00</td>
<td>$20.00</td>
<td>50%</td>
<td></td>
</tr>
</tbody>
</table>

**Total Cost**:

- Direct Labor: $35,000
- Direct Material: $25,000
- Indirect Material: $7,000
- Labor & Wages: $18,000
- Factory overhead: $12,000
- Direct Expenses: $5,000
- Office expenses: $1,000
- Administrative & selling: $3,000

**Total Expenses**:

- Total expenses: $63,000
- Total cost: $50,000
- Gross profit: $13,000

**Production Line**:

- Cost sheet for production of a cartridge: 7.62 × 39, 50 rounds
- 10 rounds
<table>
<thead>
<tr>
<th>Description</th>
<th>Cost of Production per Unit Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant and buildings</td>
<td>GB£2.7</td>
</tr>
<tr>
<td>Telephone and postern</td>
<td>GB£0.2</td>
</tr>
<tr>
<td>Factory department</td>
<td>GB£0.1</td>
</tr>
<tr>
<td>Other than above</td>
<td>GB£0.01</td>
</tr>
<tr>
<td>Total</td>
<td>GB£3.0</td>
</tr>
<tr>
<td>Date</td>
<td>Ref.</td>
</tr>
<tr>
<td>--------</td>
<td>------</td>
</tr>
<tr>
<td>0.3946</td>
<td>1.17</td>
</tr>
<tr>
<td>0.0249</td>
<td>1.17</td>
</tr>
<tr>
<td>0.0628</td>
<td>1.17</td>
</tr>
<tr>
<td>0.0526</td>
<td>1.17</td>
</tr>
<tr>
<td>0.0000</td>
<td>0.06</td>
</tr>
<tr>
<td>0.0046</td>
<td>0.06</td>
</tr>
<tr>
<td>0.0060</td>
<td>0.11</td>
</tr>
<tr>
<td>0.0090</td>
<td>0.11</td>
</tr>
<tr>
<td>0.0049</td>
<td>0.11</td>
</tr>
<tr>
<td>0.0049</td>
<td>0.11</td>
</tr>
</tbody>
</table>

**Production Line Costs**

<table>
<thead>
<tr>
<th>Cost of production (above)</th>
<th>$94,900</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory expenses</td>
<td>$3,947</td>
</tr>
<tr>
<td>Depreciation of Buildings</td>
<td>$7,191</td>
</tr>
<tr>
<td>Total</td>
<td>$12,037</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost</th>
<th>Total</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/14</td>
<td>0.314</td>
<td></td>
</tr>
<tr>
<td>0.126</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- Production LINE #4.
The local production of ammunitions can be increased to much more than that rate, when all installed machinery are properly utilized.

When the factory maximizes the output and minimizes the overhead expenses, the cost per unit can be minimized.

7.7 **STATEMENT OF PROFIT OR LOSS**

It is apparent that from our description and analysis of the factory, that this cost of producing a cartridge is higher than any factory of same or comparable operating condition. When this factory was established the cost was expected to be as low as the cost of foreign product.

This large difference indicates that the factory is operating at a loss, given the circumstances of the time. Economists will therefore either call for closing such a firm or improve its technical ability.

It is preferable to pursue the latter for the conditions stated in previous chapters.

However, it is an important recommendation to establish cost account department. This department should ascertain the marginal cost, breakdown analysis, profit or loss volume ratio, etc., to assess the effect on profit of changes in volume or type of output.

Thus, this department is useful for managerial decisions.
<table>
<thead>
<tr>
<th>Date</th>
<th>Exchange Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1957-1971</td>
<td>£ = 1.3 7.4280</td>
</tr>
<tr>
<td></td>
<td>£ = 1.6 0.368764</td>
</tr>
<tr>
<td></td>
<td>D.M = 1.8 0.080546</td>
</tr>
<tr>
<td>1.6.1979</td>
<td>D.M = p.t 20.9113</td>
</tr>
<tr>
<td></td>
<td>£ = 8 0.5220</td>
</tr>
<tr>
<td>16.9.1979</td>
<td>£ = 2 2.420</td>
</tr>
<tr>
<td>0.11.1981</td>
<td>£ = 1.11</td>
</tr>
<tr>
<td>15.11.1982</td>
<td>£ = 1 0.7692</td>
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<tr>
<td>21.10.1984</td>
<td>£ = 1 0.4762</td>
</tr>
<tr>
<td>9.2.1984</td>
<td>£ = 8 0.6</td>
</tr>
<tr>
<td>Year</td>
<td>Index</td>
</tr>
<tr>
<td>------</td>
<td>--------</td>
</tr>
<tr>
<td>1926</td>
<td>100</td>
</tr>
<tr>
<td>57</td>
<td>176</td>
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<td>58</td>
<td>183</td>
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<td>59</td>
<td>191</td>
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<tr>
<td>61</td>
<td>237</td>
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<td>62</td>
<td>238.5</td>
</tr>
<tr>
<td>63</td>
<td>239.2</td>
</tr>
<tr>
<td>64</td>
<td>241.8</td>
</tr>
<tr>
<td>65</td>
<td>244</td>
</tr>
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<td>252</td>
</tr>
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<td>82</td>
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<tr>
<td>83</td>
<td>160.8</td>
</tr>
<tr>
<td>84</td>
<td>780.4</td>
</tr>
<tr>
<td>85</td>
<td>789.6</td>
</tr>
</tbody>
</table>
CHAPTER (8)

CONCLUSIONS AND RECOMMENDATION
products, both in quality and quantity. At present there are a number of factors hindering army factories development. Ammunition factory is one among these factories unable to work at a satisfactory level, due mainly to environmental and managerial factors.

8.1.2 THE MAJOR FACTORS

- Inadequate organization structures
- Lack of clear objectives, targets and cost awareness.
- Lack of coordination between production, quality control, and maintenance work and overruling of their activities.
- Absence of production planning and control to coordinate the various functional activities.
- Lack of information systems and inadequacy of information for effective decision-making.
- Lack of information and statistical data for planning purposes and control.
- Machines, parts and raw materials are not purchased on scientific and economical basis.
- Poor quality control system is applied
- Inadequate supplies of raw materials, tools and spare parts.
Lack of adequate storage and appropriate stock control.
Shortage of foreign currencies for the importation of spare parts, tools and raw materials.
Lack of equipped workshops to produce spare parts and tools.
Absence of maintenance unit, maintenance plans, and lack of spare parts and skilled labour.
Absence of training systems.

8.3 RECOMMENDATIONS

Since the army factories will be one of the most important productive units in the F&F, it will be necessary to facilitate the success of all plants. The management of the army factories should be selected on specific criteria. Managers "commanders" must be given full responsibility and authority to run plants on profit and loss basis.

Specified targets to be achieved over a stated planning horizon must be set.

8.3.1 REQUIREMENT

This requires:

Revision of the current organization structure and staffing level in accordance with targets set.

The proposed organization Appendix "A", fig. 2.4 to fig. 2.7 is recommended to be implemented for two years and revised periodically.

Units which are lacking should be established and included according to the principle of the right man in the right place basis.
THE MAJOR UNITS REQUIRED FOR THE PROPOSED ORGANIZATION FRAMEWORK ARE:

- Statistics Unit
- Research and Development Unit
- Finance and Marketing Unit
- Stock Control and Purchasing Unit
- Accounts and Costing Unit
- Maintenance, Repair and Safety Unit
- Salvage Unit.
- Legal Advisor
- Establishment of planning, coordination and follow up directorate to plan, coordinate and monitor the progress of plans.
- Establishment of work study unit to provide management with adequate information for decision-making and control of the various processes.
- The army factories must allocate enough funds and resources to improve the collection, processing, and publication of data and information. "A computer complex is recently purchased but not yet installed"
- The reform should aim at providing statistics which are comprehensive, accurate and up-to-date to meet the requirements of all wings and departments.
- The department of statistics must provide the necessary formula for data supply and state the time of delivery. This will ensure uniformity and consistency.

"Some forms are attached Appendix, "E"
- The army factorie commander must give priority to the information systems.
- The activities of the various functional areas should be coordinated. Duties and responsibilities should be specified. 
- Job specification Appendix (1)
- Raw materials to be planned for in advance with control systems. It is now high time to introduce simple control techniques such as shown in Fig. 5.1 to 5.3 and table 2.1.
- Records, forms, cards attached in appendix "f" and "h" are to be in use to manage items movement.
- All depots should be unified together within the recommended salvage unit and managed by technical affair directorate.
- The army headquarters may allocate enough foreign currencies and funds to import production requirements "raw materials - tools and parts".
- Rehabilitation and establishment of toolshops to produce spare parts and tools locally and calibration is necessary.
- Establishing and upgrading of maintenance, repair unit and the provision of sufficient facilities for them to carry out their duties.
- Introduction of planned preventive maintenance systems, with a target to reach the optimum level.
- Maintenance should be given due importance in terms of its level in management hierarchy.
- Establishment of work standards, costing system and incentive schemes.
- Design of training programmes to enhance target attainment.
Training should be on job and in the training institutions.

Management should delegate enough authority and responsibilities to enable subordinates to act and allow themselves time for planning current and future operations.

9.2.2 IMPLEMENTATION COST

Implementation cost for the various recommendations were not covered in this study. However, at the present situation in the army factories, the various implementation cost will be fully justified. The reduction in cost and the increase in productivity and revenue will compensate, in the long run, for all incurred cost.
APPENDIX "A"
TOTAL WEIGHT = 333.161 GRAMMES
CASE INTERNAL CAPACITY
3.6 LITIRES
<table>
<thead>
<tr>
<th>ASME Symbol</th>
<th>Name of Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Operation</td>
</tr>
<tr>
<td></td>
<td>Inspection</td>
</tr>
<tr>
<td></td>
<td>Transportation</td>
</tr>
<tr>
<td></td>
<td>Delay</td>
</tr>
<tr>
<td></td>
<td>Storage</td>
</tr>
<tr>
<td></td>
<td>Combined Activity</td>
</tr>
</tbody>
</table>

AS STANDARIZED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
SEQUENCE OF OPERATIONS FOR CARTRIDGE, BALL.

