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MODIFICATIONS OF THE STANDARD BASE SUPPLY SYSTEM STOCK
LEVELING TECHNIQUES(U) AIR FORCE LOGISTICS MANAGEMENT
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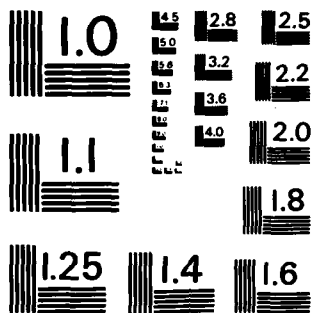
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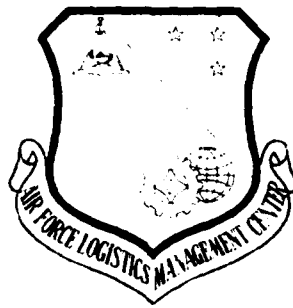
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MODIFICATIONS OF THE STANDARD BASE SUPPLY
SYSTEM STOCK LEVELING TECHNIQUES
INTERIM REPORT

AFLMC-REPORT 161138 ✓

DECEMBER 1980

CAPTAIN KENNETH B. FAULHABER

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DECEMBER 1980

CAPTAIN KENNETH B. FAULHABER

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ABSTRACT

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This report identifies recommended changes to the Air Force's Standard Base Supply System (SBSS) necessitated by DOD Directive 4140.44, Supply Management of the Intermediate and Consumer Levels of Inventory and the supporting Instruction 4140.45, Standard Stockage Policy for Consumable Items at the Intermediate and Consumer Levels of Inventory. Standardized measures of supply performance are identified along with applicable goals where practical. Current range of stock leveling methodology is identified for replacement by range of stock computations that consider economics of operation as well as demand history. Also, changes to the current depth of stock computations are suggested. The impact of these changes to current leveling computations on SBSS performance were evaluated through the use of the simulation technique.
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EXECUTIVE SUMMARY

PROBLEM. The objective of this project is to insure that the new retail stockage policies and procedures dictated by DOD Directive 4140.44, Supply Management of the Intermediate and Consumer Levels of Inventory, and supporting Instruction 4140.45, Standard Stockage Policy for Consumable Secondary Items at the Intermediate and Consumer Levels of Inventory, are implemented in the Air Force Standard Base Supply System (SBSS).

BACKGROUND. The Air Force Logistics Management Center was tasked for this effort by HQ USAF/LEYS while HQ AFLC was concurrently tasked to meet the requirements listed in DODI 4140.46, Standard Stockage Policy for Repairable Secondary Items at the Intermediate and Consumer Levels of Inventory.

OBJECTIVES. The objectives of these DOD issuances and, consequently, this project, fall into four general categories. The first was the development of standard measures by which to judge supply performance and the impact of changes to stockage policies and procedures. Secondly, appropriate goals for each measure developed had to be selected. Third, cost driven range of stock computations had to be developed to replace current range of stock criteria that do not consider any costs of operation. Finally, current depth of stock computations, while essentially identical to those required by the DOD Instruction required analysis for any possible modifications or improvements.

APPROACH. Standard supply performance measures were developed through coordinated efforts with all major commands, the Air

Force Data System Design Center, and HQ USAF/LEYS. They are presented below along with their goals, where available. The goals were developed from an analysis of Air Force wide historical data.

1. Gross Availability - 70% (all items)
2. Net Availability - 90% (non-investment items)
- 85% (investment items)
3. Average Customer Wait Time - No goal (no historical data available)
4. Average Inventory Investment - No goal
5. Reasons for Non-Availability
 - Code A (Non-Stock-First Demand)
 - 43%
 - Code B (Non-Stock - Demand History Exists)
 - 25%
 - Code C (Full Stock - Insufficient Depth)
 - 2%
 - Code D (Less Than Full Stock)
 - 30%

Simulation techniques were used to analyze the projected impact of changes to range and depth of stock computations. Cost driven range of stock computations were developed that proved not only more effective and efficient than our current system but also guaranteed a leveling decision after the very first request that grounded aircraft, engines or vehicles. Currently, such a decision is not reached until after the third such request.

Analysis of our depth of stock computation strongly suggests that they should be modified with the deletion of the variable **Stockage objective factor.**

CONCLUSIONS. Simulation results project reductions in receipts processed, requisitions placed, and aircraft and vehicle grounding incidents over current SBSS techniques using the new range of stock computations with the same inventory investment. When the new range of stock computations are coupled with the deletion of the variable stockage objective the improvements were very significant. Reductions in receipts and requisitions approach 20 percent while Gross and Net Availability both increased by approximately one percent. The reductions projected for grounding incidents were extremely substantial and are presented below:

<u>GROUNDING INCIDENT</u>	<u>PROJECTED REDUCTION</u>
Non-Mission Capable Aircraft	21%
Partially-Mission Capable Aircraft	38%
Non-Mission Capable Engines	16%
Vehicle Down for Parts	13%

The cost for these improvements is projected by the simulation runs to be a one time 7 percent increase in EOQ inventory investment. When applied to actual Air Force-wide on hand EOQ inventory investment this would amount to approximately 20 million dollars. A cost avoidance is projected as a result of the projected reduction in requisitions and receipts. This would amount to just over 6 million dollars per year resulting in a three year pay back period.

RECOMMENDATIONS. It is recommended that the changes to current stock leveling techniques identified in this report be implemented in the Standard Base Supply System. Concurrently, the necessary additional funds must be made available if the projected improvements in supply performance and support are to be realized.

ACKNOWLEDGEMENTS

The development and completion of this project required the assistance and concentrated effort of numerous people. Five separate projects were completed to determine the various cost factors required for this study. These projects and their project managers from the AFLMC/LGS are: Cost to Order by Captain Mike Folk, Holding Cost, Backorder/End-Used Order Cost, and Local Purchase Cost to Order reports by Mrs. Sally Powell, and the Cost to Add, Maintain, and Delete by SMSgt Josh Rone, retired. Additionally, Lt Cols Charles R. Mitchell and Robert A. Rappold of the Air Force Academy and Mr. Wayne B. Faulkner (formerly of the AFLMC/LGY) completed a United States Air Force Academy Technical Report, 80-6, entitled "An Analysis of Air Force Economic Order Quantity Type Inventory Data with an Application to Reorder Point Calculations", in support of this project. Particularly significant were the efforts of the project team members. Those individuals were: Major Rich Lombardi (AFLMC/LGS), Mr. Ron Hare (AFLMC/LGY), Mr. Willi Hahn (AFLMC/LGY), Mr. Jerry Powell (AFLMC/LGY), Lt Kirk Yost (AFLMC/LGY), and SMSgt Tom Czechowski (AFLMC/LGY). Special recognition must go to Mr. Willi Hahn who shouldered the brunt of the programming responsibilities. His efforts in dealing with a very complex simulation model were exemplary. Mrs. Vicki Mann and Miss Pam Bryant provided excellent administrative support. Other individuals throughout the AFLMC provided invaluable assistance in the form of comments and suggestions. Their efforts were also greatly appreciated.

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CHAPTER 1
THE PROBLEM

1-1 BACKGROUND. This study was conducted to meet the requirements of Department of Defense Directive 4140.44, Supply Management of the Intermediate and Consumer Levels of Inventory, dated February 28, 1978, and DOD Instruction 4140.45, Standard Stockage Policy for Consumable Secondary Items at the Intermediate and Consumer Levels of Inventory, dated April 7, 1978. Concurrent with the assignment of the above taskings to the Air Force Logistics Management Center, Headquarters USAF levied the Air Force Logistics Command with primary responsibility for the requirements contained in DOD Instruction 4140.46, Standard Stockage Policy for Repairable Secondary Items at the Intermediate and Consumer Levels of Inventory, dated April 7, 1978. The provisions of these DOD issuances apply to the Office of the Secretary of Defense, the Military Departments, and the Defense Agencies worldwide. They establish Department of Defense policies for the management of supply inventories of secondary items held below the wholesale level. Secondary items are defined as end items; consumable and repairable items other than principal end items. Besides principal end items (such as aircraft, missiles, and vehicles), the DOD Directive also excludes ammunition, subsistence, individual uniform clothing, medical materiel, bulk petroleum, and prepositioned war reserve materiel. The Directive applies to both consumable and repairable items as defined while DODI 4140.45 applies only to consumable

items and DODI 4140.46 only to reparable items. AFLC's D028 Recoverable Central Leveling System, scheduled to enter the test phase in early 1981, meets the requirements of the latter instruction for reparable items. Further details regarding this system or the DOD requirements should be obtained from the Air Force Logistics Command.

a. For purposes of clarity the general requirements of DODD 4140.44 and DODI 4140.45 will be presented in two groups. First, presented below, are those principals and system characteristics that are already resident in our Air Force supply systems.

(1) Levels of inventory will be limited to three in number and will be identified as either wholesale, intermediate or consumer levels. (It should be noted that the term intermediate is equivalent to the terms retail or base level as used in the Air Force supply system.)

(2) Intermediate level inventory management system procedures will include the capability to accomplish daily summary transaction item reporting to the appropriate inventory control point on supply transactions affecting the demand base or stock of limited resource, essential or high cost items.

(3) Item accounting will be maintained for all reparable assets held at the intermediate level.

(4) No more than one intermediate supply activity will be included in the requisitioning channel for a consumer and requisitions will be processed directly to the supporting intermediate echelon.

(5) All secondary items held at the intermediate level of inventory will be identified as to the reason for stockage.

b. Those principals and system characteristics that will require modifications to the Air Force Standard Base Support System (SBSS) are presented below. These requirements are designed to optimize item stockage by incorporating a balance between supply performance and economy with a consideration for mission impact.

(1) Standardized supply performance measures and goals will be established for Gross Availability, Net Availability, and Average Customer Wait Time.

(2) A standard consumable inventory control model will be used in computing the range and depth of stockage at the intermediate level of inventory. These computations will minimize total variable costs whenever practical and consistent with peacetime operations and war readiness considerations.

(a) The development of cost driven range of stock computations required the determination of numerous cost factors not currently employed in the SBSS. Numerous studies have been completed by the Air Force Logistics Management Center in the development of these cost factors and for updating and validating currently employed factors. These factors and their respective report numbers are:

1. Cost to Order, AFLMC Report #761138-2
(updated July 80).
2. Cost to Hold, AFLMC Report #761138-1
(updated July 80).

3. Backorder/End-Use Order Cost, AFLMC Report #761138-14 (dated August 1979).

4. Cost to Add, Maintain, and Delete, AFLMC Report #761138-3 (dated June 1979).

5. Local Purchase Cost to Order, AFLMC Report #790801 (dated June 1980).

(b) The DOD instruction identifies the Wilson EOQ equation as an acceptable or approximate solution for determination of depth of stock. This approach is currently used in the SBSS for determining depth of stock. However, the Wilson EOQ equation is subject to modification within the SBSS by the application of a Variable Stockage Objective (VSO). While the Wilson EOQ calls for the use of an annual demand rate, the VSO may reduce that figure to a demand rate representing from zero through ninety days worth of demand. The decision logic table for the VSO application, taken from AFM 67-1, Vol II, Part Two, Chapter 11, is presented at Attachment 1. The Variable Stockage Objective impact on SBSS performance was identified for analysis by this study.

1-2 PROBLEM STATEMENT. The objective of this project is to insure that the new retail stockage policies and procedures spelled out in DOD Directive 4140.44 and DOD Instruction 4140.45 are implemented in the Air Force Standard Base Supply System.

1-3 FACTORS BEARING ON THE PROBLEM.

a. Any changes identified for the Standard Base Supply System must consider the limitations of the UNIVAC 1050-II

computer system. Modifications to this system must be implementable using current hardware and software system constraints.

b. Modifications to the current SBSS must provide for some improvements in system performance characteristics. These improvements could be reflected in levels of performance for dollars of inventory invested, reductions in workload experienced at the retail level such as reduced receipts processed and/or requisitions placed, or reduced Non-Mission Capable/Partially Mission Capable/Vehicle Deadlined for Parts incidents.

CHAPTER 2

RESEARCH AND DEVELOPMENT

2-1 APPROACH. The basic approach used to insure compliance with DOD Directive 4140.44 and DOD Instruction 4140.45 was to identify each specific requirement of these issuances. Once identified, a complete review and analysis was conducted to determine if any of these requirements or system characteristics were already resident in the Standard Base Supply System. Those not resident in the SBSS were identified and addressed individually. These requirements are listed below in very general terms.

- Develop standard supply performance measures.
- Establish supply performance goals for each measure.
- Identify required changes, if any, to the current SBSS depth of stock computations.
- Develop range of stock computations that incorporate cost considerations as well as demand history.

The specific approach and methodology used for each of the above follows.

a. DOD Directive 4140.44 states specifically that performance measures of Gross and Net Availability and Average Customer Wait Time will be developed. It also allows that additional performance measures may be established at the option of each military service or defense agency. As defined by the directive, Gross and Net Availability are essentially the same as our current SBSS measures of Issue and Stockage Effectiveness.

The measure of Average Customer Wait Time, as defined by DODD 4140.45, is not currently measured in our current retail level inventory system (SBSS). With the coordination of, and inputs from, all Major Commands, the Air Force Data System Design Center (AFDSDC), and Headquarters USAF, the methodology for the development of each of the above mandatory measures was established. Additionally, the option to develop additive measures of supply performance was exercised. