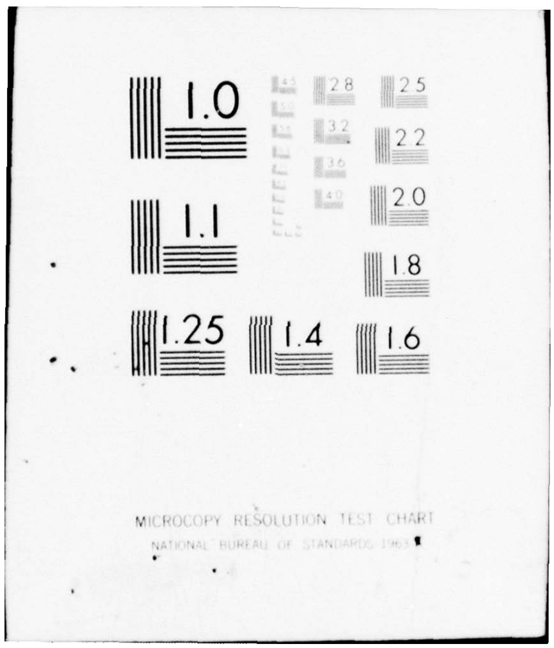
AD-A034 595 NAVY FLEET MATERIAL SUPPORT OFFICE MECHANICSBURG PA --ETC F/G 15/5
ANALYSIS OF PROPOSED INITIAL STOCKING POLICIES.(U)
DEC 76 J L ENGELMAN
UNCLASSIFIED 118A NL

1 OF 1
AD
A034595

END
DATE
FILMED
2-77


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963

ANALYSIS of PROPOSED INITIAL STOCKING POLICIES

OPERATIONS ANALYSIS DEPARTMENT

NAVY FLEET MATERIAL SUPPORT OFFICE
Mechanicsburg, Pennsylvania 17055

Report 118A

ANALYSIS OF PROPOSED INITIAL STOCKING POLICIES

REPORT 118A

PROJECT NUMBER 971255

Submitted: J. L. Engelman

J. L. ENGELMAN
Operations Research Analyst

Approved: R. E. Knachel

R. E. KNACHEL, CDR, SC, USN
Director,
Operations Analysis Department

D. P. McGillivary

D. P. MCGILLIVARY, CAPT, SC, USN
Commanding Officer,
Navy Fleet Material Support Office

Date: DEC 28 1976

ABSTRACT

DODI 4140.42 establishes policy for the determination of initial requirements for secondary item spare and repair parts. DODI 4140.42 also authorizes alternative models whose objective is to minimize time-weighted requisitions short. The Variable Threshold Rule, an alternative initial stockage model developed for the Navy, has been approved as an acceptable substitute for the DOD model.

This study compares the performance of the current UICP risk model, which meets the alternative model criteria, with the Variable Threshold Rule, the DODI rules, and the current stocking criteria. The study shows that the Variable Threshold and the UICP policies are both more cost-effective than the DOD model, but the Variable Threshold is more flexible and easier to implement.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1. Background. In DODI 4140.42 a specific rule, called the COSDIF Rule, was proposed as the wholesale stocking criterion for demand-based items. The Navy proposed an alternative range rule known as the Variable Threshold and demonstrated that the Variable Threshold Rule achieved a significantly higher gross availability than the COSDIF Rule, given the same investment. Several follow-up studies confirmed these findings for various cogs of Navy material.

Alternative models are authorized by DODI 4140.42 if the time-weighted requisitions short are minimized. The current UICP risk formula was derived to minimize time-weighted requisitions short. Therefore, an initial stocking policy based on the current UICP risk was evaluated and compared to the previously recommended stocking models.

2. Objective. To compare the impact of the various proposed initial stocking policies on a random sample of SPCC-managed NSF stock list items.

3. Approach. A candidate file of items for provisioning was not readily available for evaluation. A substitute file was developed by random selection from previously

provisioned items. It is assumed that the policy which stocked the selected items is comparable to current policy. Further, it is assumed that items rejected by current policy will also be rejected by the proposed policies. For these purposes, it appears that the current criterion stocks everything, but such was not the case. Using the basic simulation model of previous studies, four stock range rules and three initial depth computations were evaluated. The policies included:

a. Stocking every item in the sample to a depth of one year's demand.

b. Stocking items which meet the COSDIF criterion to a depth of lead time demand plus one quarter's demand.

c. Stocking items which meet the Variable Threshold criterion to a depth of lead time demand plus one quarter's demand.

d. Stocking items which have a positive reorder point (based on the current UICP risk formula) to a depth of lead time demand plus one quarter's demand.

e. Stocking items which meet the Variable Threshold criterion to a depth equal to the initial reorder point (based on the current UICP risk formula) or at least one unit.

f. Stocking items which have a positive reorder point (based on the current UICP risk formula) to a depth equal to this initial reorder point or at least one unit.

4. Findings. When all three rules use the fixed initial depth computation of lead time demand plus one quarter's demand, both the Variable Threshold and the UICP Rules for range determination are more cost-effective than the COSDIF method. Inventories determined by either the Variable Threshold or the UICP Range Rule produce very similar results, which are superior to those produced by the COSDIF stocking policy, given the same initial investment.

Substituting a variable initial depth equal to the unconstrained reorder point for the fixed depth of lead time demand plus one quarter's demand, improves both the Variable Threshold and UICP Range Rules. The fixed initial levels are more costly and less effective than the variable initial levels. The most cost-effective initial depth computation consisted of variable initial levels equal to the reorder point with an essentiality weighted shortage cost (λE) of \$150 and constrained not to exceed two year's demand forecast. Evaluation of values for λE indicates that the value determined in Stratification appears optimum for provisioning. However, the value of λE will vary by inventory segment (cog) and over time.

5. Conditional Probabilities. A key factor in the COSDIF

Rule is probability of no demand in two years given a specific demand forecast. The DODI 4140.42 provided an interim table and instructions for individual service determination of historical conditional probabilities. The SPCC provisioning history was evaluated and the results are shown in APPENDIX B. The Navy-based table indicates a higher degree of accuracy of forecasting in the lower range than the interim table. These are the prime values found in provisioning. The potential exists that Navy provisioning dollar requirements will increase under the guidance of DODI 4140.42, because of greater Navy accuracy in demand forecasting and larger initial depth permitted under COSDIF. These facts are discussed in greater detail in APPENDIX B.

6. Summary. Comparing the most cost-effective initial levels, both the Variable Threshold and the UICP Range Rules determine inventories which achieve significantly higher gross effectiveness for less investment initially than the COSDIF policy. These alternative initial stocking models give relative preference to inexpensive, high demand, long lead time items and provide essentially the same gross effectiveness as the present policy while spending less initially. Parameter determination and adjustment are much easier for the Variable Threshold Rule

than for the UICP policy; therefore, FMSO recommends implementation of the Variable Threshold Rule for range determination at SPCC with a constrained variable initial level (reorder point with stratification shortage cost). Further, that the conditional probabilities shown in APPENDIX B be adopted for use in Navy provisioning requirements determination.

