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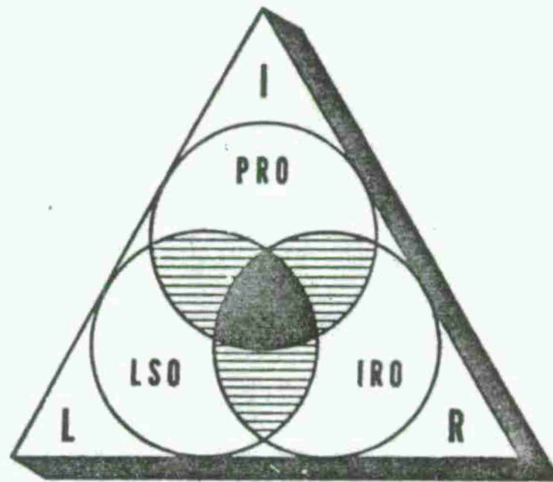ADAU21717

INVENTORY COSTS AT U.S. ARMY MATERIEL COMMAND DEPOTS

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December 1975

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The holding cost rate and the cost of ordering stock from the Inventory Control Points are estimated as they apply to supply management activities of the Installation Supply Accounts of the AMC Depots. These costs are used to compute the inventory levels for the Economic Inventory Procedure Tables of AR 710-2 that are used by the depots. The costs are composed of several constituent functions which are the dependent variables in a regression analysis.
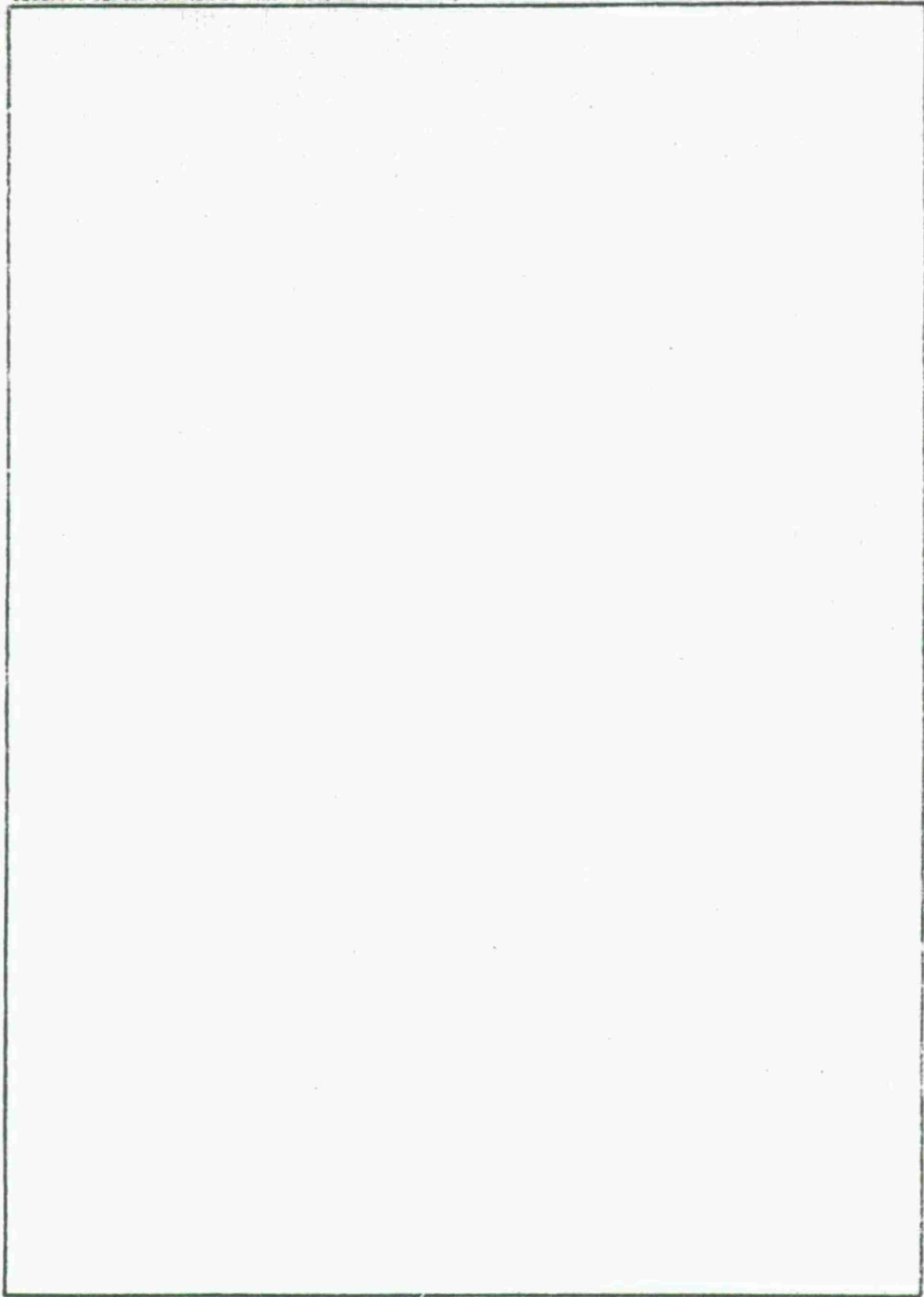
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SUMMARY