BULLET

PROPELLANT

CARTRIDGE

CASE

LOAD & ASSEMBLE

FIG 4.10
PROPOSED PROCEDURE FOR PRODUCT CONTROL

1. FIRST PIECE INSPECTION
2. OPERATOR CHECKS PARTS
   - OPERATOR SCHEDULED
   - OUTPUT BETWEEN INSPECTION CHECKS
3. PATROL INSPECTION ON REGULAR SCHEDULE
4. INSTRUCTOR OK'S JOB
5. INSPECTOR REJECTS JOB
   - SPECIAL PROCESS STUDIES
   - CORRECTIVE ACTION
     - MOVES FLOORS FOR MAN
   - INSPECTOR OK'S LOT
   - FACTORY SORTS NONCONF. PARTS FROM LOT

FIG 4-11
APPENDIX "D"

SPECIFICATION
To govern manufacture and inspection of cartridge 7.62 x 51 mm "NATO"

SECTION D-1 GENERAL

1. The dimensions and form of the round are to be strictly in accordance with the design and the quality and materials are to conform to the specification. Except with the sanction of the Sudanese Ordnance Corps, no departure is to be made from the dimensions laid down in the drawing and no change is to be made in the quality or nature of the materials or in the methods of treatment in manufacture where such are laid down in the specification.

Any question relating to the drawings or this specification should be referred to the Sudanese Ordnance Corps.

2. Where the drawing or specification permits a choice of alternative materials or forms for particular components, the manufacturer shall notify the inspecting officer, in writing, which of the permitted alternatives he chooses to produce. If the choice of alternatives is changed during the course of the contract, the manufacturer shall again notify the inspecting authority of such change.

SECTION D-2 COMPONENTS & MATERIALS

1. CASE

The case is to be manufactured in accordance with the drawing from brass containing 71.5% copper and 28.5% zinc.
1.1 The finished case should conform to the following hardness figures and must not be departed from without prior reference to the Inspecting officer.

Position

0.25" (6.3 mm) to Mean difference between these two points. Maximum at 1.5" 10
1.50" (38.1 mm) from base Minimum at 1.5" /60
(38.1 mm) 130

1.2 The finished case is to be concentric, of clean surface externally and internally, free from scratches, flaws, folds, spilly metal or other similar defects.

1.3 Before loading into complete rounds, cases will be submitted to case proof as laid down in section - 4 proof, of this specification, and in addition will be tested for case capacity. Thereafter the cases will be accepted for loading or otherwise at the discretion of the Inspecting officer.

2 CAP

The metal used for the manufacture of the cap shells is to be brass of the same quality and composition as used for the case. The cup is to be circular, fit tightly in the cap chamber so that there is no blow back when the round is fired and is to be clean free from scale, lamination or other surface defects.
2.1 A number of filled caps (minimum 40) will be selected from each lot and assembled into cases.

The caps will not be ringed - in. The capped cases will be tested for sensitivity and insensitivity in an approved apparatus, using a carbon steel ball weighing exactly 80 (227 grams).

2.2 A minimum of 20 caps will be tested for sensitivity by dropping the steel ball 7 inches (17.8 cm). One hundred percent of the caps tested must fire satisfactorily.

2.3 A minimum of 20 caps will be tested for insensitivity by dropping the steel ball 2 inches (5.08 cm). One hundred percent of the caps tested must not fire.

2.4 Should a failure occur in either test, a second proof will be taken, and should a failure occur in the second proof, or more than one at the first proof, the lot of caps will be rejected.

3 CAP COMPOSITION

The cap composition is to be composition VH.2 and must comply with the current approved specification.

4 BULLET

The bullet will be made to the form and dimensions shown on the drawing. The metal used for the envelope will be gilding metal and will consist of:-
Copper = 90%
Zinc = 10%
The core will consist of:
Lead = 90%
Antimony = 10%

From each day's run of work, or any other form of lotting agreed with the manufacturer, at least 60 bullets will be selected at random from the machines, loaded into complete rounds, and subjected to the following test:

4.1 60 rounds will be fired for bullet casuality.

4.2 10 rounds will be fired for bullet recovery. Should a defect occur at the first proof, a second proof will be taken, and if there is a further similar defect at the second proof, or more than one at the first proof, the bullets may, at the discretion of the Inspecting officer be rejected.

5 PROPELLANT
The propellant is to be single base or double base of an approved type and charge that will meet the ballistic requirements indicated in section 4. Proof of this specification.

6 VARNISHES
The varnish to be used if prior permission is obtained.

6.1 Varnish cap Anulus is to be coloured with an approved purple dye and must not chip off during firing.
6.2 Varnish cellulose Ester, lead free, coloured with an approved dye is to be used for the disc and internal surface of the cap.

6.7 Varnish, oil - bitumen (Ed. 1279) is to be used for the internal varnishing of the case mouth.

7 DISC

The discs are to be made from paper, writings Parchment and are to be clean cut, circular and free from perforations.

ASSEMBLY B-3

CAP

After charging and discing, the disc is to be varnished in such a manner as to form an effective waterproof seal and the assembled cap is then to be thoroughly dried.

INSERTION OF CAP IN CASE

The cap is to be inserted in the case and secured as shown on the drawing.

The cap must be a tight fit in the cap chamber and there must be no distortion or tilting of the cap, or distortion of the anvil or cap chamber.

After securing, the cap is to be varnished with a purple varnish so as to seal the junction of the cap chamber.

The residue of the purple varnish is to be removed so that the surfaces of the cap and base of the case are left unvarnished.
BULLET

The bullet core is to be pressed home so that it completely fills the envelope, the end of which is to be pressed over the base of the core as shown on the drawing.

INSERTION OF BULLET IN CASE

Before insertion of the bullet, the internal neck of the case is to be varnished. After varnishing the internal neck of the case the bullet is to be secured in the case within 7 days, and this period is only to be exceeded with the prior permission of the Inspecting officer.

The force required to extract the bullet must not be less than 70 lbs (32 kg), and the securing of the bullet must not cause undue stresses in the metal of the case.

COMPLETE ROUND

The assembled rounds must be of uniform weight, and each and every round of the lot must not vary more than plus or minus 8 grains (0.5 gram) from the mean weight. One round = round's mean weight + 0.5 gm.

SECTION D-4 PROOF

1. QUANTITY FOR PROOF

The quantity selected for proof will normally be 500 rounds per lot, but the quantity may be increased at the discretion of the Inspecting officer.
When loaded with the specified service charge and heated to 175°F (80°C) for 2 hours and fired, both dry and with chambers oiled, from service weapons with maximum cartridge head space permitted in the service, there must be no separation or distortion of the case and no serious cap casualty.

Cases failing to comply with these conditions, may at the discretion of the inspecting officer, be rejected.

Airtightness Test

The finished rounds must be airtight and may be subjected to rough usage trials to ensure that the ammunition retains this quality when packed in service packages.

2.1 A vacuum test will be applied, as detailed in section 6, and must show not more than 20% fast leak or 50% slow leaks or any equivalent combination of these two defects.

Velocity

The mean observed velocity after correction by the results obtained with standard ammunition fired on the same day in the same barrel is to be within 2660 ± 40 ft/sec (810.7 ± 12.2 m/sec) measured at a distance of 90 ft (27.5 m) from the muzzle, the rounds being heated to 80°F (27°C) before firing. The mean difference of the velocities from the mean velocity is not to exceed 30 ft/sec (9.2 m/sec).
Ammunition will not be rejected under this clause on the result of less than 20 rounds.

5

PRESSURE

The mean pressure in the chamber, after correction by the results obtained with standard ammunition, fired on the same day in the same barrel, is not to exceed 22.3 tons/sq. in (1512 kg/cm²) and the pressure of no single round is to exceed 23.8 tons/sq. in (1676 kg/cm²) as measured in a radial pressure gauge, using service 'L' couplers initially crushed by a dead load of 154 lbs (692.7 kgf), the rounds being heated to 80° F (27° C) before firing.

5.1 Ammunition will not be rejected under this clause on the result of less than 20 rounds.

6

ACCURACY

When fired from a service .62 mm weapon or barrel mounted in a fixed seat at a range of 500 yards (457 m), the mean figure or merit of not less than 4 targets of 20 rounds each must not exceed 8 inches (20.3 cm). A shot which strikes more than 3 feet (91.4 cm) from the mean point of impact of that target will be considered a miss.

If the mean figure of merit exceeds 8 inches (20.3 cm), or if a miss occurs, a second proof will be taken. If the mean figure of merit exceeds 8" (20.3 cm) on the second proof or more than one at the first proof, the ammunition may be rejected.
HANGFIRES

The cartridges must fire with regularity, and be free from hangfires. Cartridges will be deemed to show hangfires if the variation in the period which elapses from the time the striker hits the cap to the emergence of the bullet from the muzzle, as measured by a chronograph or other suitable means, exceed two thousandth of a second.

Should a hangfire occur at the first proof, a second proof will be taken, and should a hangfire occur at the second proof, or more than one at the first proof, the ammunition, may, at the discretion of the inspecting officer, be rejected.

CASUALTY

A portion of the cartridges selected for proof will be fired to ascertain that they are free from other defects. These rounds may be fired in rifles or machine guns of any service type, and in any state of wear within service limits. They must be easy to load and extract without splitting or fracture of any kind. If there is a misfire, audible hangfire, pierced cap, escape of gas around the cap, stripped envelope, bullet which fails to take the rifling, or if the ammunition gives excessive metallic fouling or shows any other defect which the inspecting officer may consider of importance at any proof whatsoever, a second casualty proof will be taken. If there is a further similar defect at the second proof, or more than
once at the first proof, the ammunition may be rejected.

9 BURST CASE

A burst case is defined as any separation or fracture of the metal of the cartridge case within 1 inch (25.4 mm) of its base.

Should a burst case or cases occur at any proof the delivery may be rejected and a special examination for case defects will be made of adjacent deliveries.

10 LIABILITY TO SEASON CRACKING

(i) Complete round test

A number of complete cartridges will be subjected to a mercurous nitrate test as detailed in section 9. After immersion in the mercurous nitrate solution no cartridge case shall show cracks in any part.

(ii) Fired case test

A number of complete cartridges will have the bullet and powder removed and the case fired. The cartridge cases will be subjected to the test as detailed in section 9. After immersion the cases will be rinsed and the mercury on and in the cases removed by heating. No cartridge case shall show cracks in any part. This test will be discontinued when 5 consecutive lots are found free of splits.

11 GENERAL DEFECTS

Should the firing proof or examination of any delivery bring to notice any defect
which in the opinion of the Inspecting officer, affects the serviceability of the cartridges, the delivery may be rejected or further proof taken at his discretion. If the defect is one which is liable to be present in adjacent deliveries, increased proof may be taken also from these even if they have already been accepted.

Proof of adjacent deliveries may be continued until three successive deliveries are found to be clear, both prior and subsequent to the delivery exhibiting the defect. All deliveries from the first to the last exhibiting the defect may be rejected, even if some of these have not actually shown the defect, and the acceptance of any of these deliveries which may already have been accepted may be cancelled.

The rounds will be stamped on the base as shown on the drawing. The year of manufacture will date from 1st January to 31st December.

SECTION 9-6 DELIVERY

1. The rounds normally will be supplied in lots which do not exceed 500,000 and which should not be less than 250,000.

1.1 Rounds manufactured from different batches of propellant are to be kept separate, each delivery being made from one batch of propellant only.
SECTION D - 7 INSPECTION

1. Method of Inspection

The components of the rounds may be inspected and/or proof tested during manufacture by, and on completion will be subject to examination, testing or analysis by, and to the final approval of the Inspecting officer, who shall, as a condition of the contract, have right of entry into the Manufacturer's factory.

2. Taking of Samples

The Inspecting officer may, at his discretion, take samples of any material used in the manufacture of the rounds or samples of any of the components or complete rounds for the purpose of testing or chemical analysis. The table in Appendix "C" sampling plan should be used to determine how often you read to sample.

3. Final Inspection

The finished rounds will be weighed, gauged and examined, and a portion of the proof quantity will be broken down to ensure that rounds and components comply with the specification and drawing. Any rounds which do not comply with the specification or drawing, or which exhibit scratches, damage or other defect, may be rejected.

4. Resubmission of Rejected Rounds

Rounds rejected under this specification are not to be resubmitted without the permission of the Inspecting officer.
Control charts are also used to indicate the degree of conformance of products or processes over a period of time. They reflect the relative comparison of quality to established standards or levels, or the degree of variation from the average. Variation is inherent in all natural events. Variation in the quality of processed parts are inevitable. The idea of an exact repetitive operation is unrealistic. The sources of such variations are materials, machines, man, and processing conditions. The purpose of control charts then is to identify those instances when quality exceeds the acceptable degree of variation. Appropriate action should be taken at this time to return the process to an acceptable level of quality performance.

E.3 DESIGN

(a) Control charts must be tailored to the product or process to be controlled. Normally, charts will be limited to repetitive products or processes.

(b) The most common control chart is the "p" (percent defective) chart. This chart shows the quality of defective products or processes as a percentage of the total inspected. The chart provides a convenient method of measuring lot-by-lot quality or day-to-day performance. Once a "p" chart has been established, it will provide an overall look at the production picture. It tells whether a process is operating in a normal
pattern, as compared to past performance, or whether there are variations from day-to-day that require action. The \( P \) chart may be used regardless of whether 100 percent inspection or sampling inspection is used.

Figure 4.12 is an example of the construction and information contained on a \( P \) chart. In this illustration the \( P \) chart shows inspections results obtained in machine No. 7111 "patrol inspection".

Assume a 1/4% AQL. The desired quality level AQL 1/4% is indicated on the chart to reflect the relationship of the established goal with the process average. The upper limit (0.008) is reflected on the \( P \) chart to establish the degree of variation in day-to-day operations that can be expected to occur. The inspection results are then plotted on the chart and process average \( \bar{P} \) for the 25 consecutive observations is determined and indicated. In reviewing the complete \( P \) chart for the patrol inspection operation it is concluded that the operation is in a state of control since a large portion of values are below the control limit.

If some defectives occur on certain dates, it may require investigation to determine causes when identified. In addition, the degree of variance between the AQL and process average \( \bar{P} \) indicates that some further adjustments may be required. Further trends of this operation should be closely observed to determine if a significant variance continues between the AQL and process average.
If a wide variance continues, an increase in the AQL may be justified since the value may not be realistic and attainable. An alternative to an increase in the AQL may be the review of the process itself to determine adjustments that can be economically instituted to improve the quality level of item produced, thereby reducing the process average.

Determination of appropriate action to be taken should be based on local evaluation of all factors involved.

(d) In many situations it may be more appropriate to plot inspection data as measurements control chart rather than percentage defective. This is particularly applicable to a bullet operation process, for the production of bullets whose weight tolerance was "0.45 ± 0.005". A frequency distribution analysis had been preliminarily carried out while the setup was being made. This analysis showed the setup to be satisfactory for the start of a long production run. To establish a measurements control chart to analyze and then control the quality of these bullets, during the subsequent production run, the following eight steps are followed:

Step 1:

Select the quality characteristic the weight of the bullet is most critical, and this is the characteristic for the control of which the chart is to be established.
Step 2:

Gather data for reasonable time about 7250 bullets are produced each hour. With a sample size of five bullets - one reading per bullet on five bullets - it can be arbitrarily assumed that one sample every 15 minutes may be selected for the purpose of setting the control limits. This decision is a practical matter of balancing such factors as cost, probable machine drift, availability of inspectors, and accessibility of gauging equipment. Measurements of the required 25 samples will be taken by an inspector and recorded on a form similar to that shown in table 4:2 & 4:3 table 4:2 & 4:3.

Step 3:

Compute the average and range for samples. Using formula $\bar{x} = \frac{\sum x}{n}$

Where:
- $\bar{x}$ = average value (called X bar) of the series $x_1, x_2, \ldots, x_n$ = value of successive readings
- $n$ = number of readings

(The fourth decimal is shown in this example simply for illustrative purposes)

Using formula $R = X_{\text{high}} - X_{\text{low}}$

where:
- $R$ = range value
- $X_{\text{high}}$ = highest reading in series
- $X_{\text{low}}$ = lowest reading in series
Similar calculations may be made for the other samples in Table 4:3. The average and range readings for each sample are plotted in the appropriate spot on the control chart. Figure 4:13 & 4:14.

Step 4:

Determine the grand average and the average range. Using formula:

$$\bar{Y} = \frac{\sum Y}{n} = 9.484$$

The average range may be similarly calculated using formula:

$$\bar{R} = \frac{\sum R}{n} = 0.0937$$

Step 5:

Compute the control limits:

The appropriate formula for computing these control chart limits are:

Averages:
- Lower limit = $\bar{Y} - 3 \bar{R}$
- Center line = $\bar{Y}$
- Upper limit = $\bar{Y} + 3 \bar{R}$

Ranges:
- Lower limit = $D_3 \bar{R}$
- Center line = $\bar{R}$
- Upper limit = $D_4 \bar{R}$

Referring to (Reproduced from ASTM -STP 15D by kind permission of the American society for Testing and Materials). For the constants that are applicable for a sample size of 5, it shows that

- $D_3 = 0$
- $D_4 = 2.114$
- $D_6 = 1.427$
Substituting the above const. in the previous formula therefore:

**Averages:**
Lower limit = \( \bar{X} - \bar{A}_3 \bar{R} \)
= 9.684 - 1.427 x 0.39764
= 8.427

Upper limit = \( \bar{X} + \bar{A}_3 \bar{R} \)
= 9.684 + 1.427 x 0.39764
= 9.941

**Ranges:**
Lower limit = \( D_3 \bar{R} \)
= 2.114 x 0.0937 = 0.198

Upper limit = \( D_4 \bar{R} \) = Zero

These control limits may be plotted on fig. 4:13 & 4:14.

Interpretation of the control chart for average. Process is under control if the plotted averages lying regularly within the control limits. If the bulk of the plots are near to the central line then process is firmly under control. If, on the other hand the bulk of the plots are lying symmetrically above and under the control line, then the process is moderately controlled. However, in such a case a range control chart is needed to measure the variability with the moderately controlled plots.

Range control chart: If the plots are scattered normally with narrow dispersion around \( \bar{R} \) the average range the variability is also controlled.

The conclusion in both suggest that process is not under control because the process is moderately control in terms of location.
Taking average control chart (fig. 4:13). We resort to the R chart (fig. 4:14). It indicates that the bulk of the plots are out of control i.e. the regularity of location is robust and a source of variability has been observed. Further investigation may suggest resetting the machine.

These are some examples to illustrate the techniques normally used in TQC. We recommend to follow such pattern.
# QUALITY DATA SHEET NO.

**MACHINE NO:** 08  
**OPERATION:** 2111  
**INSPECTION:** PATROL  
**OPERATOR:** PAUL LE FALCIONN  
**MONTH:** AUGUST  
**CHARACTERISTIC:** ALL defects  
**SUPERVISOR:** WALTER DETTEYAGOP

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**TABLE 4-2**
RECOMMENDED FORMS AND CARDS WHICH MAY BE ADAPTED TO BE USED IN ARM FACTORIES

- Purchase order
- Procurement Record card
- Stock Record Card "Rincard"
- Replenishment order
- Material Requisition
- Identity label
- Goods Inwards inspection report
- Reject note
- Goods received note
- Ledger Card.
Date: ____________________________

1. You are requested to submit quotations in the form for the supply of the following articles from sources available locally specifying rate of delivery:

   - [List of articles and quantities]

2. Quotation should be submitted in sealed envelope marked, "Quotation for the above article on or before _____."

3. Signature of sender and an address will be required with quotation.

4. Quotation must be received within the time specified.

Head of Unit: ____________________________

[Signature]

Address: ____________________________

Data: ____________________________

[Signature]
FORM INSTRUCTION

F.1 PURCHASE ORDER

1. PURPOSE

To provide the full name and address of the supplier of the goods.

To provide a purchase order number to identify the order.

To provide a material code and clearly describe the goods to be purchased.

To provide price details and indicate the delivery date promised by supplier for the goods.

2. HOW USED

There are existing forms in Arabic local purchase orders attached in this Appendix. These forms are used by storekeepers.

They can readily be adapted for use by the recommended purchase unit in the proposed organization.

TENDERS

Tender forms will be typed in duplicate, one copy for the potential supplier, the other held in purchasing until all tenders have been returned for consideration.

LOCAL PURCHASERS

Local purchase orders will be typed in order sets, with a pre-printed order number on all copies of the set. Copies will be distributed to
Supplier
Purchasing
Stock control
Depots
Accounts

order details for local and imported goods will be obtained from material procurement requisitions submitted by stock control.

3. **HOW COMPILED**

Tenders will be typed in duplicate following a request either on a procurement requisition from stock control or a request from a maintenance engineer or other departmental manager. Tenders can be for bulk purchases or small quantities of goods.

4. **WHEN COMPILED**

Each time an order for goods is to be placed.

5. **BY WHOM COMPILED**

Purchasing department

6. **ISSUED TO**

Tenders
Potential suppliers
Purchasing
Purchase orders
Suppliers
Purchasing
Stock control
Depots
Account
7. NOW FILED

TENDERS

After issue of tenders to suppliers the purchase department copy of the tender will be filed in order number in numerical sequence in a pending file. On receipt of quotations the tenders will be withdrawn, purchase orders raised and tenders filed in a completed file in numerical sequence.

PURCHASE ORDERS

The supplier copy will be dispatched to the supplier the purchase order copy will be filed in order number sequence in a pending file, with a cross reference for highlighting when progress action should be taken. When an order has been received the purchase order copy will be filed in completed file in numerical sequence.

The goods received note and inspection report for the purchase order will be attached. After 2 years they will destroyed.

Stock control will hold their purchase order copy in an outstanding order file until the goods received note and inspection reports are received. Details of receipt will be recorded on the stock record cards "Bin cards", then the purchase order with the goods received note and inspection report will be filed in purchase order sequence for one year then destroyed.

The stores copy of the order will be withdrawn from the outstanding order file, which will be in purchase order sequence when
the goods are received. After preparing the goods received note the purchase order copy, with the inspection good. received note copy will be passed to the inspector. After inspection the purchase order copy will be returned to the stores with the stores copy of the inspection report. If the goods pass inspection they will be placed in stock and the purchase order placed in a completed file in purchase order number sequence until after annual audit then destroyed. Should goods be rejected, the inspection report will be attached to the purchase order and re-filed in the outstanding order file until replacement of the goods arrive. It will then be placed in a completed file if goods pass inspection.

The account copy will be held until purchasing sends a weekly list of completed orders. Most orders will be paid for in advance, those which are paid monthly will be paid in accordance with the list submitted by purchasing. After payment the accounts copy of the order will be filed in a completed file until after annual audit, then destroyed.
FORM INSTRUCTION

P.2 PROCUREMENT RECORD CARD

1. PURPOSE

To provide details of purchase orders placed.
To provide supplier details.
To provide the cost comparison between prices paid over a period of time and delivery charges made.
To supply the unit of quantity by which the goods will be ordered.
To enable procurement lead times to be established.
To allow the standard cost of the goods to be allocated.

2. HOW USED

A procurement record card will be raised for each item of goods that is ordered. Initially every purchase order raised will require a procurement record card to be prepared but as orders for goods are repeated, the preparation of cards will be reduced.

Only after a period of time will it be possible to establish lead times, suppliers and standard cost data for each item of goods. As each purchase order is raised, the order details together with price and the delivery promised, will be inserted on the record card. Over a period of time the ability of suppliers to meet delivery promised dates will also be indicated.
3. How Compiled

A procurement record card will be raised for each item of goods ordered by the purchasing department. The following information will be handwritten on the procurement records card.

DESCRIPTION

A complete description of the goods, to enable ordering action to be taken, by quoting the description on the card.

MATERIAL CODE

The numerical classification allocated to the goods.

DATE

Date the purchase order was placed.

ORDER NO.

The purchase order number.

SUPP. CODE

The reference number of the supplier, listed at the bottom of the card.

QUANTITY

The quantity of the goods ordered.

PRICE TERMS ETC.

The price agreed to be paid for the goods, transport costs, method of payment etc.

DELIVERY PROMISED

The agreed date by which the supplier promised to deliver the goods.

ACTUAL DELIVERY

The actual date the goods were received.
PROCUREMENT NO.
The pre-printed requisition number of the procurement requisition, from which the purchase order was raised.

UNIT QTY
The basic quantity by which multiples of the goods will be ordered.

STANDARD COST
The standard cost established for the part, for a particular period of time.

SUPPLIER
The supplier's name and code number, the code number is referred to under supp. code.

4. WHEN COMPILED
A procurement record card will be raised for each item of goods that is ordered, until all stock items have record cards prepared. These provide a detailed history of cost values and quantity usage of the part.

5. BY WHOM COMPILED
The purchasing department.

6. ISSUED TO
Procurement record cards will be retained in the purchasing department.

7. HOW FILED
Procurement record cards will be filed in material code sequence. After the front of the card has been used, the reverse will then
be used for recording order details. As each is filled, additional procurement record cards will be introduced and filed together with the existing cards. After a period of time, depending on the number of cards used; surplus cards will be removed and filed in a historic record file.
FORM INSTRUCTION

F.3 STOCK RECORD CARD

1. PURPOSE

To provide a permanent record of the stock movement of parts.
To enable stock levels to be maintained at a pre-determined level.
To indicate when ordering action is necessary to replenish the supply of parts.
To indicate when issues are made from stock.
To indicate when material or parts are received into stock.
To provide the stock position of material or parts held in the depots.

2. HOW USED

Each time action is taken concerning stock movement, this will be recorded on the respective stock record cards i.e.:

(i) When a replenishment order or purchase order is placed, order details will be inserted.

(ii) When the material or parts are received, the details will be recorded.

(iii) When parts are issued, these will be deducted from the stock balance, thus providing an actual stock position of the part. A stock record card will be held in stock control. The motive is to know the physical stock position in the stores.
Stock control requires this information plus data to take ordering action via production control or the purchasing department, such as maximum stock levels and re-order levels for standard stock items. Other items which are manufactured for other maintenance purposes will be ordered by a maintenance order.

3. **How Compiled**

A stock record card will be raised for each item of goods ordered by stock control. The following information will be manuscripted on the card:

**DESCRIPTION**

A complete description of the material, tools or part, to enable ordering action to be taken, by quoting the description on the replenishment, or purchase order.

**MATERIAL CODE**

The numerical classification allocated to the goods.

**DATE**

Date the order was raised.

**ORDER NO.**

The order number for which the part is to be manufactured.

**ORDER QTY**

The quantity of the material or part ordered.

**RECEIVED QTY**

Quantity of the material or part received into stock.
The quantity of the material or part to be ordered from stock.

ORDER NO.

The order number on which the material or part will be used.

STOCK BALANCE

The quantity of the material or part remaining in stock, after issues or receipt require the new stock position to be calculated.

DELIVERY PERIOD

The normal period of time it takes to manufacture a batch of the part, or purchase material.

MAXIMUM STOCK

The maximum stock level that must be held of the material or part.

Re-order level

The level when re-ordering action will be taken by stock control to replenish supplies, to maintain a regular supply of the material or part in stock.
4. **WHEN COMPILED**

A stock record card will be raised for each item of goods ordered, until all stock items have record cards. These provide a detailed listing of stock movement and the current stock position.

5. **BY WHOM COMPILED**

Stock control for stock control records.

6. **ISSUED TO**

Stock record cards will be retained in stock control.

7. **HOW FILED**

Stock record cards will be filed in part number or material code sequence. As each card is filed, further cards can be introduced into the record cabinet.
FORM INSTRUCTION

P. 4 REPLENISHMENT ORDER

1. PURPOSE

To provide a material code and description of the parts required.

To provide the quantity required and the date on which delivery is required, i.e the lead time established for the part.

To indicate the cost centre code to which the cost of the parts will be charged.

2. HOW USED

A replenishment order will be raised in duplicate, in the requisition book provided for this purpose, when parts require to be manufactured. The top copy of the requisition which will be perforated will be extracted and passed to production control for manufacturing paperwork to be produced. The other copy will remain in the Requisition Book for reference purposes.

Production control will programme the parts for manufacture to meet the completion date required by stock control.

3. HOW COMPILED

Replenishment orders will be printed in Book form, with two copies in each requisition set. The order numbers will be serial, each copy of the requisition set having the same number.

The following information will be manuscripted on the replenishment order copies by the stock control.
DATE
The date the replenishment order was raised.

MATERIAL CODE
The numerical classification allocated to the goods to be supplied.

DESCRIPTION
Authorised name of each part to be manufactured.

SPECIF
The material specification of the parts.

QUANTITY REQUIRED
The quantity of the parts required to be made.

DEPARTMENT
The department or wing which requires the goods.

PREPARED BY
The name of the person who prepared the replenishment order. "stock controller".

AUTHORISED BY
The person authorised to sanction replacement of the parts "technical affairs director".

COST CENTRE CODE
The cost centre to which the cost of the parts will be allocated.