I. INTRODUCTION

DODI 4140.42 establishes policy for the determination of initial requirements for secondary item spare and repair parts (see reference 1). In the DOD instruction a specific rule, called the COSDIF Rule, provides criterion for the wholesale stocking of demand-based items. Another stocking model, called the Variable Threshold Rule, first used in reference 2, is a minor modification of an initial provisioning model developed for the Navy by reference 3. In references 4 through 7, these stocking models were compared and evaluated for various cogs of Navy material. The Variable Threshold Rule achieved a significantly higher gross availability than the COSDIF Rule for the same inventory investment. On the basis of the results of reference 4, OSD approved the Variable Threshold Rule as an acceptable substitute for the COSDIF Rule, with the proviso that the Variable Threshold Rule not exceed the COSDIF Rule investment constraint (see references 8 and 9.)

Since DODI 4140.42 authorizes alternative models whose objective is to minimize time-weighted requisitions short, reference 10 requested FMSO to compare the long range impact of a model based on the current UICP (Uniform Inventory Control Program) risk formula for days delay developed in reference 11 in accordance with DODI 4140.39 (see reference 12).

This study analyzes the impact of proposed initial stocking policies on SPCC managed NSF (Navy Stock Fund) material (i.e., 1H cog) and not on total fleet support.

II. TECHNICAL APPROACH

Using the basic simulation model of previous studies and a sample of NSF material, four stock range rules and three initial depth computations were compared and contrasted. FMSO evaluated the following policies:

- stocking every item in the sample to a depth of one year's demand
- stocking items which meet the COSDIF criteria to a depth of lead time demand plus one quarter's demand
- stocking items which meet the Variable Threshold criteria to a depth of lead time demand plus one quarter's demand
- stocking items which have a positive reorder point (based on the current UICP risk formula) to a depth of lead time demand plus one quarter's demand
- stocking items which meet the Variable Threshold criteria to a depth equal to the initial reorder point (based on the current UICP risk formula) or at least one unit

. stocking items which have a positive reorder point (based on the current UICP risk formula) to a depth equal to this initial reorder point or at least one unit.

The input data, simulation model, and the various stocking policies are described in the following paragraphs.

A. INPUT DATA. The 10% random sample of 1H items used in references 4 and 6 was combined with the 9% sample of 1N items used in references 5 and 6 to reflect the merger of SPCC NSF cogs. From the above combined samples, a new sample (8338 items) was drawn and used as the input data. No 1A items were included in the sample which is deemed to have small impact on the study results.

Although every item in the sample is presently carried, the distinction between items stocked on the basis of anticipated demand and items stocked for insurance purposes has been lost. Since the insurance items in the sample cannot be identified, insurance type items are not added to the range in any alternative stocking policy, but are included in the stock every item policy.

B. SIMULATION MODEL. The CONUS Inventory Simulator, described in reference 4, replicates the inventory management operations for SPCC-managed consumable material. As in the previous analyses, the simulator was updated to reflect current management policies. For example, SPCC recently substituted the Poisson distribution in levels computations for low demand items rather than use a fixed stockage objective table. Because of changes to the simulator and the data bases, the results of this study are not strictly comparable to previous studies.

As in the previous analyses, items with a zero requisition forecast are not carried (except in the rule which stocks every item in the sample) and items with a requisition forecast greater than or equal to 12 are automatically stocked in a depth of at least one unit. Before the simulation begins, the alternative stock range rules determine whether to carry or not carry each item. The range of stocked items remains constant throughout the simulation; items do not migrate into or out of the carried inventory.

Previous studies dealt primarily with the long range impact of the alternative range rules. For carried items, the initial on-hand was defined as the theoretical average on-hand: the reorder point quantity plus one-half the order quantity. During the simulation, the model considered this initial on-hand to satisfy the demands and complied with the UICP rules to replenish stocks. The analyses considered the first two years of the five year simulation as a transition period and evaluated the performance of the different range rules during the final three years -- the steady state conditions. Steady state effectiveness statistics were then compared using the steady state priced out on-hand plus due-in ($ inventory investment) as the financial basis.

Besides evaluating the long range consequences of the newest proposed stocking policy, the present study attempts to quantify the short range impact of each alternative stocking policy. For carried items, the initial on-hand is defined as the initial depth corresponding to each stocking policy. Since the different policies stock different initial quantities, the effectiveness statistics at the end of the first year reveal the effects of differences in the initial depth computation, as well as differences in the range computation. Also, for each stocking policy the cost of this initial quantity ($ initial provisioning) became the financial basis for policy comparisons.

C. STOCKING POLICIES.

1. Stock All Items. Since every item in the sample has met the present stocking criteria, this rule duplicates the present SPCC policy. Similar to the present SPCC policy, carried items are stocked to a depth equal to one year's demand. Reference 13 contains a detailed description of the SPCC stockage rules.

2. COSDIF Rule. The COSDIF equation considers costs associated with stocking and not stocking a candidate item. If the projected cost of not stocking the item is greater than the projected cost of stocking the item, then the item is carried. As directed by reference 1, items which pass the COSDIF are stocked in an initial depth equal to lead time demand plus one quarter's demand. The modified COSDIF equation as used in previous analysis is:

$$\mathrm{COSDIF} = (F_0/F_D)[C_P + 2\,HU\,(R+Q)]$$
$$+ (1-F_0/F_D)[C_P(D/Q) + HU\,(S + Q/2) + C_I\,F_D]$$
$$- (1-F_0/F_D)\left[KC_PF_D + PDU + F_D\,L\,\max\left\{\begin{matrix}\lambda E/115\\ HUD/365F_D\end{matrix}\right.\right]$$

where

F_0/F_D = probability of zero demand in coming two years, given annual frequency of demand F_D

C_P = ICP cost to procure

H = holding cost rate

U = item unit price

R = reorder level

Q = economic order quantity

D = forecast of annual demand

S = safety level

C_I = cost to issue

F_D = annual frequency of demand

K = conversion factor to adjust procurement costs for non-stocked items

P = increase in item unit price (U) due to spot buy

L = procurement lead time (in days)

λ = shortage cost

E = item essentiality

3. Variable Threshold Range Rule with Fixed Initial Depth. The Variable Threshold Range Rule calculates the probability that one or more demands will occur during lead time per dollar invested. There is a criterion value for each candidate line item. After ranking the probabilities from highest to lowest, the Variable Threshold Range Rule stocks the items with the higher demand probabilities. To reach the COSDIF investment goal, items with correspondingly smaller and smaller probabilities of demand are added to the range of carried items in a methodical and systematic manner. The Variable Threshold equation is:

$$P = \frac{1-e^{-DL}}{c}$$

where

P = probability that one or more demands will occur during a lead time per dollar invested

D = forecast of quarterly demand

L = lead time (in quarters)

c = item unit price

e = Napier's number

Items which meet the Variable Threshold Range criterion are stocked in a fixed initial depth equal to lead time demand plus one quarter's demand.

