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PREVENTIVE MAINTENANCE DEVELOPMENT CENTRE, PMDC, LAHORE

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PAKISTAN

Technical Report

Mission [illegible]3th Dec. 198[illegible] to 28th Jan. 198[illegible]

Prepared for the Government of Pakistan
by the United Nations Industrial Development Organization
acting as executing agency for United Nations Development Programme

Based on the work of John P. Gooderson
Consultant on Inventory Management Systems

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Appendices

I INTRODUCTION

1.1 This report outlines the work carried out by J.B. Gooderson, a Consultant in Inventory Management Systems, during a one month assignment at the Preventive Maintenance Development Centre (PMDC) at Kala Shah Kaku, Ravi Rayon Ltd., part of the Federal Chemical and Ceramics Corporation Ltd. (FCCCL). The terms of reference of the assignment, as set out by Dr. A. Banescu the Chief Technical Advisor of the Project, were:-

- To advise on the content of a course on Inventory Management to be given at the Centre.
- To assist in solving an Inventory Control problem in the Ravi Rayon factory.
- To give guidance to the staff of the Centre and of Ravi Rayon on the principles and techniques of Inventory Management.

1.2 I should like to express my appreciation of the assistance given to me on this assignment by Dr. Banescu, Chief Technical Advisor, Mr. Sarfraz, Head of the PMDC, Mr. Butt, Chief Engineer of Ravi Rayon Ltd. and all of their staff with whom I worked. The cooperation given was unstinting.

II SUMMARY OF RECOMMENDATIONS

2.1 The main recommendations that are made in this report are:-

1. The course prepared on Inventory Management should be presented, for a minimum three day period, to Managers and Supervisors from FCCCL and other industries in Pakistan.

2. The Finance Function of Ravi Rayon Ltd. should investigate means of avoiding delays in installing replacement equipment which are due to accountig practices.

3. A policy of equipment standardisation should be introduced in Ravi Rayon Ltd. and in other FCCCL factories in order to reduce the number of spare parts that are required to be stocked.

4. Consideration should be given to writing down the value of obsolete stocks and to disposing of them at the best price available.

5. A study to increase the incidence of Planned Maintenance should be undertaken to reduce the occurrence of unplanned stock-outs.

6. Data for a sample of the Engineering inventory at Ravi Rayon Ltd. should be collected and analysed to determine suitable systems of control for each classification. Detailed instructions for this work have been given.

7. Before deciding on a Computer Control System, Ravi Rayon Ltd. should determine which stock items to control by computer, which methods of control are required and what software programs are available.

8. The classification of Engineering stock items at Ravi Rayon Ltd. should be reviewed in the light of the detailed comments in this report.

9. It is unlikely that the control of low usage value items by computer systems will be economic.

10. Classification of inventory should take into account the Annual Usage Value of an item not only its Item Value.

III INVENTORY CONTROL COURSE

3.1 I have prepared a course in Inventory Management based on material that I brought with me to the duty station. The course, which consists of twelve 2-hour sessions, has been fully edited to bring it in line with the requirements for training in Pakistan including the translation of all worked examples into local currency. Each session of the course is supported by designs for visual aids, with handouts for participants and extensive course notes for the instructor, amounting in total to some 150 pages of text.

3.2 The course is designed for training Supervisors and Managers in Pakistan industry with a special bias towards the problems concerned with maintenance inventories. It can also act as a basis for examining problems with particular inventories and for devising and implementing solutions to these problems. I recommend that the course should be presented, for a minimum three day period, to appropriate personnel from FCCCL and other chemical industries, using instructors at the Preventive Maintenance Development Centre. As the instructors gain experience it will be possible to offer the course to participants from a wider industrial base in Pakistan. An outline of the course is given at Appendix 'A'.

IV INVENTORY CONTROL AT RAVI RAYON LTD.

4.1 There are two main stores at Ravi Rayon, an Engineering Maintenance Store, holding approximately 40,000 items, and a Production Material Store with about 50 items. Finished products are also held in stock. My investigation concentrated on the Engineering Maintenance Store.