4. WHEN COMPLETED
Each time stock control require to re-order standard stock items, they will raise a replenishment order.
5. By whom compiled
Stock control.

6. Issued to
Production control.

7. How filed
Replenishment orders, passed to production control will be filed in order number sequence after ordering action has been taken, for six months then destroyed.
F.5 MATERIAL REQUISITION

1. PURPOSE

To provide information concerning the quantity, size, and specification of the material required to be issued from stock.

To notify the stores that material or parts will be required for issue on a specific date.

To act as authority for the issue of such materials or parts from stock.

To enable stock records to be updated when the material or parts are issued.

To allocate the cost of the material or parts to a particular replenishment order number or cost centre code.

2. HOW USED

Material requisitions for parts or material will be raised by production control from operation layouts for the parts concerned. Holding of material stocks will be the responsibility of stock control. This department must maintain stock of material and parts to ensure that manufacturing is not hampered, in keeping with the budget level established for stock.

Material requisition will be issued together with identity labels to the stores when issue of parts or material is required.

After the material or parts have been issued, the material requisitions will be passed by the stores, to stock control after the Bin cards have been updated. Stock control will record the issue details on their stock record cards.
3. **HOW COMPILED**

Compiled by production control

Material requisitions will be manuascripted from
the operation layout for the part concerned.
They will have the following information recorded:

**ORDER NO.**
The maintenance or replenishment order number
for which the parts are to be manufactured.

**DESCRIPTION**
The authorised name for the part.

**PART NO.**
The part number allocated to the part to
identify it.

**QUANTITY TO MAKE**
The total quantity required to be
manufactured.

**MATERIAL CODE**
The numerical classification allocated to each
piece of material required to make the part.

**DESCRIPTION**
Authorised name for each piece of material
required to make the part.

**QUANTITY**
Quantity of material required to make the
part.

**SPECIFICATION**
The authorised specification of the material.
DELIVERY TO
The department or location to which the material is to be delivered.

WEIGHT
Weight of material

ISSUE SANCTION
Signature of stock control clerk confirming that material is available for issue.

DATE REQUIRED
Date material is required for issue to manufacturing.

QUANTITY FOR ISSUE
The quantity required for issue, whether for the full batch or part quantity due to lack of material or limited manufacturing capacity.

Compiled by stores or material preparation.

QUANTITY ISSUED
The actual quantity of material issued.

BAL. LEFT
The actual quantity of material remaining un-issued, if only part quantity issued.
* The balance should not fall below the physical minimum.

DATE ISSUED
The date material was made ready and marshalled for issue to manufacturing.

ISSUED BY
The person who prepared the material for issue.
4. **WHEN COMPILED**

Material requisitions will be prepared from the operation layout when works orders are raised by production control to manufacture parts or carry out stripping and assembly work.

5. **BY WHOM COMPILED**

Production control
Stock control
Stores
Material preparation

6. **ISSUED TO**

Material requisitions will be issued by production control to the stores or material preparation for material or parts to be made ready for issue to the workshops.

7. **HOW FILED**

Production control will retain all manufacturing documents together until the work is programmed. When material availability has been cleared, the material requisitions will be issued to the stores or material preparation indicating a requirement date. When material has been issued the requisitions will be passed to stock control for recording issues then filed in material code number until after the annual stock audit, then destroyed.
FORM INSTRUCTION

F.6 IDENTITY LABEL

1. PURPOSE

To identify the material or parts which are to be processed, when issued from stock.
To identify material or parts as they pass through the various operations to completion.

2. HOW USED

The Identity Label will be passed together with the Material Requisition to the stores by production control, for material or parts to be issued. The label will be attached to the material part, or the container housing the contents.

After all the operations are completed, the parts will be delivered to the stores with the label attached, identifying the part and indicating the maintenance or replenishment order number.

3. HOW COMPILED

The Identity Label will be manuscripted from the operation layout for the part concerned. It will have the following information recorded:-

ORDER NO.
The maintenance or replenishment order number for which the parts are to be manufactured.

PART NO.
The official part number allotted to the part.
QUANTITY TO MAKE

The quantity required to be manufactured.

ROUTE

The operations through which the material will pass to completion.

ROUTE

The operations through which the material will pass to completion.

DELIVER MATERIAL TO

The particular machine or department to which the material will be delivered.

4. WHEN COMPILED

Identity labels will be prepared when works order sets are raised to manufacture or repair parts or to replenish supplies of standard parts.

5. BY WHOM COMPILED

Production control.

6. ISSUED TO

One identity label will be issued with each material requisition to the stores or material preparation. When samples are provided these also will have identity labels raised and attached.

7. HOW FILED

Identity labels will be held in production control until released for material issue. On receipt into the stores or material preparation they will be attached to the part, material or container.
On completion of the work the identity labels will identify the parts through inspection into stores stocks, then be destroyed. Parts delivered direct to the maintenance department will retain their identity label until fitted by the maintenance fitter, then destroyed.
FORM INSTRUCTION

F.7 GOODS INWARDS INSPECTION REPORT

"2ND JOB OF T.O.C."

1. PURPOSE

To provide a material code and description of the goods being inspected.

To identify the goods received and relate them to the purchase order.

To provide the supplier's name and advise note reference number.

To initiate corrective action when goods are rejected.

To authorise the goods to be accepted into the stores.

2. HOW USED

A.R.I. Inspection report will be raised by the goods inwards inspector, for all goods received into the goods inwards area. Details of the goods will be available from the copy of the goods received note and store copy of the purchase order.

The goods will be inspected for quality and to comply with any condition specified on the purchase order.

After inspection, the inspector will raise a G.I. Inspection report and indicate whether the goods are accepted or rejected. Should they be rejected, reasons for rejection will be specified on the report. Accepted goods will pass into the stores, reject goods will remain in the inspection area until disposal instructions are obtained from the purchasing department.
3. HOW COMPILED

G.I. Inspection reports, will be printed and bound in book form with four copies per set. Each set will have the serial number. The top three copies of the report will be perforated for easy removal. The fourth copy will remain in the book in the quality control wing as the inspectors record of the report.

The following information will be manu eperated on the report by the goods inwards inspector.

PART NAME

Authorised name of the material or part as specified on the purchase order.

MATERIAL CODE

The numerical classification allocated to the goods and quoted on the purchase order.

SUPPLIER

The name of the supplier of the goods.

ADVICE NOTE NO.

The serial number of the advice note sent by the supplier describing the goods.

QUANTITY GOODS

The quantity of the goods that have passed inspection.

QUANTITY REJECTED

The quantity rejected of the goods that have not passed inspection.
PURCHASE ORDER NO

The number of the purchase order to which the goods relate.

DATE OF ORDER

The date the purchase order was placed.

DATE RECEIVED

The date the goods were received into the goods inwards area.

ORDER QUANTITY

The quantity of the goods ordered as stated on the purchase order.

REASON FOR REJECTION

When goods are rejected, the inspector will record the reasons for rejection in the requisite section.

INSPECTION BY

Signature of the inspector who inspects the goods "Quality Control Wing Commander".

DATE

Date of inspection.

Prepared by Quality Control Wing with the Purchasing Department.

ACTION TAKEN

The action taken by the purchasing department with relation to having goods replaced, rectified etc. This will be recorded on the purchased copy of the Q.I. inspection report.
4. WHEN COMPILED

Each time goods are received into the goods inward area, an inspection report will be raised before goods will be accepted into stock.

5. BY WHOM COMPILED

Goods Inward Inspector: "Quality Control Wing"
Purchasing Department (for reject goods)

6. ISSUED TO

G.I. Inspection report copies will be issued to:

(i) Stores
(ii) Purchasing
(iii) Stock Control
(iv) File copy "Quality Control Wing"

7. NOW FILED

The stores copy of the G.I. inspection report will be used for accepting goods into stock. It will be passed to the stores with their copy of the purchase order from inspection. They will be filed together in purchase order sequence.

The purchase department copy of the report will be filed in report serial number sequence, if goods are acceptable. If the goods are rejected, the inspection report will be kept in a pending file until the goods have been rectified or returned to the supplier. After recording the action taken on the goods and issuing disposal instruction, the report will be filed with the other report copies.
The stock control report is to advise whether goods are accepted or rejected and should be held until the goods are replaced or rectified then destroyed.

The inspectors copy of the report will remain in his report book in quality control wing for future reference if required.
FORM INSTRUCTION

P.R. REJECT NOTE

1. PURPOSE

To record those parts which have not passed inspection and to indicate what action will be taken, to rectify or replace them in order to complete the order.

To specify the department where the blame is laid for the faulty workmanship.

To enable planning to produce operation layouts for the work needed to complete the order.

To advise production control of the rejection to enable their records to be updated.

2. HOW USED

When during either line inspection "patrol inspection" or final inspection faulty material or workmanship is found, the inspector will reject the parts concerned. He will prepare a reject note indicating the reason for rejection and the quantity that have not passed inspection and sign the note.

He will then pass the reject book to the chief inspector "Quality Control Wing Commander" who will decide whether the parts have to be renewed or rectified and indicate how this will be done. The chief inspector will sign the reject note and indicate the cost centre to which the work will be charged then the copies will
be distributed, to enable either replacement or rectification to be carried out.

3. **Now Compiled**

Reject notes will be printed in book form in triplicate. The notes will be serially numbered, each copy of the set having the same number.

The following information will be manuscripted on the reject note copies by the inspector.

**ORDER NO.**

The replenishment order number to which the reject note applies.

**DESCRIPTION**

The authorized name of the part.

**PART NO.**

The numerical classification of the part.

**REASON FOR REJECTION**

Description of why a part or parts which have been rejected, indicating whether the cause is labour or material and at what operation this occurred.

**QUANTITY REJECTED**

The quantity of the part that did not pass inspection.

**ORDER QUANTITY**

The quantity of the part ordered as specified on the job card.
INSPECTOR

Signature of the inspector who rejected the part.

DATE

Date the rejection note was raised.

CORRECTIVE ACTION TO BE TAKEN

The chief inspector "quality control commander" instructions on how the defect will be overcome.

CHIEF INSPECTOR "QUALITY CONTROL COMMANDER"

Signature of the chief inspector.

DATE

Date he wrote the corrective action instructions.

COST CENTRE TO CHARGE

The cost centre to which the cost of rectification or replacement will be charged.

4. WHEN COMPILED

A reject note will be raised whenever a part is rejected in the workshop "line" as being below an acceptable standard.

5. BY WHICH COMPILED

Inspector
Patrol inspector
Chief inspector

6. ISSUED TO

Planning
Production control.
7. How filed

The planning copy will provide information to prepare an operation layout for rectification or replacement. It will be filed in Reject Note sequence for one year then destroyed. The production control copy will advise them that the order has been delayed due to faulty work and that another operation layout will be provided by planning to complete the job. The reject note will be filed initially in a pending file until the operation layout is received then transferred to a completed file when the work has been completed. The inspection copy will remain in the reject note books as a file copy in the quality control wing.
FORM INSTRUCTION

P. 9 GOODS RECEIVED NOTE (G.R.N.)

1. PURPOSE

To provide details of goods received from a supplier.
To indicate the purchase order to which the goods were ordered.
To provide an instruction to inspection to inspect the goods.
To advise purchasing that the goods have been received.

2. HOW USED

A goods received note will be raised for all goods received into the stores from suppliers. The storekeeper will be responsible for a quantity check of the goods received into the stores. To do this he must refer to his purchase order copy and suppliers advise note supplied with the goods. After a quantity check the storekeeper will raise a goods received note and a copy will be issued to the goods inwards inspector, for inspection of the goods to be carried out.

3. HOW COMPILED

Goods received notes will be printed in books, there will be four copies per set. The three top copies will be perforated for easy extraction from the book. The fourth copy will remain in the book as the stores file copy.

Goods received notes will have pre-printed numbers, each set having the same serial number. Information for recording on the (G.R.N.) will be obtained from:-
(i) The stores purchase order copy.
(ii) The supplier advice note.
(iii) The goods themselves.

The following information will be
manuscripted on all copies of the C.R.M.
acts, by the storekeepers.

SUPPLIER
Name of the supplier of the goods.

PER: ROAD/SEA/AIR
The method by which the goods were sent by
the supplier. Delete those not applicable.

DESCRIPTION OF PACKAGES
Details of packaged i.e. crates cartons,
barrels etc... and the quantity.

PURCHASE ORDER NO.
The number of the purchase order to which
the goods relate.

ADVICE NOTE NO.
The serial number of the note sent by the
supplier describing the goods.

MATERIAL CODE
The numerical classification allocated to
the goods and quoted on the purchase order.

DESCRIPTION
Authorised name of each piece of material
or part as specified on the purchase order.
QUANTITY ADVISED
The quantity of goods the supplier states be sent, as indicated on the advice note.

QUANTITY RECEIVED
The actual quantity of the goods received.

WEIGHT RECEIVED
The actual weight of the goods received. This need only be recorded when the goods are delivered by weight.

RECEIVED BY
Signature of the storekeeper who receives, counts and compares the goods visually with the purchase order and advice note.

DATE
The date the goods received note was raised.

5. WHEN COMPILED
A goods received note will be compiled, when goods are received from a supplier.

6. AT WHEN COMPILED
The storekeeper who receives the goods.

6. ISSUED TO
Four copies of the goods received note will be prepared by the storekeeper.

They will be distributed to:
(a) Goods Inwards Inspector "Quality control"
(b) Purchasing
(c) Stock control
(d) Stores (file copy)
The stock control copy of the G.R.N. will be held until an inspection report is received and after recording order receipt details on the stock record cards, file the G.R.N. copies in serial number sequence for one year then destroyed. The Inspection G.R.N. copy will be used in the preparation of an inspection report, filed for three months, then destroyed. The stores copy will remain in the book, after annual audit old G.R.N. books can be destroyed.
EXISTING FORMS USED BY AMMUNITION FACTORY

Army Form 0.12
Ledger book
Local purchase order
Production requirement list
FORM INSTRUCTION

C.1 ISSUE RECEIPT VOUCHER "ARMY FORM 0.12"

To be prepared in triplicate by carbon copy except the column "Ledger Folio" which should be completed by the unit when posting in the stores ledgers. Two copies will be sent to the receiving unit which will return one copy duly signed and completed in top right hand corner to the issuing unit to support that unit's account if any.

This form is to be used as a certificate issue or receipt voucher, this form is recommended to be used by Army Factories.

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**البيانات الإضافية**

- جميع الموظفين يتبلغ عمرهم فوق 18 سنة.
- الراتب السنوي يتراوح بين 2000 و 5000 درهم.
- موظفو不允许 rumors تبلغ السن من 25 إلى 35 عامًا.
APPENDIX II
RECOMMENDED FORMS AND CARDS WHICH MAY BE ADAPTED TO BE USED IN MAINTENANCE

Maintenance schedule
Maintenance order
Job card
Equipment inspection report
Spares order
Equipment History card
Defect report
Accountable spares used
Repairs and spares used
Weekly maintenance list.
FORM INSTRUCTION

II. 1 MAINTENANCE SCHEDULE

1. PURPOSE

To provide detailed information concerning all parts plant or equipment that requires work to be performed.
To enable planning to produce an operation layout for each part to be processed, indicating the work to be carried out.
To allocate the cost of the work to the correct cost centre.

2. NOW USED

A maintenance schedule will be raised by an engineer who requires work to be carried out in the control engineering workshop on a piece of plant or equipment. In some instances where this is not done, the workshop planning engineer may have a list to strip down the equipment concerned and an inspector will produce an equipment inspection report on the work to be carried out.

The maintenance schedule will be attached to the maintenance order and sent to planning. The process planner will prepare an operation layout for each part to be manufactured and if stripping and assembly of the plant or equipment is necessary, an operation layout for this will also be prepared.

3. NOW COMPILED

The maintenance schedule will be raised by maintenance engineers, for major work they
require to be carried out. The schedules will be prepared in duplicate and will detail the work, the maintenance engineer anticipates will be required to repair or recondition plant or equipment.

The following information will be provided:

**PLANT OR EQUIPMENT**

Full details of the plant or equipment to be repaired or reconditioned. Should it have a plant number this should also be indicated.

**DATE AVAILABLE**

The date the plant or equipment will be made available for the work to commence.

**COMPLETION DATE**

The date completion of the work is required.

**MAINTENANCE ORDER NUMBER**

The maintenance order number on which the work will be carried out.

**PART NUMBER**

The number of the part on which work will be carried out.

**DESCRIPTION**

The authorized name of the part.

**QUANTITY**

Quantity of the part required.

**WORK TO BE DONE**

Details of the work to be carried out on each part whether repair, modification, renewal, etc.
ENGINEER SIGNATURE

Signature of the engineer who authorises the work.

DATE

Date the maintenance schedule was signed.

COST CENTRE CODE

The cost centre to which the cost of repair or recondition will be allocated.

4. WHEN COMPILED

When a maintenance engineer requires plant or equipment repaired or reconditioned, he will submit a schedule to ensure that all the work he considers necessary will be carried out.

5. BY WHOM COMPILED

Maintenance Engineer "Maintenance and Repair commander"

6. ISSUED TO

Maintenance schedule will be issued to process planning for planning of the work to be carried out.

7. HOW FILED

After planning the work, the process planner will file the maintenance schedule with the maintenance order for the part in maintenance order number sequence. He will retain these for reference purposes for as long as considered necessary.

The maintenance engineer copy should be held in a plant file for historic reference data.
FORM INSTRUCTION

M.2 MAINTENANCE ORDER

1. PURPOSE

To ensure that a maintenance order is raised for all repair or renewal work.

To enable full details of maintenance requirements to be clearly defined and the location and plant availability to be specified.

The priority to be given to the work, which should be fair and reasonable. Should be stated. The cost centre code to which the job will be allocated must be indicated and signed by the maintenance and repair commander. Cost will be allocated accordingly.

2. HOW USED

A maintenance order will be raised by an engineer in charge of a maintenance and repair wing. When repair or renewal of parts is required by the central maintenance wing. This is exclusive of scheduled maintenance.

When a maintenance order is received by planning, an operation layout will be prepared, detailing the material, labour, machines required to carry out the work, should repeat orders be received for maintenance work, the existing operation layout for the part will be withdrawn from the file and the operation details transferred to a new operation layout accordingly the new maintenance order.
number and quantity required together with other relevant data.
After actioning maintenance orders, planning will file those in maintenance order sequence for reference purposes.

3. HOW COMPILED

Maintenance orders will be printed in book form, with two copies in each requisition set.
The order numbers will be serial, each copy of the requisition set having the same number.
The following information will be manuscripted on the maintenance order copies by the originator.

**Priority**
The degree of priority considered necessary for the work, if any.

**Date Issued**
The date the maintenance order was raised.

**Plant or Machine**
Plant location of the machine or piece of equipment for which the part is required.

**Part No.**
The official part number allocated to the part to identify it.

**Quantity**
Quantity of the part required.
DESCRIPTION OF WORK

Description of the part, or if repair work, details of the repairs needed.

DATE REQUIRED

The date completion of the work is required to meet maintenance needs.

JOB AVAILABLE DATE

Should the part or work not be immediately available the date when it will be provided for work to commence.

LOCATION

For work that may need inspecting in situ, where it can be examined will be stated.

SIGNATURE

Of the maintenance and repair wing commander.

C.C. CODE

Cost centre code to which the work will be charged.

WHEN COMPILED

Each time maintenance work required to be carried out in the production line wing or behalf of the maintenance section, a maintenance order will be raised.

BY WHOM COMPILED

Maintenance and repair wing commander.

ISSUED TO

Central maintenance and repair wing planning section.
After maintenance details have been extracted and recorded on an operation layout, the maintenance orders will be filed in maintenance order sequence for six months then destroyed.
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FORM INSTRUCTION

II. 1 JOB CARD

1. PURPOSE

To provide details of the part number, descriptions and operation to be performed.

To provide the Workshop Supervisors with information concerning the jobs to be run in their departments.

To provide, by having a work load of Job cards waiting to be processed, a complete picture of the work outstanding position for a department or machine.

To provide the Workshop Supervisors and the Progress Chaser with information concerning the jobs actually in progress in their departments at any period of time.

To advise production control of the completion of operations and the quantity good of the part at completion of the operation.

2. HOW USED

Job cards will be issued by production control in machine or departmental bundles. Production control will sort the cards, allocating priority in keeping with the production programme. They will ensure that multi-operation jobs are to be started first to make certain that these do not over run the manufacturing lead time imposed. Workers will be booked on and off job cards by the Workshop Clerks, who will record the actual time taken on the reverse of the card.
3. HOW COMPILED

A job card will be raised for each operation to performed on a machine or by a worker in the central toolshop and production line.

The following information will be manuscripted on the card.

**FRONT**

Order no.

The maintenance or replenishment order number for which the parts are to be manufactured.

**DESCRIPTION**

Authorised name of the part.

**PART NUMBER**

The part number allocated to the part to identify it.

**QUANTITY GOOD TO DATE**

This is the quantity good from the previous operation.

**QUANTITY TO MAKE**

The total quantity required to be manufactured.
OPERATION NUMBER

The number of the operation to be performed.

MACHINE OR DEPARTMENT

The machine or department where the operation is to be carried out.

OPERATION DETAILS

Brief details of the work to be done at the operation specified.

ESTIMATED HOURS

The estimated hours that planning consider for the duration of the operation.

JIG OR TOOL NUMBER

Where jigs or non standard tools are required for an operation the number of these will be specified. This will enable them to be withdrawn from the tool store.

REJECT

MASTER/PLAN

The quantity of a part at this operation that have been rejected for faulty material or work error.

QUANTITY GOOD TO DATE

The quantity of the part that have passed inspection at this operation.

INSPECTED BY

Name of the inspector who inspected and recorded the reject or goods parts.
DATE
Date of inspection.

REVERSE NAME
Name of the worker carrying out the operation.

NUMBER
Identification number of the worker i.e. clock number or payroll number "identity card number".

DATE
Date the operation started.

START
Time the operation started.

FINISH
Time the operation was completed or stopped.

TOTAL (DAILY)
Total time spent during that day on the operation.

TOTAL
Total time taken to complete the operation.

4. WHEN COMPILED
Job cards will be prepared when work is to be issued to the workshop for manufacture of a part.

5. BY WHOM COMPILED
Production control
Workshop clerk
Inspector

6. ISSUED TO
Workshop, relevant department.
HOW FILED

Job cards will be held in production control together with other works order documents until programmed, then issued to the workshop for manufacture to commence. After completion of the operations, job cards will be returned to production control to update their production programme.

Then to planning to check estimated with actual operation times. From planning completed job cards will be passed to the accounts department, where after reconciliation, they will be filed in part number and operation sequence for an indefinite.
FORM INSTRUCTION

II.4 EQUIPMENT INSPECTION REPORT

1. PURPOSE

To enable an inspector to examine the parts of an assembly, to determine.

(a) What work is necessary to recondition, or repair or renew the assembly, which ever is called for on the maintenance order.

(b) To indicate, by sketches if necessary, essential dimensions where changes to existing sizes are required.

To provide the planning department with details of work to be carried out on a part or a piece of equipment.

To enable the operation layout to be prepared by planning for each part to be repaired, renewed or modified.

2. HOW USED

Equipment Inspection Reports will be produced in duplicate. One copy remaining with the inspector, the other passed to the planning department with details of work to be done.

They will be raised by the inspector when equipment is sent to the maintenance workshop to be stripped down, examined and either repaired or reconditioned. The work required will be stated on the maintenance order by the engineer authorising the work.

When planning receives the order, a job card will be issued to the fitting section to strip down the equipment, to enable inspector to make examination and report his findings on an
equipment inspection report. On receipt of the inspection report, planning will raise an operation layout for stripping and assembly of the equipment and an operation layout for each part requiring repair, renewal or modification. Ancillary parts i.e. bolts, seals, gaskets etc. which will be required, will be quoted in the assembly operation layout material section. Each part being processed will have the part number quoted on the assembly operation layout to enable the fitting progress chaser to know when the parts are all available ready for assembly.

3. HOW COMPILED

Machine inspection reports will be manuscripted in duplicate from duplicated report sheets using carbon paper. The chief inspector will retain an inspection report book and will issue a report number from this each time a report is prepared.

The following information will be manuscripted on the form:-

PART NUMBER

Number of the report related to the particular order for which inspection is required.

ORDER NUMBER

The maintenance order number for the work to be carried out.

DESCRIPTION

The authorised name of the equipment or part.
ASSEMBLY OR PART NUMBER

The numerical classification allocated to the part or assembly.

PART NUMBER

The numerical classification of each part that requires processing, when equipment is involved.

DESCRIPTION

The authorized name of the part

WORK TO BE DONE

Full description of the work needed to repair, recondition, or renew the equipment or part concerned.

INSPECTOR

Signature of the inspector who prepared the report.

DATE

Date the report was prepared.

4. WHEN COMPILED

A machine inspection report will be compiled on request by planning, when receipt of a maintenance order asks for repair or recondition of parts or equipment.

5. BY WHOM COMPILED

Maintenance Inspector

6. ISSUED TO

Planning

7. HOW FILED

One copy of the machine inspection report will
be submitted to planning to prepare operation layouts. It will be filed after preparation of the operation layout in report number sequence for one year then destroyed.

The inspection copy of the report will be filed in inspection in report number sequence for as long as is considered necessary, for reference.
JOB SPECIFICATION

Planning Engineer
Production Engineer
Workshop Engineer
Production Controller
Workshop Supervisors
Maintenance Engineer
Technical Affair Director
Stock Controller
Purchasing Officer
I. JOB SPECIFICATION

I.1 PLANNING ENGINEER

"Planning - research - follow up and co-ordination director".

DUTIES

1. The planning engineer will be responsible to the Director general for planning, research and coordination work carried out in all factories.

2. Will carry out the policies of the Army factories as directed by the Director general.

3. Will provide technical affair directorate with all necessary manufacturing information necessary to:
   (a) Procure materials
   (b) Programme work

4. To enable maximum utilisation of production facilities to be achieved.

5. Will reconcile estimated with actual job times and adjust these where necessary.

6. Will consider existing and alternative methods of production and introduce improvements where possible.

7. Examine techniques and provide equipments, tools, jigs and fixtures where improved quality greater output can be achieved, with a lower level of skill.

8. Formulate outline proposals for achieving optimum production conditions.
9. Investigate availability and suitability of different types of machinery and as necessary discuss proposals with engineers of Army factories.

10. Decide on equipment and layout.

11. Prepare drawings and specifications to ensure correct installation.

12. Liaise with purchasing and stock control to ensure smooth flow of supplies.

13. Evaluate and advise management on new production methods, techniques and equipment.

14. Plan and direct layout of new workshops or re-tooling of existing workshops.

15. Be responsible for the administration, training, quality and rate of working of all personnel under his control.

16. Make all necessary arrangements to cover absenteeism, sickness and holidays.

17. Handle all departmental problems.
1. The production engineer will be responsible to the Director General for co-ordinating the activities of:-
   (a) Production control "production line wing".
   (b) Electrical and water supply wing.
   (c) Quality control and Lab. wing.
   (d) Tool shops
   (e) Maintenance and repair wing.
   (f) Technical school.

2. He will carry out the policies of the army factories as directed by the director general in providing a plants output to the Ordnance Corps.

3. Consider existing and alternative methods of production, with regard to work and production flow, types of machinery, layout of plant, cost and output.

4. Revise production control procedures to enable effective checks to be made on production methods.

5. Investigate and eliminate bottlenecks due to technical inadequacy.

6. Advise on product standardisation and value analysis.

7. Be responsible for the systematic training quality and rate of working of all workshop personnel.

8. Ensure that the standard of performance of operators, utilization of machines and resources and quality of production are
maintained at a level acceptable by the Director General.

Coordinate all the activities of the wings both direct and indirect, to make certain that work programme targets are met.

Make adjustment to manning levels i.e redeploy labour to eliminate bottlenecks in work loads as they arise.

Not exceed the manning levels established for the workshop without consent of the Director general.

Maintain plant and machinery in good order to ensure reliability.

Maintain proper discipline. Make all necessary arrangements through the wing commanders to cover absenteeism, sickness and holidays.

Handle all problems related to the wings.

Analyse performance reports for machine and operator performance and take action when necessary where this does not reach the required standard.
JOB SPECIFICATION

1.3 WORKSHOP ENGINEER "Toolshop Wing Commander"

DUTIES

The workshop Engineer will be responsible to the production engineer for all manufacturing and overhaul activities in the workshop. He will coordinate the work of the workshops to ensure:

1. Efficient and economic use of all productive resources in the central engineering workshop.

2. The optimum layout of equipment and plant and the production of tools, parts, etc., necessary for production.

3. Provision of information to stock control to ensure that material, parts, tools and other items are available as required.

4. Support procedures for progressing work through production lines, for materials and parts.

5. Co-ordinate and arrange for work study and rate fixing activities in relation to new methods and procedures and generally to improve productivity.

6. Ensure that instructions on work methods, prepared for guidance and use of workers, are adopted.

7. Constantly review production plans and procedures and make such alterations in conjunction with the production engineer and production controller as are necessary to meet contingencies arising.
8. Advise the production engineer on all manufacturing activities and report on spare capacity or bottlenecks, and recommend courses of action to deal with these.

9. Co-ordinate all the activities of the workshop both direct and indirect, to make certain that work programme targets are met.

10. Work to the production programme as laid down by production control, deviating only in extreme emergencies, after consultation with production control.

11. Make adjustment to manning levels i.e. redeploy labour, to eliminate bottlenecks in workloads as they arise.

12. Will not exceed the manning levels established for the workshop, without consent of the production engineer.

13. Will maintain machinery in good order to ensure reliability.

14. Maintain proper discipline. Make all necessary arrangement through sections leads to cover absenteeism, sickness and holidays.

15. Analyse performance for machine and operator performance, submit reports to the production engineer and take corrective action when this does not reach the required standard.
JOB SPECIFICATION

1. A PRODUCTION CONTROLLER - Production line Commander

DUTIES:

The production controller will be responsible to the production Engineer. He will be responsible for:

1. Carrying out the policies of the Army factories, as directed by the production engineer relating to production control in the line of production.

2. The satisfactory execution of the following functions:
   (a) Programming
   (b) Progress
   (c) Clerical function

3. Determine material needs to establish output requirements.

4. Checking specification and maintain standard.

5. Prepare schedules of material plant, progress etc. Coordinate operations within a line programme.

6. Check progress reports against schedules and adjust as necessary to allow for alteration as they occur.

7. Calculate starting and finishing time of scheduled operations and target delivery or completion dates.

8. Check availability of materials and parts for each phase of the production.

9. Order material via stock control to maintain stock levels established.

10. Maintain production records of all work done in the wing.
11. Raise and clear all documents necessary to make up shortages caused by bad workmanship or loss.

12. Advise the production engineer and the maintenance engineer, immediately it becomes apparent that a completion date cannot be met.

13. Anticipate delays and if shortages occur, allocate the available resources to the requirement with the highest priority.

14. Advise the heads of sections when necessary on the priority and sequence of work.

15. Be responsible for the administration, training, quality and rate of working of all personnel under his control.

16. Make all necessary arrangements to cover absenteeism, sickness and holidays.

17. Handle all problems related to labour relations.
JOB SPECIFICATION

I.6 WORKSHOP SUPERVISORS

DUTIES

The workshop supervisors will be responsible to the production controller. Their duties will include:

1. Considering the workers and allocating them to specific machines or duties.
2. Distribute the work to the various work stations in accordance with the production programmes.
3. Ensure that the quality and quantity of output of individual workers and the group, as a whole, is satisfactory, and re-allocate workers and duties as necessary.
4. Maintain daily records of output to enable the work progress position to be readily available.
5. Assist and advise operators who encounter difficulties.
6. Keep workers informed of management policy decisions and ensure that factory and other regulations are adhered to.
7. Inform the wing commander of problems, and suggestions arising from the work. Advise on or effect the engagement, transfer or promotion of workers.
8. Utilise the services of the progress chaser in obtaining working documents, material transfer, resolving production control queries, progressing output etc.
JOB SPECIFICATION

1.6 MAINTENANCE ENGINEER  "Maintenance and Repair Wing Commander"

The maintenance engineer will be responsible to the production engineer for all maintenance repair activities in the factory. He will coordinate the work of maintenance to ensure:

1. A sound preventive maintenance programme.
2. Adequate spare parts.
3. Continuous investigation into the causes and remedies of emergency breakdowns.
4. Engineering of planned maintenance, repair minor installations and replacement.
5. To provide freedom from breakdown during manufacturing operations.
6. To maintain equipment in a satisfactory condition for safe operation.
7. To maintain equipment at its maximum operating efficiency, during their effective life.
8. To reduce to a minimum the downtime resulting from breakdown.
9. To reduce to a minimum the cost of this maintenance consistent with the above items.
10. Generation of distribution of power and other utilities.
11. The provision of economical and reliable utilities electricity, compressed air, water and air as the function of the power group of the maintenance wing.
12. To maintain all buildings in a good condition this include lighting, wiring, foundation etc.

13. Keep records such as a list of all items i.e. all parts of a site, building, and contents, for the purpose of identification including information such as constructional and technical details about each.

14. Constantly review production plans and procedures and make such alterations in conjunction with the production engineer and production controller as are necessary to meet contingencies arising.

15. Be responsible for the administration, training quality and rate of working of all personnel under his control.

16. Make all necessary arrangements to cover absenteeism, sickness and holidays.

17. Handle all problems related to labour relations.
JOB SPECIFICATION

1. TECHNICAL AFFAIR DIRECTOR

The technical affair director will be responsible to the Director general for co-ordinating the activities of:-

1. Purchasing
   - Stock control
   - Account

2. He will carry out the policies of the Army Factories as directed by Director general, relating to: provisioning, procuring, receiving, issuing, inspecting and maintaining stock.

3. These activities encompass all production requirements such as: materials, tools, parts, plant, equipment, and products and other items.

4. Maintain material and part stock levels at that agreed by management.

5. Co-ordinate with planning engineer in preparing the annual budget.

6. Finding and approving suppliers,

7. Finalise orders and contracts.

8. Advise on material standardisation.

9. Determine alternatives concerning material, tools, parts and other items.

10. Support procedures for progressing work through production department, for materials, tools and parts.

11. Administer the department within the budget limit set by the Director general.

12. Provision of information concerning all transaction in the books of account.
13. To determine which commodities or goods it is profitable than others.


15. Maintain proper discipline. Make all necessary arrangement through departmental heads to cover absenteeism, sickness and holidays.

16. Be responsible for the systematic training quality and rate of working of all department personnel.
JOB SPECIFICATION

I, A_ STOCK CONTROLLER

DUTIES

The stock controller will be responsible to the technical affairs director for:


2. Check requisitions against stock records and forward to stores or material preparation.

3. Receive requisitions for stock issues and adjust stock records accordingly.

4. Maintain maximum/minimum stock levels for raw materials and selected maintenance replacement parts.

5. Make physical checks to ensure accuracy of stores and stock recording.

6. Prepare replenishment orders for replacement of maintenance parts.

7. Ensure preparation of parts and raw material is carried out to meet production requirements, as specified by production control.

8. Be responsible for the layout, cleanliness, safety, and accuracy of storage of all raw materials and finished parts held.
JOB SPECIFICATION

19 PURCHASING OFFICER

The purchasing officer will be responsible to the technical affair director. He will:

1. Carry out the policies of the Army Factories as directed by the technical affair director, relating to the purchasing activities of the factories.

2. Buy raw materials, plant, equipment, parts and other items from manufacturers, and other suppliers on behalf of the Army factories.

3. Ascertain the type, quality and cost ceiling of items required and the dates by which they must be available.

4. Determine whether orders or part orders can be met from current supply contracts, whether new or renewal contracts should be negotiated with suppliers. Whether orders should be put out to tender and whether it would be more economical for the factories to manufacture certain items themselves.

5. Examine suppliers literature, price lists, samples etc. and as necessary obtain price, quality and delivery quotation from one or more suppliers.

6. Evaluate terms and select most suitable suppliers "vendors".

7. Negotiate new or renewal contracts with suppliers endeavouring to obtain the most advantageous terms possible.
4. Draw up orders and contract documents specifying type of items, quantities, quality, delivery requirements and other relevant factors.

9. Finalise orders and contracts within his authority or submit them to finance committee board or other authority for finalisation.

10. Arrange for incoming supplies to be checked for quality and quantity and for items which fail below specification to be returned to suppliers.

11. Arrange for, or undertake the expediting of orders when delivery delays occur.

12. Keep appropriate records and prepare reports as required, e.g. expenditure analysis.

13. Recommend stock levels to be held, based on lead times needed for procurement.

14. Administer his department within the financial budget for purchases by the planning Engineer.

15. Warning all concerned if delivery promises are not going to be met.

16. Analyse the service provided by suppliers taking into account:

(a) Percentage of orders delivered on time or late.

(b) Percentage of reject or scrap supplies obtained from suppliers if any.

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في عام 1952م تم إنشاء جمعية الدعارة بولاية الإيواز الساحلية بدعم توجيهات الاستحقاقات الوراثية لقيمة الدعارة المحترقة. ومنذ ذلك الوقت تزامن عدد النقاط وأنواع الدعارة ينخفض في مستوى النظافة والسلامة. إلى ذلك تقوم بعض الجمعيات الناشئة بتدريبجمعات شبابية ومنظمات على تطبيق نظم السلامة في عائلات الإيواز.

وقد واجهت الجمعيات الفردية في الإيواز الكثير من العقبات، وكذلك العديد من التحديات والتحديات التي يمكن تجنبها وهي تتعلق في تطور الوعي العام والإيواز. بالرغم من ذلك، تم توصيف الدعارة في حديثة الأمور، ومع ذلك فالمشاكل في المناطق النائية، ولهذا الأسباب فقد شهد الإيواز تطورًا وظامية للإيواز. ويعتبر النشاط الذي يملأه على الدعارة في الواجهة.

هذه الدراسة تحتوي على تنويهات ودوريات حول ربط النشاطات المختلفة والعلاجات المستخدمة في معركة السلامة في مجال النشاط. وأظهرت الدعارة في مجال النشاط. وأظهرت الدعارة في مجال النشاط. وأظهرت الدعارة في مجال النشاط. وأظهرت الدعارة في مجال النشاط.

منهج البحث

يهدف البحث إلى دراسة حجم توزيع جمعية الدعارة في الإيواز. وتكون له أهداف محددة، وهي مراجعة حيويًا وتحقيقية. واتجاه الدراسة هو توضيح العوامل المختلفة التي تؤدي إلى السلوكيات المرتبطة بجمعية الدعارة. وتؤدي الدراسة إلى تحديد النشاطات المختلفة التي يمكن أن يكون لها أثرًا على السلامة والصحة العامة. ويعتبر النشاط الذي يملأه على الدعارة في الواجهة.

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