4. UICP Range Rule with Fixed Initial Depth. The UICP Range Rule is based on the risk equation currently used under the UICP replenishment rules. The risk equation is:

$$RISK = \frac{SIC}{SIC + \lambda E}$$

where

S = requisition size in units

I = annual holding cost

C = item unit price

λ = shortage cost

E = item essentiality

After selecting a probability distribution to represent demand in accordance with the UICP replenishment rules, the unconstrained risk, the lead time demand, and the variance of lead time demand are used to compute the item's reorder point. If this reorder point is positive, then the item is carried in a fixed initial depth equal to lead time demand plus one quarter's demand.

Changes to the shortage cost parameter produce different risks which may yield different reorder points and, therefore, may increase or decrease the range of carried items. To meet the COSDIF investment goal requires a series of computer runs to determine the optimum shortage cost which generates the specified initial investment. Given an initial shortage cost which determines a range of items, the fixed initial depth has to be priced out and compared to the COSDIF's. If the initial investment is less than the COSDIF's, then the shortage cost must be increased, the reorder points recomputed, the fixed depth priced out again, and the initial investment recompared to the COSDIF's. The reiterative process must continue until the initial investments match.

5. Variable Threshold Range With Variable Initial Depth. The Variable Threshold Range Rule explained above was also used with a variable initial depth equal to the unconstrained reorder point. The unconstrained reorder point is based on the current UICP risk formula and calculated as previously explained in paragraph II.C.4.

This stocking policy requires the manipulation of two distinct parameters to determine an initial investment equal to the COSDIFs. The more difficult method of matching the COSDIF's initial investment would be to vary both the range and depth parameters simultaneously. A simpler approach would be to hold the range constant and vary the initial depth (by changing the shortage cost) or to select a shortage cost (and, therefore, the initial depth) and vary the range until the investment goal is reached.

6. UICP Range Rule with Variable Initial Depth. The UICP Range Rule explained above was also used with an initial depth equal to the same positive unconstrained reorder point which qualified the item for stockage. Thus, this policy uses the same range criteria as paragraph II.C.4 and the same initial depth as paragraph II.C.5.

Unlike any of the previous policies, this policy has only one parameter which determines both the range of items carried and their initial depth simultaneously. However, similar to the UICP Range Rule with fixed initial depth, the determination of the optimum shortage cost which generates the same initial investment as the COSDIF consists of a series of time consuming and, therefore, costly computerized reiterations.

Stock depth in supply terminology refers to the units of stock allocated to a line item at a particular echelon of supply. Net effectiveness is a direct measure of the adequacy of stock depth. Two general concepts for computing stock depth are the fixed and variable level. Under the fixed concept, each item in a segment of the inventory is allocated an equal number of days/months of supply. Months of supply are based on the current forecast of demand for the individual item. Another method for expressing fixed depth might be to allocate each item stocks equal to lead time demand. Demand varies by item as does lead time, but the product of the two averages gives a fixed protection to all items of approximately 50%. This assumes use of the normal distribution of demand and minor impact due to rounding of numbers in the final levels determination. The variable depth computation considers several item characteristics for each item and seeks to allocate depth to the various items to provide the greatest overall net effectiveness. Usually the predominant characteristics in the determination are demand and unit price for the various items. Consider two items with like characteristics, except unit price. If the price of one item is $1 and for the second $100, then investment in several units of the first item is much more cost-effective than one unit of the second item. Within a given funding constraint, more net effectiveness can be afforded from the first item, so the manager is motivated under the variable depth concept to stock fast-moving, inexpensive items. Unfortunately, military essentiality is an inoperative factor in most segments of the inventory for the simple reason that relative essentiality has not been established among most items of supply. Variable depth is a relatively new concept, it has not been fully exploited due to lack of quantification of needed variables. It has been used to generate higher net effectiveness than that attainable from fixed levels for specific inventory situations.

III. FINDINGS

The study findings are divided into five separate sections explained in detail below. The first section presents an overall view of the performance of each of the six stocking policies described above. The analysis shows that regardless of the initial depth computation, inventories determined by the Variable Threshold Range Rule or the UICP Range Rule produce very similar results, which are superior to those produced by the COSDIF stocking policy, given the same initial investment. The second section further analyzes initial depth calculations, and concludes that fixed initial levels (lead time demand plus one quarter's demand) are more costly and less effective than variable initial levels (unconstrained reorder point). The third section measures the sensitivity of the shortage cost in the variable initial depth computations. Increasing the essentiality weighted shortage cost above the $150 last used in stratification produces significant increases in investment and no significant change in performance. The fourth section examines the theoretical and practical aspects of constraining the initial reorder point. The study does not reveal any evidence of a superior performance for either the unconstrained or constrained initial reorder point. However, from a theoretical viewpoint alone, the constraint on the initial buy is a necessary precaution. The fifth and final section concludes the analysis by comparing the present policy and the COSDIF policy with both the Variable Threshold and UICP Range Rules, with variable initial depth constrained to be no greater than two years demand. The limitations and flexibilities of the Variable Threshold and UICP Range Rules are discussed.

A. <u>POLICY COMPARISON</u>. Table I contains the results of the six basic policies evaluated. Comparing the COSDIF Rule with the present (stock all) rule, COSDIF reduces the range of items by 53.8% and inventory investment by 53.2%. Steady state gross effectiveness declines by more than 10 percentage points. Total buys increase almost 60% with the greatest impact in spot buys. The above statistics reveal the same trends discovered in previous analyses; however, the reductions in the range of items, gross effectiveness, and inventory investment are much more moderate. The more moderate reductions are a result of changing two parameters in the COSDIF equation. The most significant change was the substitution of the conditional probabilities given in reference 1 for those derived in reference 14 which were used in all previous analyses. At the time of this study, preliminary results on a concurrent study (see reference 15) indicated that the conditional probabilities originally derived for the Navy were overstated. Using a larger sample, the initial findings indicated that the Navy conditional probabilities would be much closer to those in DODI 4140.42 than those earlier published for the Navy. The new recommended Navy conditional probabilities have just been published in reference 15 , and Appendix B

TABLE I

STOCKING POLICIES

RANGE RULE	STOCK ALL	COSDIF	THRESHOLD	UICP	THRESHOLD	UICP
DEPTH COMPUTATION	ONE YR'S DMD	LTDMD + 1 QTR	LTDMD + 1 QTR	LTDMD + 1 QTR	UN-CONSTRAINED REORDER PT	UN-CONSTRAINED REORDER PT
Items Stocked (#)	8,338	3,852	7,167	6,874	7,167	7,167
% of Items Stocked	100	46.2	86.0	82.4	86.0	86.0
Net Eff (End 1st Yr)	89.45	93.81	91.50	91.88	96.29	96.39
Net Eff (S.S.)	86.15	88.04	86.94	87.11	88.03	88.16
Gross Eff (End 1st Yr)	89.45	81.19	89.04	88.72	93.69	93.83
Gross Eff (S.S.)	86.15	75.89	84.62	84.24	85.69	85.99
$ Initial Provisioning	8.3M	7.2M	7.3M	7.2M	7.1M	7.2M
$ Inventory Invest. (On Hand + Due In S.S)	20.3M	9.5M	10.6M	10.3M	10.8M	11.4M
Avg Annual Buys (S.S.)	3,467	5,523	3,666	3,742	3,349	3,360
Replenishments (S.S.)	2,695	1,397	2,283	2,215	2,050	2,095
NIS Spot Buys (S.S.)	772	431	670	645	586	606
NC Spot Buys (S.S.)	0	3,695	713	882	713	659