1. Background

The Economic Inventory Procedures (EIP) Tables developed in AR 710-2 determine among other things the reorder quantity the users should order to replenish their stock. To develop such a table, it is necessary that the tradeoff between holding additional stock in inventory versus ordering a new supply of items more frequently be computed so that the reorder quantity can be found.

Circa 1959 Harbridge House [6] developed the holding and ordering cost used to calculate order frequency and the reorder point shown under the EIP Tables (Figure 3-9 of AR 710-2 [3]). The present tables have used the holding and ordering costs dating back to that time.

In August 1974, AMC requested that the Inventory Research Office (IRO) undertake a project to update the tables [1] of Figure 3-9 of AR 710-2 by reevaluating the costs associated with holding stock in inventory and ordering new stock at the AMC depot level of supply.

Logistics Management Institute (LMI) had been previously requested to update the cost parameters at the Direct Support Unit (DSU) level of supply for repair part items [7]. This method of finding the holding and ordering costs at the DSU level was based on gathering total cost data at the DSU level and applying a multiple regression analysis procedure. The regression analysis was applied to the total direct inventory system costs since a more definitive breakdown of costs were not possible at this level of supply.

IRO undertook the task of finding the current values of the holding and ordering cost at the AMC depot level of supply by using the method suggested by LMI. The regression analysis technique applied to the AMC depot level of supply had one big advantage. Due to the more sophisticated data recording at this level of supply, the regression analysis could be applied to composite elements of holding and ordering rather than the total cost of the installation operations themselves.

2. Purpose and Objectives

The purpose of this study was to revise the holding and ordering costs incurred at the AMC depot level of supply in the Installation Supply

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Account, ISA, activities. These costs are essential to the computation of any values for the decision levels (reorder quantity, reorder point, and stockage criteria).

The holding cost developed is a yearly rate which is applied to the quantity of items stocked. The higher the holding cost rate, the lower the quantity of stock desired to have in inventory.

The order cost developed reflects the cost incurred when a new supply of items is needed for the ISA activity to accomplish its mission. The higher the order cost, the less often a customer will wish to order which implies he will order more items when he orders. An order in this report will refer to the ISA placing a request for additional items with the ICP, Inventory Control Point, the Army wholesale level of supply.

3. Scope and Method

In requesting this study, AMC asked for revised costs to represent current conditions since the old costs were no longer useable for the purpose intended. In particular, AMC was interested in revising the automatic data processing system for use in inventory control by the AMC depots.

Data was collected from the AMC depots to accomplish this task and, therefore, the costs derived are only representative of the AMC depots.

The method used to derive the costs is a theoretical regression analysis using the functions which contribute to the holding cost rate and the ordering cost as the independent variables. As in all regression analysis, it is unknown what will happen if the results are extrapolated past the range of applicability.

4. Conclusions and Findings

The yearly holding cost rate is found to be 25% of the value of the material stocked. This rate is made up of:

Investment [*]	10%
Obsolescence [**]	10%
Other Losses [**]	2%
Storage	3%
TOTAL	25%

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[*] This rate is set by DoDI 7041.3 [5].

[**] DoDI 4140.39 [4] sets guidelines on how to determine this rate. The Army is presently using the value shown for this function.