4.2 Much of the manufacturing equipment at Ravi Rayon is 20 years old and now requires total replacement, in many cases spares for the equipment are no longer available. In these cases the solution has been to try to obtain similar items from alternative suppliers, if this is not possible then the part has to be manufactured specially. Mr. Butt, the Chief Engineer has estimated the requirements for future equipment replacement and cash is now being made available for this, however, lack of investment in replacement equipment in the past is now causing serious problems.

4.3 Replacement equipment is sometimes purchased and held in stock under an inventory account. It is not debited to the particular production operation for which it is required until it is installed. This can mean a delay in installation until there is sufficient income from the production operation to cover its cost. Since the Company has already purchased the equipment, delays of this kind, to accord with accounting practices, should not be necessary and I recommend that the Finance Function should investigate means of avoiding this delay.

4.4 A further problem is caused by the lack of standardisation of equipment and the resulting large variety of spares that are required to maintain the different types and models. This problem cannot be overcome in the short term but can be reduced in the future if a policy of standardization is introduced now. I recommend that this should be done.

Present Classification Of Inventory

4.5 There are, at present, two main classifications of inventory in the Engineering Store:-

- Replenishment Items
- Non-Replenishment Items

Non-Replenishment Items are purchased for special projects or for replacements or are items for which the demand is very intermittent. Replenishment Items are those required for, normal maintenance and for general usage.

Present Control Systems

4.6 Non-Replenishment Items are ordered as required for a period or for equipment replacement. Those with very low usage have an appropriate re-order level set. Special authority is required from the production unit concerned for those items that are purchased from abroad.

4.7 Each Replenishment Item has a Bin Card on which are recorded an order level, an order quantity and a minimum stock level. In general the levels are set as follows:-

- Order Quantity	12 months supply
- Order Level	6 months supply
- Minimum Stock	3 months supply

Variations to these levels are necessary for imported items, which can take up to 9 months to obtain.

Items purchased in Lahore are usually allowed one month lead time but can often be obtained within 24 hours. Items which have a unit value of more than 5,000 rupees are subject to a special review by the Chief Engineer before any replenishment is made.

4.8 Many items in stock have no usage and are obsolete. Disposal lists of these items have been prepared in the past but many could not be sold because accounting practices would not permit disposal at a price below their book value. Since these items are of no use to the company and are a burden in the form inventory carrying costs, I recommend that consideration should be given to writing down their value and to the disposal of them at the best price obtainable.

4.9 There are also occasions when items required for maintenance are not in stock. These occurences can only be reduced by the implementation of more planned maintenance and I recommend that a study of ways to increase the amount of planned maintenance should be made.

Recommendations For Improvement

4.10 In order to determine what improvements can be made to the control of the Engineering inventory at Ravi Rayon, I asked for a random sample of stocks and movements to be taken at the factory. As can be seen from the graph at Appendix 'B' it is not necessary to analyse a large sample to obtain details of the behaviour of the inventory under the present control systems. Thus the sample size was set at 400 items. Some general instructions for collecting the data were taken from the inventory control course and are shown at Appendix 'C'. The data collected for each item was as follows:-

Code No. or other Identification
Unit Cost of Item
Usage for last two years
Present Stock Quantity
Number of Issues in Last two years
Classification of Item

4.11 It is likely that the present classification of the inventory is not sufficient to give proper control and I recommend that the following classification should be adopted:

Normal Replenishment.
Capital Projects (new or replacement).
Security Items.
Obsolete Items

A description of each classification is given at Appendix 'D'.

4.12 An analysis should be carried out on the sample collected in the manner described in sessions 9 and 10 of the Inventory Control Course and suitable systems, as described in the course, should be devised for each category according to the findings of the analyses. When designing the systems the following points should be borne in mind:-

Normal Replacement Items

Control systems for these items should be designed for three classifications of Annual Usage Value, not by their Item Value as at present. 'A' items should have personal control, 'B' items automatic control and 'C' items a control system such as the 'Two Bin Systems' which reduces clerical activity to a minimum.