S.S. = Steady State--the mean value during the last three years of the five year simulation

indicates their impact. The substituted conditional probabilities of zero demand in the next two years are smaller and allow more items to be carried which increases gross effectiveness and inventory investment. Also, the essentiality weighted shortage cost (λE) used in the COSDIF equation was raised to $150 to reflect the current stratification value. Using a larger shortage cost than previous studies, makes more items eligible for stockage and, therefore, could increase both gross effectiveness and inventory investment. However, based on the sensitivity analysis of the COSDIF parameters in reference 4 , the COSDIF stocking policy is much more sensitive to changes in the conditional probabilities of the extent employed in this study than to $50 increases in the value of λE.

The remaining stock range policies in Table I all meet the initial investment constraint of 7.2M dollars established by the COSDIF Rule. Combining either the Variable Threshold Range Rule or the UICP Rule with the fixed initial depth computation equivalent to the COSDIF (Columns 3 and 4) produces almost nine percentage points higher steady state gross effectiveness than the COSDIF for about the same initial provisioning investment. Both stocking policies expand the range of carried items--the Variable

Threshold Range Rule stocks 86% more items than the COSDIF while the UICP Range Rule stocks 78% more. Under either alternative range rule with fixed initial depth, gross effectiveness at the end of the first year is almost eight percentage points higher than the COSDIF's and almost the same as the current policy. Also, total buys decrease approximately 33% from the COSDIF to either stocking policy, and the alternative range criteria increase annual buys only about 7% when compared to the present policy.

The Variable Threshold Rule was rerun using the same threshold cutoff as before and a variable initial depth equal to a reorder point, with the value of λE raised to \$350 so that the stocking policy would spend all the money the COSDIF allows. Thus, both Variable Threshold Rules spend about the same money stocking the same items in different initial depths. Similar to the Variable Threshold Range Rule, the UICP Range Rule was rerun stocking a variable initial depth equal to the reorder point, with the value of λE raised to \$337.50 so that the stocking policy would spend the entire amount authorized by the COSDIF Rule. Although the number of items stocked under this UICP Range Rule and the threshold rule coincide, the items stocked under these rules do not coincide.

For the same initial provisioning investment authorized by the COSDIF, either alternative range rule with variable initial depth produces a superior performance not only when compared to the COSDIF but also when compared to the same range rule with fixed initial depth. Both alternative range rules with variable initial depth achieve the following results when compared to the corresponding range rule with fixed initial depth (lead time demand plus one quarter's demand): (1) steady state gross effectiveness improves more than one percentage point; (2) gross effectiveness at the end of the first year improves about five percentage points; and (3) total buys decrease about 9% due to increased depth of inexpensive items. The alternative range rules with variable initial depth improve gross effectiveness at the end of the first year by over four percentage points and lower annual buys over 3% when compared with the current policy.

In summary, given the same initial investment constraint, both the Variable Threshold and UICP Range Rules are equally more cost-effective than the COSDIF when each stocks a fixed initial depth of lead time demand plus one quarter's demand. The alternative rules improve on the COSDIF's performance (end of first year gross effectiveness up almost eight percentage points and steady state gross effectiveness up almost nine percentage points) while almost matching the current policy (a decrease of less than one percentage point at end of first year gross effectiveness and less than two percentage points in steady state gross effectiveness).

Also, both alternative range rules used with variable initial depth are equally more cost-effective than the COSDIF, given the same initial investment. In addition, the alternative range rules used with variable initial depth appear more cost-effective than the same rules with fixed initial depth, given the same initial investment. The variable depth rules are further analyzed in the following section.

B. COMPARISON OF FIXED VS VARIABLE INITIAL DEPTHS. In the preceding analysis both the Variable Threshold and the UICP Range Rules produced higher effectiveness for the same investment when variable initial depths were substituted for the fixed initial depth. For the Variable Threshold, the range of items carried was identical under either depth computation; therefore, the improvement of gross effectiveness resulted entirely from the variable initial depth. However, for the UICP Rule to spend the authorized amount, the range of items was increased. Thus, the increased performance under the UICP Range Rule with variable initial depth may be caused by the expanded range alone or in combination with the variable initial depth.

Table II compares differences in the performance of inventories caused by changing only the initial depth and holding the range of items constant for both the Variable Threshold and UICP Range Rules. The first column measures

TABLE II

COMPARISON OF INITIAL DEPTH FOR GIVEN RANGE

RANGE RULE / DEPTH COMPUTATION	UICP $\lambda E = \$150$		VAR THRESHOLD SAME CUT-OFF	
	LTDMD + 1 QTR	UNCONSTRAINED RP	LTDMD + 1 QTR	UNCONSTRAINED RP
Item Stocked (#)	6,709	6,709	7,167	7,167
% of Items Stocked	80.5	80.5	86.0	86.0
Net Eff (End 1st Yr)	91.66	94.95	91.50	94.62
Net EFF (S.S.)	86.81	87.50	86.94	87.12
Gross Eff (End 1st Yr)	88.03	91.19	89.04	92.07
Gross Eff (S.S.)	83.49	84.14	84.62	84.86
$ Initial Provisioning	7.0M	5.3M	7.3M	5.4M
$ Inventory Invest. (On Hand + Due In S.S.)	10.1M	9.9M	10.6M	10.4M
Avg Annual Buys (S.S.)	3,812	3,674	3,666	3,536
Replenishments (S.S.)	2,151	2,094	2,283	2,185
NIS Spot Buys (S.S.)	635	599	670	638
NC Spot Buys (S.S.)	1,026	1,026	713	713

S.S. = Steady State--the mean value during the last three years of the five year simulation

the performance of the fixed initial depth (lead time plus one quarter's demand) for the range of items determined by the UICP Rule using the same shortage cost used in the last stratification. Column two shows, for the same range of items, the effects of the variable initial depth (based on the same unconstrained reorder point, $\lambda E = \$150$, which qualified the item for stockage). The UICP Range Rule with variable initial depth reduces the initial investment for the same range rule with fixed initial depth by more than 24%. Yet the variable initial depth achieves slightly higher steady state gross effectiveness (less than one percentage point), significantly higher end of first year gross effectiveness (over three percentage points) and lower annual buys (3.6% decrease).

Columns three and four reveal the effects of both fixed and variable initial depth ($\lambda E = \$150$) computations for the same range of items determined by the Variable Threshold Rule. The range shown is that which met the COSDIF investment goal when using the fixed initial depth computation. For the given range of items determined by the Variable Threshold Rule, the variable initial depth performs better for less money. These results are similar to those found in the analysis of the UICP Range Rule. Variable initial depth reduces initial investment by 26% while improving gross effectiveness at the end of the first year over three percentage points, maintaining about the same steady state gross effectiveness, and lowering annual buys by 3.6%.

Table II demonstrates the degree to which fixed initial levels dissipate provisioning funds. Neither of the range rules with variable initial depth spend as much as the identical rule with fixed initial depth. Yet both achieve slightly higher steady state gross effectiveness, significantly higher end of first year gross effectiveness and lower annual buys.

C. SENSITIVITY ANALYSIS OF THE SHORTAGE COST PARAMETER IN THE VARIABLE INITIAL DEPTH COMPUTATION. The variable initial depth computation of the reorder point utilizes (1) unique item defined characteristics (such as the item unit price and the lead time demand) and (2) a parameter called the shortage cost. Changing the shortage cost changes the item's risk and, therefore, the item's reorder point. In the UICP Range Rule with variable initial depth, the reorder point determines not only whether the item is carried or not but also the initial depth. Table III measures the consequences of varying the shortage cost. As the shortage cost increases, the number of items stocked, gross effectiveness for end of first year and steady state, and investment for initial and steady state, all increase at a diminishing rate, while annual buys decrease at a similar diminishing rate. As the shortage cost increases, the most drastic

TABLE III

SENSITIVITY OF λE IN VARIABLE INITIAL DEPTH FOR UICP RANGE RULE

	λE = $1	λE = $50	λE = $150	λE = $250	λE = $337.50
Item Stocked (#)	1,751	5,726	6,709	7,015	7,167
% of Items Stocked	21.0	68.7	80.5	84.1	86.0
Net Eff (End 1st Yr)	77.66	92.07	94.95	95.88	96.39
Net EFF (S.S.)	91.16	87.96	87.50	87.88	88.16
Gross Eff (End 1st Yr)	50.64	85.02	91.19	92.99	93.83
Gross Eff (S.S.)	59.10	81.23	84.14	85.37	85.99
$ Initial Provisioning	1.0M	3.4M	5.3M	6.4M	7.2M
$ Inventory Invest. (On Hand + Due In S.S.)	4.9M	8.6M	9.9M	10.6M	11.4M
Avg Annual Buys (S.S.)	10,196	4,351	3,674	3,477	3,360
Replenishments (S.S.)	652	1,778	2,049	2,104	2,095
NIS Spot Buys (S.S.)	129	525	599	610	606
NC Spot Buys (S.S.)	9,415	2,048	1,026	763	659

S.S. = Steady State--the mean value during the last three years of the five year simulation

increment in the marginal changes of the above statistics occurs in initial investment. Raising the value of λE from \$50 to \$150 increases steady state gross effectiveness almost three percentage points and end of first year gross effectiveness over six percentage points while raising initial investment \$1.9M or 56%--the largest marginal change. Further increases in the shortage cost (necessary to spend the entire amount authorized by COSDIF) raise the initial depth on items stocked under smaller shortage costs and add more items to the range of carried items. However, the resulting increase in performance is small compared to the increase in initial investment. Raising the value of λE from \$150 to \$250 produces a 21% increase in initial investment, yet the increase in both steady state gross effectiveness and end of first year gross effectiveness is less than two percentage points. The final increase in the value of λE from \$250 to \$337.50 achieves less than one percentage point increase in both steady state and end of first year gross effectiveness for an almost 12% increase in initial investment.

Table IV deals with the sensitivity of the shortage cost in the variable initial depth computation for a fixed range of items determined by the Variable Threshold criteria. The results are similar to those displayed in Table III for the UICP Range Rule; as the shortage cost increases all the

TABLE IV

SENSITIVITY OF λE IN VARIABLE INITIAL DEPTH FOR VARIABLE THRESHOLD RANGE

	λE = $150	λE = $250	λE = $350
Item Stocked (#)	7,167	7,167	7,167
% of Items Stocked	86.0	86.0	86.0
Net Eff (End 1st Yr)	94.62	95.77	96.29
Net EFF (S.S.)	87.12	87.61	88.03
Gross Eff (End 1st Yr)	92.07	93.19	93.69
Gross Eff (S.S.)	84.86	85.28	85.69
$ Initial Provisioning	5.4M	6.4M	7.1M
$ Inventory Invest. (On Hand + Due In S.S.)	10.4M	10.6M	10.8M
Avg Annual Buys (S.S.)	3,536	3,441	3,349
Replenishments (S.S.)	2,185	2,112	2,050
NIS Spot Buys (S.S.)	638	616	586
NC Spot Buys (S.S.)	713	713	713

S.S. = Steady State--the mean value of during the last three years of the five year simulation performance indices improve at a diminishing rate. The greatest marginal changes occur in initial investment. Raising the value of λE from \$150 to \$350 produces only a one percentage point increase in steady state gross effectiveness and a less than two percentage point increase in end of the first year gross effectiveness while increasing initial investment \$1.7M or 31.5%.

A comparison of Table IV with Table III reveals not only the same trends for changes in the shortage cost, regardless of the alternative range criteria involved, but also shows a remarkable similarity in the effectiveness statistics for the same shortage costs. For example, regardless of the range criteria, for the \$250 value of λE both policies achieve approximately 93% end of first year gross effectiveness and 85% steady state gross effectiveness. Given the same initial depth computation, both the Variable Threshold and the UICP Range Rules produce very similar results for the same initial investment.

Tables III and IV demonstrate that increases in the value of λE above \$150 (value used in the last stratification process) result in a negligible increase in effectiveness. This phenomenon may be due in part to the method of evaluation and/or characteristics of the sample inventory. Nevertheless, the data indicates that determination of a reasonable essentiality weighted shortage cost may well satisfy the future requirements of OASD without repeated resort to a provisioning dollar ceiling determination using COSDIF.

D. EFFECTS OF A TWO YEAR DEMAND CONSTRAINT ON THE VARIABLE INITIAL DEPTH. Calculating an initial reorder point with no constraints on either the risk or the reorder point may yield a reorder point equal to several year's demand. If the actual demand occurs at a rate less than initially estimated, then the reorder point would equal many more year's demand based on the item's true demand. To minimize this situation, it was proposed that the variable initial depth for both the Variable Threshold and the UICP Range Rules be constrained not to exceed two year's demand forecast.

Table V measures the effects of the constraint for the range of items determined by the two different stocking policies. For the UICP Rule with both the range and initial depth based on a value of λE of \$150, columns one and two compare the effects of an initial depth quantity equal to (1) the unconstrained reorder point and (2) the reorder point constrained not to exceed two year's demand forecast. Because the same range of items experienced the same demand patterns and were replenished under the same

TABLE V

EFFECTS OF REORDER POINT CONSTRAINT (TWO YRS DMD)

RANGE RULE DEPTH COMPUTATION	UICP UNCONSTRAINED RP λE = \$150	UICP CONSTRAINED RP λE =\$150	THRESHOLD UNCONSTRAINED RP λE = \$150	THRESHOLD CONSTRAINED RP λE =\$150
Item Stocked (#)	6,709	6,709	7,167	7,167
% of Items Stocked	80.5	80.5	86.0	86.0
Net Eff (End 1st Yr)	94.95	94.02	94.62	93.63
Net Eff (S.S.)	87.50	87.08	87.12	86.73
Gross Eff (End 1st Yr)	91.19	90.31	92.07	91.11
Gross Eff (S.S.)	84.14	83.75	84.86	84.42
\$ Initial Provisoning	5.3M	5.1M	5.4M	5.2M
\$ Inventory Invest. (On Hand + Due In S.S.	9.9M	9.9M	10.4M	10.4M
Avg Annual Busy (S.S.)	3,674	3,784	3,536	3,647
Replenishments (S.S.)	2,049	2,128	2,185	2,260
NIS Spot Buys (S.S.)	599	630	638	674
NC Spot Buys (S.S.)	1,026	1,026	713	713

S.S. = Steady State--the mean value during the last three years of the five year simulation

rules, steady state inventory investment remains constant. By constraining the initial reorder point, provisioning investment declines less than 4%. Also, end of first year gross effectiveness declines less than one percentage point, steady state gross effectiveness declines an insignificant amount, and annual buys increase less than 3%.

Columns three and four compare the unconstrained and constrained variable initial depth for a range of items determined by the Variable Threshold criteria. Items considered passed the range test of the Variable Threshold Rule with fixed initial levels that spent the amount authorized by the COSDIF Rule. When the initial depth is constrained, provisioning investment decreases by less than 4% and steady state inventory investment remains constant. Also, end of the first year gross effectiveness declines less than one percentage point, steady state gross effectiveness declines an insignificant amount, and annual buys increase just over 3%.

Independent of the range determination, constraining the reorder point not to exceed two year's demand forecast produces an insignificant long range impact. Both steady state inventory investment and gross effectiveness remain constant, while annual buys increase slightly (3%). The short term effects are more pronounced. End of first year gross effectiveness declines almost one percentage point and initial investment decreases 4%. Applying the savings realized from the initial depth constraint to expand the range of stocked items could increase end of first year gross effectiveness and decrease annual buys without procuring years of material based on an estimated demand rate which may not occur.

It is noted that a high correlation exists between the demands experienced during the simulation and the initially forecasted demand for the sample data due to the technique for generating demands. This high correlation probably does not exist at the time of provisoning. If the provisioning estimate of demand is overstated, then the constraint would have an even smaller impact on effectiveness than Table V reveals.

E. <u>COMPARISON OF REVISED POLICIES</u>. The preceding analyses found:

- The Variable Threshold and the UICP range criteria are equally more cost-effective than the COSDIF, independent of the initial depth. By manipulating the parameters, either stocking policy could produce an inventory whose performance would match the other's for any given investment target.
- Independent of the range criteria, inventories determined by the variable initial depth computation not only perform better than those based on the DODI 4140.42 fixed initial depths but also

out perform the current fixed depth policy.

- *Raising the value of λE in the variable* initial depth computation above $150 for this inventory segment gains little in effectiveness while increasing the initial investment substantially.
- If an item experiences demand at a rate below the initial forecast, then the initially procured material could become obsolete or excess. To minimize the excesses arising from overestimating the demand rate, it is necessary to constrain the initial depth not to exceed some upper limit such as two years of forecasted demand.

Using these modifications to the initial depth computation, the UICP Range Rule was rerun. The first three columns of Table VI contain the results of this stocking policy along with the results of the stock every item and COSDIF Rules. The constrained UICP stocking policy with $150 value of λE stocked over 74% more items than the COSDIF while reducing the initial investment by more than 30%. Steady state gross effectiveness improved about eight percentage points, end of first year gross effectiveness improved over nine percentage points, annual buys decreased more than 31%, yet steady state inventory

TABLE VI

COMPARISON OF REVISED STOCKING POLICIES

RANGE RULE	STOCK ALL	COSDIF	UICP	UICP	VAR THRESHOLD
DEPTH COMPUTATION	ONE YR'S DMD	LTDMD = 1 QTR	CONSTRAINED RP λE = $150	CONSTRAINED RP λE = $437.50	CONSTRAINED RP λE = $150
Item Stocked (#)	8,338	3,852	6,709	7,259	7,656
% of Items Stocked	100	46.2	80.5	87.1	91.8
Net Eff (End 1st Yr)	89.45	93.81	94.02	95.28	93.23
Net Eff (S.S.)	86.15	88.04	87.08	87.39	86.12
Gross Eff (End 1st Yr)	89.45	81.19	90.31	92.96	92.07
Gross Eff (S.S.)	86.15	75.89	83.75	85.46	85.10
$ Initial Provisioning	8.3M	7.2M	5.1M	7.3M	6.0M
$ Inventory Invest. (On Hand + Due in S.S.)	20.3M	9.5M	9.9M	11.8M	12.4M
Avg Annual Buys (S.S.)	3,467	5,523	3,784	3,515	3,544
Replenishments (S.S.)	2,695	1,397	2,128	2,269	2,475
NIS Spot Buys (S.S.)	772	431	630	654	751
NC Spot Buys (S.S.)	0	3,695	1,026	592	318

S.S. = Steady State--the mean value during the last three years of the five year simulation

investment increased less than 5%. Comparing this revised UICP policy with the current practice revealed a 20% decline in the number of items carried. Steady state gross effectiveness declined less than 2.5 percentage points, end of first year gross effectiveness improved almost one percentage point, and annual buys increased by slightly more than 9%. Both investment statistics declined--initial investment by over 38% and steady state inventory investment by more than 51%.

As noted earlier, the UICP stocking policy with a \$150 value of λE spent less than COSDIF. To spend the full amount authorized by COSDIF, the value of λE has to be raised to \$437.50. However, a comparison of the constrained UICP stocking policy with the \$437.50 value for λE to the UICP policy with \$150 value for λE reveals an increase in steady state gross effectiveness of less than two percentage points while increasing the initial investment over 30%.

The major limitation of the UICP stocking policy is the lack of flexibility to expand either the range or depth while holding the other constant. Under the UICP stocking policy, after the shortage cost is determined, both the initial depth and range of carried items are fixed. The range of stocked items cannot be expanded to achieve higher gross effectiveness without also increasing the depth of items previously stocked. However, the Variable Threshold stocking policy does offer this flexibility.

Under the Variable Threshold stocking policy, the more cost-effective constrained variable initial depth based on $150 value of λE can be used for all items; independent of the shortage cost, the range of carried items can be expanded to spend the amount of money authorized with a corresponding improvement in gross effectiveness.

Column five shows the Variable Threshold Range Rule with a constrained reorder point based on a $150 value of λE. By fixing the shortage cost and, therefore, the initial depth, this Variable Threshold policy attempts to spend the amount authorized by expanding the range of items. In this example, the range includes every item in the sample that has a positive probability of demand during lead time. Yet, this stocking policy fails to spend the full amount authorized by the COSDIF. Since the range of items cannot be further extended, to spend the remaining amount requires a higher shortage cost and greater initial depth. However, previous analysis showed that higher shortage costs, while spending more money, gained little in effectiveness.