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This study only derived the storage rate. The storage rate is composed of:

Care of material	.34%
Rewarehousing, Preservation and Packaging	.14%
Physical Inventory	.53%
Container Assembly and Manufacture	2.02%
TOTAL	3.03%

The ordering cost developed is $18.40 based on components of:

Receipt and Packing	$12.94
Other Stock Control Operations	.57
Supply Management	4.89
TOTAL	$18.40

An additional cost derived in this study was the fixed cost of maintaining an item on the depot Authorized Stockage List (ASL). This cost is $7.73. Such a cost is necessary for an economic stockage policy to tell if an item should be stocked or not. The components of maintaining an item on the ASL are:

Care of Material	$4.11
Rewarehousing, Preservation and Packaging	.48
Physical Inventory	1.26
Container Assembly and Manufacture	1.88
TOTAL	$7.73

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CHAPTER I

METHODOLOGY

1.1 Regression Analysis

The LMI work at the DSU level of supply [7] demonstrated that re-
gression analysis techniques could be applied to problems of this nature.
LMI basically took the theoretical approach and found the components of
a function called total direct inventory system costs. This cost was only
the direct "out-of-pocket" costs at the DSU. This cost did not include
fixed or overhead costs, supplies on order, shipping and transportation
costs, stockout costs to DSU customers, or financial bookkeeping costs.

The work reported on here is slightly different in that component
costs could be distinguished although this work likewise does not attempt
to quantify shipping and transportation costs.

The holding cost rate consists of four elements. DoD specified the
rates themselves or techniques to find the rates at the wholesale level
for three of them. The first is the investment cost. This cost can be
used at the depot level because DoDI 7041.3 [5] specifies the rate to be
used in all decisions affecting dollar investment. The other two costs,
obsolescence and other losses, have recently been updated by the Army along
guidelines set forth in DoDI 4140.39 [4]. Since the obsolescence rate was
based on world-wide assets and disposals, the rate is applicable at the
depot level. This report describes the derivation of the fourth rate,
storage. Along with the storage rate, the cost incurred by the depot to
replace its own stock, the ordering cost and the yearly cost involved with
maintaining an item on the ASL are also derived.

A regression analysis is carried out separately for five components
of the storage cost rate and three components of the ordering cost. The
analysis is designed to find the storage cost rate per item by finding the
relation of the total cost of the five various functions, one at a time,
to the value of stock on hand. The ordering cost analysis is designed to
find the relation between the total cost of the three various functions, one
at a time, making up the ordering cost and the number of items ordered to
yield a cost to order per item.

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The dangers of extrapolating beyond the range of the variables used in the analysis should be recognized. The data covered only the AMC depots and, therefore, the results derived are only applicable to them. Extrapolation beyond this range of information leads to uncertain results.

1.2 Data

The AMC depots were the source of data for the derivation of the desired costs. The data covered FY 74 and came from the following depots:

Anniston	Sacramento
Corpus Christi	Savanna
Letterkenny	Seneca
Lexington	Sharpe
New Cumberland	Sierra
Pueblo	Tobyhanna
Red River	Tooele

The AMC depots perform two supply functions. They are: (1) to serve as a storage location for wholesale stocks - Mission Function and (2) to serve as a supplier for material which is used in maintenance and every day activities of the depot - Installation Supply Account (ISA) Function. The costs of concern are costs connected with the latter - ISA stocks. Whenever costs could be broken out by Mission and ISA Functions, such breakdowns were done and only the ISA costs were summarized.

The Major Item Data Agency (MIDA) collects data in many forms and for many functional areas for the depot level of supply in the Army system. Most of the data used in this work was gathered from MIDA records. However, some data could only be derived by direct contact with the depots because they did not report the costs or performance figures to MIDA.

The MIDA data for FY 74 included information on Navajo and Fort Wingate which were separate cost centers under Pueblo, i.e., Pueblo took care of the supply functions for them and thus Pueblo's costs reflect actions at Navajo and Fort Wingate as well as their own ISA. Umatilla was incorporated into Tooele in a similar manner.

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The data was broken down into major categories for the storage rate and the ordering cost. These are called direct costs. There were other costs which are contributors to these direct costs, but which could not be included as a total figure. Such costs were costs which fitted more than one direct category or also applied to costs which were not considered to be one of the direct costs. Such costs are called indirect costs. The next two sections explain these two areas in more detail.