Security Items

These items require personal control and the Chief Engineer should consider the following when deciding whether to replace items used in this category:

- Is there a suitable alternative item already in stock that could be used?
- Would it be possible to effect a temporary repair when failure occurs and order the item only when required?
- Could planned maintenance be introduced to forecast the need for replacement?
- Does any other factory in FCCCL hold the same item in stock and could it be transferred?

Obsolete Items

Items in each category should be regularly reviewed to determine whether they should be placed in the obsolete category. Obsolete items should be written down in the books and disposed of.

Computer Systems

4.13 Ravi Rayon has plans to ~~purchase~~ utilise a computer, purchased by the UNDP, for Inventory Control and Costing. It is important that the analyses recommended should be carried out and that manual systems should be designed and implemented before determining which items are suitable for computer control. Certainly, it would not be economic to use a computer for low usage value items.

4.14 Only in this way will it be possible to determine which software programs are required to control the various categories of stock and whether a particular computer manufacture can provide them. A computer will not improve the control of inventory at Ravi Rayon unless the management understand exactly how it will be used and they can obtain the software that they require.

V GUIDANCE TO STAFF

5.1 During the last week of my assignment I worked with three members of the PMDC and a Manager from Ravi Rayon to instruct them on the principles of inventory control. Each session of the Inventory Control Course was reviewed and evaluated and all queries that they had were fully discussed and answered. I also supervised the start of the work involved in collecting the data for the inventory sample at Ravi Rayon. The people involved in my discussions were:

-	Mr. Sarfraz	Head of PMDC
-	Mr. Irfan	Lecturer
-	Mr. Idrees	Lecturer
-	Mr. Niaz	Manager, Engineer's Store Ravi Rayon

In addition to the instructions given I presented the library of the PMDC with copies of 16 papers, from various sources, concerning Inventory Control and Training Methods. A list of these papers is given at Appendix 'E'.

5.2 With regard to other literature and books that the Centre should purchase, I left, with the PMDC, a list of books that are held at the library of the British Production and Inventory Control Society, of which I am a Fellow. I also left a bibliography of conference papers on Production and Inventory Control. I attach, at Appendix 'F', a resumé, which I have prepared for the PMDC, of the principal books of interest in that library. I recommend, in particular, that the library of the PMDC should purchase the following books on Inventory Management:

1.	A Guide to Stock Control	Albert Battersby Pitman Publishing Ltd.
2.	Stock Control in Manufacturing Industries	Adin B. Thomas Gower Press Ltd.
3.	Automatic Inventory Control Techniques	D.A. Barrett Business Books Ltd.
4.	Effective Warehousing	J.A. Burton MacDonald and Evans Ltd.

5.3 On the subject of computer systems I was able to leave the following material at the Centre:-

1. A General Information Manual on the Hewlett Packard Maintenance Management System.
2. An Introduction to the Xerox 'Just in Time' System.
3. A price list for computer training films.
4. A copy of a half hour Videc Recording of H.P.'s Just in Time system.

OUTLINE OF INVENTORY CONTROL COURSE

1. An Introduction to Stock Control

   Types of Stock
   Costs of Stockholding
   Examples of Stockholdings

2. Elements of Stock Control

   Materials Requirements Planning System
   Order Point System
   Lead Times
   Safety Stock
   Order Point
   Order Quantity

3. Level of Service and Safety Stocks

   Effect of Order Quantities
   Effect of Re-Order Levels
   Exercises

4. Ordering Strategies - Economic Order Quantities

   Costs of Stockholding
   Costs of Set-up and Ordering
   Basis of EOQ Theory
   Nomograms
   Exercises

5. Ordering Strategies

   Multi-level Inventories
   Interaction between Levels
   Simulation Exercise

6. Simple Forecasting Methods

   Predictions and Forecasts
   Short and Long Term Forecasts
   Averages and Moving Averages
   Exercises

7. Simple and Low Cost Systems

   Free Stock Balance
   Two and Three Bin Systems
   Examples

8. Slow Moving Stocks

   Is Stock Required?
   Base Stock System

9. Stock Analysis

   Sampling
   Distribution Analysis
   Analysis of Cover Provided

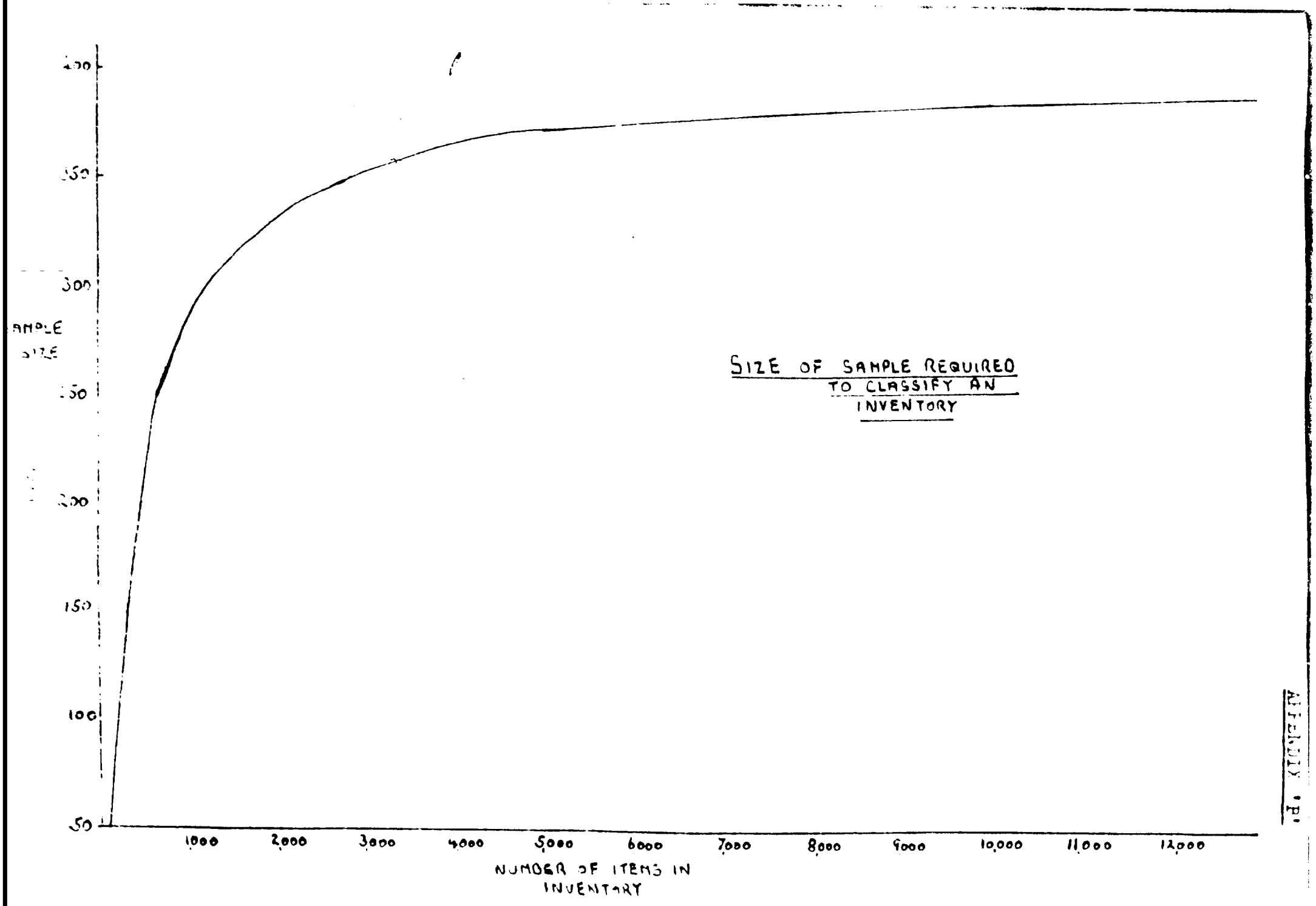
10. Stock Classification

   ABC Classification
   'A' Item Analysis
   Low Value Analysis

11.

A Analysis Exercise

12.


SIZE OF SAMPLE REQUIRED
TO CLASSIFY AN
INVENTORY
SAMPLE
SIZE
400
350
300
250
200
150
100
50
1000
2000
3000
4000
5000
6000
7000
8000
9000
10,000
11,000
12,000
NUMBER OF ITEMS IN
INVENTORY

APPENDIX "B"

Appendix 'C'

INSTRUCTIONS FOR COLLECTING INVENTORY SAMPLE DATA

In theory it would be a good thing if we could examine every item in an inventory to obtain an idea of how the inventory is made up and how it behaves. In practice this is, of course, impossible, particularly with inventories comprising up to 20,000 items. However, there is a practical answer to the problem, that is to take a representative sample of items in the inventory and to study data for the sample and from this draw conclusions concerning the whole inventory. If the sample is correctly taken, one can be 99% certain that the salient conclusions one draws from its analysis will be correct within ± 5%.

As you can see from the graph shown at Appendix 'B' it is not necessary to have a very big sample to obtain the information you require, in fact the sample size will never be very much over 400 items even for very large inventories of 50,000 or more. However, for the largest inventories one would probably take sub-samples of sections of the inventory for the more detailed analyses. The manner in which the sample is chosen is very important. It is essential that the sample should be representative and should not incorporate any bias due to personal preference or other reasons. The classic manner of chosing the items to be included in the sample would be to use tables of random numbers to locate the appropriate items. However, I have found this to be tedious and not really worth the effort. The method I usually adopt is to first determine the sample size, then divide the sample size into the total inventory size, to obtain the frequency of selection, for example a sample of 380 for an Inventory of 8,000 would mean selecting one in 8,000/380 or one in 21 items. The next step is to give the stock clerk a simple method of selecting the items, for example if the stock cards were held in trays of 200, I would suggest he takes 10 items from each tray approximately 20 cards apart. The important thing is that the clerk should not exercise any judgement in this choice, he must take whatever card comes to hand. The worst enemy of the sampling method is the 'helpful' person who constantly discards items because, in his opinion, they are not representative.

Appendix 'I'

CLASSIFICATION OF INVENTORY AT HAVI MAJOR

Normal Replenishment

Items which have a fairly regular usage and for which normal order point/order quantity systems can be used. When these items are used for planned, preventive maintenance it will be possible to determine the usage of the item in advance. The control systems used for these items will depend on the usage value of the item, high usage value ('A' items) having personal control, medium usage value, ('B' items), automatic control and low usage value items, ('C' items), simple systems of control using minimum clerical effort. Only 'A' and 'B' items are suitable for computer control.

Capital Projects

Items in this category are not normally held in stock but have been purchased for a particular capital project such as the installation of new or replacement equipment.

Security Items

These items are held in stock as a security against the failure of parts of the equipment which would take a long time to replace and would shut the equipment, and possibly the production line, down completely until they are replaced. They are often items of high unit value and, if so, absolute minimum stocks should be held.

Obsolete Items

Items for which no demand has occurred for some time and for which no future demand can be foreseen. Items should be moved into this category whenever a review of their usage shows that they are obsolete. Obsolete items should be written down in the books and should be disposed of at the best possible price.

Appendix 'L'

LIST OF PAPERS DONATED TO THE LIBRARY OF THE PREVENTIVE MAINTENANCE DEVELOPMENT CENTRE

Training

1. The Do's and Dont's of Films in Training

   Keith Evans
   The Training Officer

2. How to Plan a Training Program

   Gale E. Newell
   Personnel Journal

3. Designing Training Programs

   Dr. Trever J. Bentley
   The Training Officer

4. How to Plan and Conduct Effective Presentation and Education Programs

   Leroy D. Reinhart
   APICS Conference Proceedings

Inventory Management

1. Process Industry Production and Inventory Planning Framework

   Taylor, Seward, Bolander and Heard
   Production and Inventory Management

2. MRP and Inventory and Production Control in Process Industries

   Nancy S. Nelson
   Production and Inventory Management

3. How to Achieve and Maintain Inventory Accuracy

   Richard L. Thompson
   Production and Inventory Management

4. Effective Stockroom Control: It is possible?

   Kevin Wolfmeyer
   Production and Inventory Management

5. Management Control Sectors for Inventory

Hugh E. Warren
Production and Inventory
Management

6. Managing a Central Service Parts Inventory

Larry G. DeVries
American Production & Inventory
Control Society

7. Effective Stock Control Procedures

Terrence Annan
Management Accounting

8. Effective Safety Stock Planning

James A.G. Krupp
Production and Inventory Management

9. The Management of Stocks - Some Case Histories

Geoff Lockett
Journal of Management Science

10. Planning Technique Improves Inventory Control (MRP)

Michael H. Peters
Chemical Engineering

11. Stock Control in Small Companies

Gregory, Klesniks and Piper
International Journal of
Production Research

12. The Cost of Holding Stocks

Leslie Chadwick
Management Services

Appendix 'F'

[illegible] and Training Aids in the Stock Library

No. 1[illegible]	[illegible] and Materials Management (A Textbook of Purchasing and Supply) Mainly concerning Purchasing Organisation and Techniques	M.A. Compton	Business Books Ltd
No. 1[illegible]	Warehouse and Stockyard Management. Covers Staffing, Classification, Layout and Storage. The text is comprehensive but illustrations are poor.	H.L. Compton	MacDonald and Evans
No. [illegible]	A Guide to Stock Control Good Standard Textbook Chapters on Spares and Two Bin	A. Battersby	Pitman
No. 19[illegible]	Effective Warehousing Chapters on Yards and their Maintenance Storage (including climatic problems) Material Handling	J. Burton	MacDonald and Evans
No. 11[illegible]	Industrial Inventory Control Full of mathematics and simulation very theoretical	Reisman et. al	Gordon and Breach
No. 28[illegible]	Zero Inventories Concentrates on Manufacturing rather theoretical	R.W. Hall	Dow Jones-Irwin
No. 4[illegible]	Inventory Policy An interesting collection of articles with a good pull-out on forecasting	Harvard Business Review	Heinemann
No. 15[illegible]	Scientific Inventory Control Rather theoretical but with small though good section on the control of slow moving items (Including Decision Chart based on stock out costs/occasions/lead times)	C.D. Lewin	Butterworth
No. 170	Inventory Control (out of print?) Nothing special - Theoretical	S. Love	McGraw-Hill

No. [illegible]	Storage and Control of Stock A good general treatise with 24 plates Sections on Coding, Records, Building, Inspection, Accounting, Depots, Control and Equipment	Alex Morrison	Pitman
?	The Role of Top Management A US Blurb concerned with Manufacturing	Evert Welch & Flossl	
No. [illegible]	Production and Inventory Control Applications Manufacturing only		
No. 309	Production and Inventory Control Techniques Manufacturing only		
No. 81	An Introduction to Production and Inventory Control. Theoretical Treatise	Van Hees & Monhemius	Philips Tech. Lab. MacMillan
No. 88	Warehouse Management Fairly theoretical	John Warman	Heinemann
No. 43	Control over Inventory and Production General Treatise - mainly manufacturing	J. Hobbs	McGraw-Hill

Detailed Titles

Cycle Counting	Quite Good
Basic Models and Systems	Manufacturing - EOQ, Forecasting
Inventory Management - An Introduction	Manufacturing oriented but does explain basic Inventory Control
Distribution Inventory	Not bad on control problems of control and distributed warehouses (as always with a manufacturing bias)
Discrete, Static and other Order quantity Models	Concentrates on Ordering Systems in manufacturing
Aggregate Inventory Management	Only really applicable to manufacturing