The revised Variable Threshold stocking policy stocked almost twice as many items as the COSDIF Rule for 16.7% less in initial investment. Steady state gross effectiveness improved more than nine percentage points, end of first year gross effectiveness improved almost 11 percentage points, annual buys decreased almost 36%; however, steady state inventory investment increased over 30%. Comparing this Variable Threshold policy with the current policy revealed an 8% decline in the number of items carried. Steady state gross effectiveness declined just over one percentage point, end of first year gross effectiveness improved over 2.5 percentage points, and annual buys increased by slightly more than 2%. Both investment statistics dropped significantly--initial investment by almost 28% and steady state inventory investment by almost 39%.

A comparison of the revised Variable Threshold policy to the revised UICP policy with either shortage cost indicates the Variable Threshold policy stocked the widest range of items. Although the Variable Threshold's initial investment is closer to the \$150 value of λE UICP policy, the performance is remarkably similar to the better performing UICP policy with \$437.50 value for λE.

IV. SUMMARY AND CONCLUSIONS

Both the Variable Threshold and the UICP Rules for range determination are more cost-effective than the COSDIF method under the condition that all three rules use the fixed initial depth computation of lead time demand plus one quarter's demand. Given the COSDIF investment constraint, both alternative stocking policies stock a wider range of items (approximately 80% more) and improve both end of first year gross effectiveness (about eight percentage points) and steady state gross effectiveness (almost nine percentage points). However, the alternative range rules attained neither the end of first year gross effectiveness (off by less than one percentage point) nor the steady state gross effectiveness (off by less than two percentage points) of the current policy.

Substituting a variable initial depth equal to the unconstrained reorder point for the fixed depth of lead time demand plus one quarter's demand, improves both the Variable Threshold and the UICP Range Rules. Given the same COSDIF investment constraint cited above, these alternative stocking policies improve previous performance in end of first year gross effectiveness almost five percentage points and improve steady state gross effectiveness over one percentage point. These alternative stocking policies actually improve on the current policy in end of first year gross effectiveness (over four percentage points) while equaling steady state gross effectiveness. Clearly, the variable initial depth of a reorder point is more cost-effective than the fixed initial depth of lead time demand plus one quarter's demand.

Sensitivity analyses of the shortage cost parameter in the variable initial depth show that as the shortage cost increases--the number of items stocked, gross effectiveness (steady state and end of first year), and investment (initial and steady state) all increase at a diminishing rate while annual buys decrease at a similar diminishing rate. Consistent with the law of diminishing marginal returns, raising the value of λE above $150 provides little increase in effectiveness.

Without constraints on the reorder point, the reorder point could conceivably equal three, four, or more times the item's forecasted annual demand. If the item experiences demand at a rate below the forecast, then the initially provisioned material could become obsolete before demanded. Therefore, the variable initial depth of a reorder point was constrained not to exceed two year's forecasted demand. By constraining the reorder point, the initial investment decreased (4%) with a corresponding decline of about one percentage point in end of first year gross effectiveness. If the savings in initial investment were used to expand the range of stocked items, then the slight decline in end of first year gross effectiveness could be lessened. The preceding analysis found:

- Independent of the initial depth, either alternative range rule was equally more cost-effective than the COSDIF. By manipulating the parameters, either stocking policy could produce an inventory whose performance would almost match the other's for any given investment target.
- The most cost-effective initial depth computation consisted of (1) variable levels equal to the reorder point with a value for λE of $150, and (2) constrained initial levels not to exceed two year's demand forecast.

When modifying the UICP policy and the Variable Threshold policy to include the most cost-effective initial depth computation described above, neither of these revised stocking policies spend as much as the COSDIF when all three policies use the same $150 value for λE. To spend additional money under the UICP stocking policy requires a higher shortage cost. The larger shortage cost not only expands the range of carried items but also increases the initial depth on items which would have been stocked under smaller shortage costs. However, previous analyses have shown that, although higher shortage costs increase the initial investment substantially, higher shortage costs gain little in effectiveness. The Variable Threshold offers the flexibility to expand either the range of carried items, the initial depth, or both. The range of carried items may be held constant and the shortage cost raised; but, similar to the UICP stocking policy, this higher initial depth, while costing more, would not gain much in effectiveness. The more cost-effective approach to improving effectiveness is to maintain the same variable initial depth on items carried and add new items to the range of carried items. The concept of fixing the shortage cost and increasing the range of carried items until the investment target is reached is also easier to implement than varying the shortage cost under the UICP stocking policy until reaching the investment goal.

V. RECOMMENDATION

FMSO recommends, for implementation at SPCC, the Variable Threshold for range determination with a constrained reorder point (using the stratification shortage cost) as the initial depth computation. This is based on the ease of implementation and added flexibility when compared to the UICP policy and the superior performance when compared with the COSDIF, given the same investment goal.

APPENDIX A: REFERENCES

1. DODINST 4140.42, Determination of Initial Requirements for Secondary Item Spare and Repair Parts of 7 Aug 1974.

2. Ships Supply Support Study, by James W. Prichard, dated 15 Jun 1973.

3. The Initial Provisioning Decision for Insurance Type Items, by Robert W. Barton and Stratton C. Jaquette, Naval Research Logistics Quarterly, Vol 20, Mar 1973, pp 123-146.

4. Operations Analysis Study Report 118 (Analysis of Proposed Stock Range Rules) of 15 Apr 1975.

5. FMSO ltr 971240/JLE/292 of 15 Sep 1975.

6. FMSO ltr 971240/JLE/320 of 9 Oct 1975.

7. FMSO ltr 971240/JLE/351 of 22 Dec 1975.

8. Memorandum for the Record, SUP 0411B/RDS dated 10 Jul 1975.

9. Memorandum for the Deputy Assistance Secretary of Defense (Supply, Maintenance, and Services), SER 412E/ 109447, dated 16 Jul 1975.

10. NAVSUP ltr SUP 0411B/RDS of 18 May 1976.

11. Operations Analysis Study Report 82 (Procurement Cycles and Safety Levels of Supply for Secondary Items) of 24 Aug 1972.

12. DODINST 4140.39, Procurement Cyles and Safety Levels of Supply for Secondary Items of 17 Jul 1970.

13. SPCCINST 4400.30 Rev B, Provisioning Policy, Procedures and Responsibilities of 6 Feb 1974.

14. ALRAND Working Memorandum 233, Derivation of Conditional Demand Probability of 15 Oct 1974.

15. ALRAND Working Memorandum 233A, Derivation of Conditional Demand Probability of 24 Sep 1976.

APPENDIX B: EVALUATION OF THE RECOMMENDED NAVY CONDITIONAL PROBABILITIES

Based on a larger and more recent data base, reference (15) derived new conditional probabilities of zero demand in the next two years (based on demand forecasts) for use in the COSDIF equation as required by reference (1). The recommended conditional probabilities are given below.

D	0	1	2	3-12
F_0/D	.70	.59	.49	.32

where

D = annual demand forecast

F_0/D = probability of zero demand in the next two years given the annual demand forecast D

The following table indicates the impact of the recommended Navy conditional probabilities in the COSDIF equation (Column three). Replacing the DOD conditional probabilities (Column two) with the recommended Navy's, produces a significant improvement in the performance indices of the COSDIF determined inventory. However, the large improvement in gross effectiveness--six percentage points--is not gained without a correspondingly large increase in initial investment--20%.

Comparing the recommended Navy conditional probabilities in the COSDIF stocking policy with the current policy (Column one) reveals that although the recommended probabilities reduce the range of carried items by more than 31%, this

COMPARISON OF DOD AND NAVY CONDITIONAL PROBABILITIES IN COSDIF RULE

RANGE RULE	STOCK ALL	COSDIF-DOD	COSDIF-NAVY
DEPTH COMPUTATION	ONE YR'S DMD	LTDMD + 1 QTR	LTDMD + 1 QTR
Items Stocked (#)	8,338	3,852	5,735
% of Items Stocked	100	46.2	68.8
Net Eff (End 1st Yr)	89.45	93.81	92.57
Net Eff (S.S.)	86.15	88.04	87.42
Gross Eff (End 1st Yr)	89.45	81.19	87.21
Gross Eff (S.S.)	86.15	75.89	82.42
$ Initial Provisioning	8.3M	7.2M	8.6M
$ Inventory Invest. (On Hand + Due in S.S.)	20.3M	9.5M	11.5M
Avg Annual Buys (S.S.)	3,467	5,523	4,075
Replenishments (S.S.)	2,695	1,397	1,935
NIS Spot Buys (S.S.)	772	431	609
NC Spot Buys (S.S.)	0	3,695	1,531

S.S. = Steady State--the mean value during the last three years of the five year simulation

smaller range requires a larger initial investment than the current policy. The higher initial cost results from the larger initial depth used in the COSDIF stocking policy. The COSDIF stocking policy stocks fixed levels of lead time demand plus one quarter's demand. Presently the average lead time at SPCC for NSF material is approximately one year. Therefore, the COSDIF stocking policy stocks an average of five quarters of demand which exceeds the current policy of stocking four quarters demand. It is concluded that following the guidance of DODI 4140.42 can in fact expand initial provisioning budget requirements when compared to current SPCC policies.

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Operations Analysis Department Navy Fleet Material Support Office Mechanicsburg, Pa. 17055	2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED 2b. GROUP

3. REPORT TITLE

(6) Analysis of Proposed Initial Stocking Policies

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

5. AUTHOR(S) (First name, middle initial, last name)

(10) J. L. ENGELMAN (11) 28 Dec 76 (12) 54p.

6. REPORT DATE	7a. TOTAL NO. OF PAGES 48	7b. NO. OF REFS 15
8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S) (14) 118A	
b. PROJECT NO. 971255		
c.	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
d.		

10. DISTRIBUTION STATEMENT

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY

13. ABSTRACT

DODI 4140.42 establishes policy for the determination of initial requirements for secondary item spare and repair parts. DODI 4140.42 also authorizes alternative models whose objective is to minimize time-weighted requisitions short. The Variable Threshold Rule, an alternative initial stockage model developed for the Navy, has been approved as an acceptable substitute for the DOD model.

This study compares the performance of the current UICP risk model, (which meets the alternative model criteria) with the Variable Threshold Rule, the DODI rules, and the current stocking criteria. The study shows that the Variable Threshold and the UICP policies are both more cost-effective than the DOD model, but the Variable Threshold is more flexible and easier to implement.

DD FORM 1 NOV 65 1473 (PAGE 1) 401 589

UNCLASSIFIED

Security Classification

S/N 0101-807-6801

Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT

DD FORM 1 NOV 65 1473 (BACK)

(PAGE 2)

Security Classification

DISTRIBUTION LIST

Commander
Naval Supply Systems Command
Washington, D. C. 20376
Attn: SUP 041
0411
Library

Commanding Officer
Navy Aviation Supply Office
Code SDB4-A
700 Robbins Avenue
Philadelphia, Pa. 19111

Commander
Naval Surface Forces
U. S. Atlantic Fleet
Attn: Code N7
N713
Norfolk, Virginia 23511

Commanding Officer
Naval Supply Center
Code 50.1
Norfolk, Virginia 23512

Commanding Officer
937 North Harbor Drive
Naval Supply Center
Code 51
San Diego, Calif. 92132

Commanding Officer
Naval Supply Center
Puget Sound
Bremerton, Washington 98314

Commanding Officer
Naval Supply Center
Code 40
Charleston, S. C. 29408

Commanding Officer
U. S. Naval Supply Depot
Code 51
FPO San Francisco 96630

Commanding Officer
U. S. Naval Supply Depot
Code 51
Box 300
FPO San Francisco 96610

Commanding Officer
U. S. Naval Supply Depot
Code 51
FPO San Francisco 96651

Commanding Officer
U. S. Naval Supply Depot
Code 11
FPO Seattle 98762

Chief of Naval Operations
Navy Department (OP-96)
Washington, D. C. 20350

Chief of Naval Operations
Navy Department (OP-41)
Washington, D. C. 20350

Commander in Chief
U. S. Pacific Fleet
Attn: Code 412
FPO San Francisco 96610

Commander in Chief
U. S. Atlantic Fleet
Attn: Supply Officer
Norfolk, Va. 23511

Commander Naval Air Force
U. S. Pacific Fleet
Attn: Code 40
Naval Air Station, North Island
San Diego, Calif. 92135

Commander Naval Air Force
U. S. Atlantic Fleet
Attn: Code 40
Naval Air Station
Norfolk, Va. 23511

Commander Submarine Force
U. S. Pacific Fleet
Attn: Force Supply Officer
FPO San Francisco 96610

Commander Submarine Force
U. S. Atlantic Fleet
Attn: Code N41
Norfolk, Va. 23511

Chief of Naval Research
800 North Quincy Street
Arlington, Va. 22217

Director
Defense Supply Agency
Operations Research and
Economic Analysis Office
(DSAH-LO)
Cameron Station
Alexandria, Va. 22314

Bernard B. Rosenman
Director, AMC, Z5000
Inventory Research Office
Frankford Arsenal
Philadelphia, Pa. 19137

Marine Corps Supply Activity
Attn: Code 120
1100 S. Broad Street
Philadelphia, Pa. 19146

Headquarters
Air Force Logistics Command
Wright Patterson Air Force Base
Attn: Code ADDR
Dayton, Ohio 45433

Commandant
Industrial College of the Armed Forces
Fort Leslie J. McNair
Washington, D. C.

Chairman, Operations Analysis
Naval Postgraduate School
Attn: Code 55
Monterey, Calif. 93940

Commandant
Armed Forces Staff College
Norfolk, Va. 23511

Commanding Officer
Navy Supply Corps School
Attn: Code 46
Athens, Georgia 30601

Defense Documentation Center
Cameron Station
Alexandria, Va. 22314

U. S. Army Logistics Managemer
Center
Defense Logistics Studies
Information Exchange
Fort Lee, Va. 23801

Naval Ship Research and
Development Center
Attn: NSRDC 1867
Bethesda, Md. 20034