AR 37-100-74 [2] lists the functional areas for which different costs and performance measures were reported. The cost structure of AR 37-100-74 is such that major categories are broken up into several subdivisions. From the subdivisions come the direct and indirect costs. The indirect costs are added to the direct costs in the proportion of the direct costs to the major categories. The functions of concern are covered in Program 7 - Central Supply and Maintenance.

The categories used in this study are shown in Table 1.

The notation at the end of the line indicates where the costs for the functions are to be applied. Thus, S-D functions are direct storage costs, O-D functions are direct order costs, S-I are indirect storage costs, and O-I are indirect order costs. The S,O-I functions are indirect costs applied to both storage and ordering.

Program 7 does not cover all the functions necessary to order stock. The supply management operation is under Base Operations - Z Accounts - Supply Operations. This is a single function with no subfunctions.

TABLE 1 - FUNCTIONAL STRUCTURE

I	Receipt		(O-D)
II	Packing and Issue		
	1.	Packing	
		a. Packing for Storage	(O-D)
III	Storage Support		
	1.	Care of Material in Storage	(S-D)
	2.	Rewarehousing	(S-D)
	3.	Preservation and Packaging	
		a. Storage	(S-D)
	4.	Physical Inventory	(S-D)
	5.	Container Assembly and Manufacture	(S-D)
	6.	Training (Storage Support)	(S-I)
	7.	General Storage Support	(S-I)
IV	Other Storage Operations		
	1.	Quality Control	
		a. Receiving Inspection	(O-I)
		b. Cyclic Inspection	(S-I)
		c. Preservation, Packaging and Packing (Inspection)	(S,O-I)
		d. Training (Inspection)	(S-I)
		e. Inspection Support	(S-I)
V	Other Stock Control Operations		(O-D)
VI	Stock Control Support		(O-I)
VII	Overall Supply Depot Support		(S,O-I)

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1.3 Functional Areas: Direct

The depots report costs and performance by various functions. The functions of AR 37-100-74 used to define the direct storage cost rate are:

Care of Material. Covers such activities as necessary to protect stocks in storage. This included but was not restricted to: effort required to keep material in working order; assembly, maintenance and placement of storage aids (racks, bins, pallets, etc.); visual inspection of outer containers; and, necessary turning or moving of supplies.

Rewarehousing. Provides for the movement of stock from one storage area to another; preparation of unit loads incident to movement of material; and, remarking of containers after movement.

Preservation and Packing (P&P) for Storage. Provides for P&P activities necessary incident to storage and included all linking, belting, cleaning, spraying, and application of preservatives and interior packaging, painting and masking.

Physical Inventory. Includes statistical sampling inventories, marking stocks not to be inventoried, preparation of inventory count sheets and conducting locator surveys and audits.

Container Assembly and Manufacture. Provides for assembly or manufacture of boxes, cartons, crates and all types of containers and protective devices for use in storage and warehousing.

The functions of AR 37-100-74 used to define the direct ordering cost are:

Receipt and Packing.* Includes receiving stock, opening transportation vehicle, palletizing and movement to permanent storage location, filling containers and marking for storage.

Other Stock Control Operations. Provides for maintaining files and stock records, preparation of stock status reports, and processing documents affecting stock records.

Supply Management Operations. Covers issue and control functions of operating supplies and equipment.

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*These are actually two different functions (see Table 1). However, because the performance objective of the Packing function is containers, the functions were combined to get a cost per item.

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Maintaining an item on the Authorized Stockage List (ASL) requires all the functions necessary for storage of items. However, instead of a yearly rate, the dimension of concern is cost per item stocked, i.e., the cost of maintaining an item on the ASL. Since the functions that make up this activity are exactly the same as the storage cost rate, they will not be described again.

1.4 Functional Areas: Indirect

The functions which were described in the last section were direct costs. That is, the functions were directly or wholly related to the activity of concern, e.g., Care of Material in storage is related to the storage activity and not to some other activity, say ordering. However, there are some functions which are not associated fully with one activity of storage or ordering cost; but, which are partially connected with several activities of storage or ordering or even both activities. These functions will be referred to as indirect functions (see Section 1.2 for overall structure of relevant functions, both direct and indirect).

Within AR 37-100-74, the Central Supply and Maintenance Program defines all the activities. Within the Central Supply and Maintenance Program there are these seven major categories:

Receipt. Includes such activities as: receiving documents of material; opening transportation vehicles; unloading vehicles; and checking, tallying and external visual inspection of incoming material.

Packing and Issue. Provides for: repacking of supplies for storage; and, includes documentation, supervision and clerical effort related to these operations.

Storage Support. Provides for all activities necessary to maintain supplies in storage such as care of material while in storage, rewarehousing, preservation and packaging, inventory and training.

Other Storage Operations. Encompasses storage and warehousing activities not included in above accounts.

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Other Stock Control Operations. Includes such activities as: maintaining order files; preparation of stock status reports; and, maintaining historical item demand data.

Stock Control Support. Includes all supervision and clerical support that is applicable to more than a single function within the stock control function.

Overall Supply Depot Support. Encompasses: requirements for contractual support; and, clerical and supervision effort applicable to more than a single function with supply depot operations.

There are other major areas such as traffic management which covers the direction, control and supervision of all functions incident to procurement and use of commercial for-hire transportation service. However, there is nothing of concern in these functions for this work.

The indirect functions have some of their activities related to both holding and ordering cost or to several functions within holding or ordering, e.g., training, for storage support which encompasses training personnel for the many facets of depot storage operations. Therefore, a decision had to be made on how to extract applicable training costs from the various activities of the storage function. The approach taken here is to take the same proportion of the direct cost category to the major activity category.

To pursue the training function example further, training is a sub-function of all the storage costs. Care of Material in storage is a sub-function of Storage Support. Therefore, the cost of training (Storage Support) is in the proportion of the Care of Material to the total Storage Support function cost.

The functions which were examined as indirect cost applied to the storage function are:

Training (Storage Support). Covers the training of storage and warehousing handling personnel in those functions and operations pertaining to storage and warehousing. Excludes the quality assurance, quality control training activities.

General Storage Support. Encompasses work performed which could not be clearly identified to any single function such as Care of Material,

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Rewarehousing, etc.

Cyclic Inspection. Includes periodic examination of samples of
material selected from storage in order to determine overall quality of
material stored in the depot.

Preservation, Packaging and Packing (Inspection). Pertains to
inspection performed during operations incident to cleaning, preservation,
packaging, packing or marking for storage or shipment.

Training (Inspection). Represents the applicable elements of
cost for training quality control personnel in those functions pertaining
to quality control.

Inspection Support. Covers work done within the quality control
account but which could not be clearly identified to any single function.

Overall Supply Depot Support. Encompasses work which could not
clearly be identified to any single function such as Storage and Ware-
housing, Stock Control or Traffic Management.

The functions which were examined as indirect ordering costs are:

Receiving Inspection. Includes examination or testing to deter-
mine conformance of material to certain specifications set forth in
purchase descriptions or contracts.

Preservation, Packaging and Packing (Inspection). Same as indirect
storage function of same name.

Stock Control Support. Covers work wholly within Stock Control
operations but which could not be clearly identified to any single function
within Stock Control.

Overall Supply Depot Support. Same as indirect storage function
of same name.

CHAPTER II

COSTS

2.1 Storage

The storage cost is made up of five components. The rates for the five components and the 90% confidence limits for these rates are:

TABLE 2 - STORAGE COST ELEMENTS

Function	Rate	90% Confidence Limits
Care of Material	.0034	-.0706 to .0774
Rewarehousing	.0153	.0056 to .0250
Preservation and Packaging for Storage	-.0139	-.0694 to .0416
Physical Inventory	.0053	-.0402 to .0508
Container Assembly and Manufacture	.0202	-.0438 to .0842
TOTAL	.0303	

(See Appendix B for regression analysis equations)

All the components of the storage rate are subject to a very high degree of standard error. This, of course, implies a great deal of random variation which quite likely explains the negative rate for the Preservation and Packaging function.

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2.2 Ordering

The ordering cost is comprised of three elements. The three areas
with their costs and 90% confidence limits are:

TABLE 3 - ORDER COST ELEMENTS

Function	Cost	90% Confidence Limits
Receipt and Packing	$12.94	$8.18 to $17.70
Other Stock Control	.57	-.84 to 1.98
Supply Management	4.89	3.15 to 6.62
TOTAL	$18.40	

Like the storage cost functions, the ordering cost function also
includes Mission and ISA activities. Since there was no way to differentiate
between the two activities with the data available, the cost as shown pro-
jects both Mission and ISA activities.

2.3 Maintaining ASL Items in Stock

A by-product of the originally defined work was the development of the
cost to maintain an item on the Authorized Stockage List (ASL). Stockage
criteria of some sort are required to determine what items the depot should
have available in stock to satisfy its own requisitions as it would be too
costly to stock all items which might have a demand. Part of the stockage
criteria development should include the cost to maintain an item on the ASL.
This cost represents the cost per item to maintain an item on the ASL for
one year. The cost of maintaining an item on the ASL is independent of
the holding cost rate of the item.

The functions involved in maintaining an item on the ASL are the same
as the functions for storing items. The costs and the 90% confidence
limits are:

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TABLE 4 - MAINTAIN ITEM ON ASL

Function	Cost	90% Confidence Limits
Care of Material	$4.11	$-15.76 to $23.98
Rewarehousing	-.69	-3.29 to 1.91
Preservation and Packaging for Storage	1.17	-13.74 to 16.08
Physical Inventory	1.26	-10.95 to 13.47
Container Assembly and Manufacturer	1.88	-15.32 to 19.08
TOTAL	$7.73	

These results are similar to the previous results with respect to the high degree of error found in the observations. Again this is the most likely explanation of the negative cost for Rewarehousing.

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DERIVATION OF INDIRECT COSTS

The storage cost rate and the ordering cost are broken down into costs which were considered to be direct functions of these two activities. However, some additional costs were not included in these areas which are partially functions of direct storage and ordering; but, are also partially functions of other activities. At the same time, some of these partial costs relate to more than one direct storage or ordering cost. The question arises as to how to incorporate these partial costs into the costs to be considered for storage and ordering costs. These partial costs are referred to as indirect costs.

There are three different levels of functions by which the Central Supply and Maintenance Activities are broken up. The overall structure is given in Section 1.2, Table 1 where Roman numerals represent the major functions, regular Arabic numerals represent the first level functions and small alphabetic letters represent the second level functions.

Storage

The first objective is to revise the notation from Table 1 so one letter stands for the multiple notation necessary in Table 1. Thus, the direct storage rate elements are:

Functions	Table 1	Revised
Care of Material	III-1	A
Rewarehousing	III-2	B
Preservation and Packaging for Storage	III-3-a	C
Physical Inventory	III-4	D
Container Assembly	III-5	E

Using the revision scheme for indirect storage elements yields -

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Function	Table 1	Revised
Training (Storage Support)	III-6	a
General Storage Support	III-7	b
Cyclic Inspection	IV-1-b	c
Preservation, Packaging and Packing (Inspection)	IV-1-c	d
Training (Inspection)	IV-1-d	e
Inspection Support	IV-1-e	f
Overall Supply Depot Support	VII	g

The revised notation is now of the form: Major function - Roman Numeral, Direct function - Capital Alphabetic character, Indirect function - small Alphabetic character.

The objective is to find the fraction of indirect storage cost applicable to the direct costs. From the Table 1 notation, it is observed that the direct costs are all subfunctions of major category III, Storage Support. Hence, Training (Storage Support) and General Storage Support are applicable to all the direct costs. The Training and General Storage Support indirect costs are defined as:

$$TSX = a \frac{X}{III}$$

$$(A-1)$$

$$GSSX = b \frac{X}{III}$$

where X represents the direct functions A through E. Thus, there are five such Training functions, TSA, TSB, TSC, TSD and TSE, and five such General Storage Support functions, GSSA, GSSB, GSSC, GSSD and GSSE.

From the Table 1 notation, the indirect functions c through f are subfunctions of major category IV, Other Storage Operations. Thus, these functions are applied to the direct functions in a different manner then the indirect functions which are subfunctions of Storage Support, III. The

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inspection subfunctions c, e and f are applicable to the direct functions Care of Material, A, and Rewarehousing, B, and to no other functions, viz, C, D or E. Hence, the inspection subfunctions are included into the direct costs by the relationships:

$$CIY = c \frac{Y}{A+B}$$

$$TIY = e \frac{Y}{A+B} \qquad (A-2)$$

$$ISY = f \frac{Y}{A+B}$$

where Y is either A or B depending on whether the indirect function is applied to Care of Material or Rewarehousing.

The Preservation, Packaging and Packing, Inspection, (PP&P) indirect function, d, is applicable to both the storage cost rate (direct subfunction C, Preservation and Packaging) and the order cost (direct subfunction F^*, Receiving and Packing). The PP&P function is applicable to only C and F and thus the amount of PP&P applicable to storage is in the ratio of C to the sum of C and F, i.e.,

$$PPPS = d \left(\frac{C}{C+F}\right)^{**} \qquad (A-3)$$

The remaining indirect storage function is the Overall Supply Depot Support, g. This function is also the major function, VII. This function is a sort of "catch-all" function, i.e., functions that do not fit into any of the other major functions are included in this function. It is necessary to find the amount of this function which can be applied to the storage

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[*] See *Order* Section of this Appendix.

[**] This is not the actual relation used in the calculation. The fraction used in the computations gave results not significantly different from the numerical results of this expression.

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cost function. The fraction of the storage cost functions to all the other major functions is:

$$H = \frac{A+B+C+D+E}{I+II+III+IV+V+VI} \qquad (A-4)$$

Hence, the amount of Overall Supply Depot Support applicable to the storage function is in the same ratio and thus

$$OH = (H)(g) \qquad (A-5)$$

The amount of Overall Supply Depot Support applicable to the different storage functions is

$$HX = OH \left(\frac{X}{A+B+C+D+E} \right) \qquad (A-6)$$

where X is as above, i.e., the direct storage functions, A through E.

The total cost of the five storage functions is the sum of the direct costs and the various indirect components applicable to each function. Hence, the total cost of the storage elements is:

$$TCA = A + TSA + GSSA + CIA + TIA + ISA + HA$$
$$TCB = B + TSB + GSSB + CIB + TIB + ISB + HB$$
$$TCC = C + TSC + GSSC + PPPS + HC \qquad (A-7)$$
$$TCD = D + TSD + GSSD + HD$$
$$TCE = E + TSE + GSSE + HE$$

Expressions in (A-7) are the dependent variables in the regression analysis for the storage cost rate.

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<u>Order</u>

Revising the Table 1 notation for the direct order cost functions yields -

Function	Table 1	Revised
Receiving and Packing for Storage	I and II-1-a	F
Other Stock Control	V	G
Supply Management	-	H

The indirect functions with Table 1 and revised notations are:

Function	Table 1	Revised
Receiving Inspection	IV-1-a	h
Preservation, Packaging and Packing (Inspection)	IV-1-c	i*
Stock Control Support	VI	j
Overall Supply Depot Support	VII	k**

Receiving Inspection, h, is only applicable to Receipt and Packing, F, and is therefore applied fully to the Receipt function.

The Preservation, Packaging and Packing, Inspection, (PP&P) function is applied to the Receipt and Packing function and the storage cost as described earlier. As in the storage breakdown, the PP&P (Inspection) function is applied in the proportion of the amount of the order cost activity, F, to the sum of F plus the storage activity, C, Preservation and Packing for storage.

$$PPPO = i \left(\frac{F}{C+F}\right)^{***} \qquad (A-8)$$

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* Same as d in the storage cost rate.

** Same as g in the storage cost rate.

*** The actual ratio used in computation, although slightly different, gave insignificantly different results.

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The Stock Control Support function, j, is applicable to both Receipt of Stock and Other Stock Control activities. Hence the amount of j applied to these functions is:

$$SZ = j \left(\frac{Z}{F+G}\right) \qquad (A-9)$$

where Z is either F or G.

As in the storage cost rate development, the Overall Supply Depot Support applies to all the elements of the order cost. The fraction of the ordering cost functions to all the major functions is:

$$O = \frac{F+G}{I+II+III+IV+V+VI} \qquad (A-10)$$

and the amount of Overall Supply Depot Support applicable to the order cost is:

$$OO = (O)(k) \qquad (A-11)$$

The amount of OO applicable to each of the order cost elements is thus

$$OZ = OO \left(\frac{Z}{F+G}\right) \qquad (A-12)$$

where Z is as above.

The total cost of two of the order cost elements is

$$TCF = F + h + PPPO + SF + OF$$

$$(A-13)$$

$$TCG = G + SG + OG$$

where the total cost is the sum of the direct costs and the indirect cost applicable to that function.

Expressions in (A-13) are two of the dependent variables in the regression analysis for the order cost.

The third element of order cost is Supply Management. Supply Management is not a subfunction under the Central Supply and Maintenance Activity. The activities inherent in Supply Management function are

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found under the Post Supply function of the Base Operations Account. The Post Supply function includes more activities than Supply Management; however, there was no way to break down this cost. Hence, the Supply Management function is equated to the Post Supply function. There were no indirect costs that had to be added to the Post Supply function.

REGRESSION EQUATIONS

The regression technique was a standard multiple regression methodology.[*]
This appendix will explain how the cost and performance measures were related into a regression expression.

Storage (Maintain ASL Item)[**]

Section 2.1 defined the functions and the rates involved in the composition of the storage cost rate. Section 2.3 defined the functions and costs for maintaining an item on the ASL. Appendix A described how the direct costs of these functions were modified to allow for indirect costs from other areas. The storage functions and the functions for maintaining an item on the ASL were the same. They were:

Care of Material

Rewarehousing

Preservation and Packaging for Storage

Physical Inventory

Container Assembly and Manufacture

To find the storage cost rate and the maintenance cost due to each of these elements, the same regression was used where only the dependent variable, the costs (direct plus indirect) of each of the above functions, was changed. The regression expression was

$$TC_i = a_i + b_i x + c_i y + d_i z$$

where   i went from 1 to 5 and represented the functions above

TC$_i$ = costs of the five functions

x = value of depot ASF items on-hand

y = total number of line items in storage

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[*] See for example, "Applied Regression Analysis," Draper, N.R. and H. Smith, Wiley Press, New York, 1966.

[**] This section includes the storage analysis and the maintenance of items on the ASL since they were obtained from the same regression.

z = cost of non-depot ASF items on-hand
    (all ASF on-hand inventory minus depot ASF on-hand)

a_1 = constant regression coefficient

b_1 = storage cost rate for depot ASF items

c_1 = cost of having an item on-hand

d_1 = storage cost rate for all items other than depot ASF

The regression coefficients values are shown in Table B-1.

TABLE B-1 - STORAGE RATE (MAINTENANCE COST)
REGRESSION COEFFICIENTS

Function	a	b	c	d
Care of Material	54.97	.0034	4.11	.0022
Rewarehousing	24.37	.0153	-.69	.0001
Preservation and Packaging	60.84	-.0139	1.17	.0006
Physical Inventory	104.53	.0053	1.26	.0009
Container Assembly	67.81	.0202	1.68	.0010
TOTAL		.0303	7.73	.0048

The average values of the independent variables are shown in Table B-2.

TABLE B-2 - STORAGE RATE INDEPENDENT VARIABLES
(AVERAGE)

Variable	Value
Depot on-hand (x)	$4,165,000
Number Items in Storage (y)	55,873
Non-Depot on-hand (z)	$505,126,000

Order

Section 2.2 defined the functions and the costs involved in the composition of the ordering cost. Appendix A described how the direct costs of the functions were modified to allow for indirect costs from other areas to be included in the major functions of ordering. The ordering cost included:

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Receipt and Packing for Storage

.   Other Stock Control Operations

.   Supply Management

The general regression expression for the ordering cost was:

$$TC_1 = \alpha_1 + \beta_1 N + \gamma_1 L_1 + \delta M$$

where

    i went from 1 to 3 and represented the components cited above

    TC_1 = total cost associated with each function i

      N = number of orders placed on the ICP

      L_1 = number of line items passed through each function i

      M = number of containers packed (only entered into the regression for Receipt and Packing for Storage)

      α_1 = regression constant

      β_1 = costs of placing an order on the ICP

      γ_1 = rate per item per year for each function, e.g. rate per item to receive

      δ = cost per packed container

Table B-3 represents the coefficients as found in the regression.

TABLE B-3 - ORDERING COST REGRESSION COEFFICIENTS

Function	α	β	γ	δ
Receipt and Packing	21.49	12.94	-.03	5.83
Other Stock Control	71.26	.57	.45	–
Supply Management	232.94	4.89	.28	–
TOTAL		18.40		

The average values of the independent variables are shown in Table B-4.

TABLE B-4 - ORDER COST INDEPENDENT VARIABLES (AVERAGE)

Variable	Value
Orders on ICP (N)	60468
Items Passed Receipt (L_1)	158,000
Items Passed Other Stock Control (L_2)	251,000
Items Passed Supply Management (L_3)	453,000
Containers Packed (M)	48,000

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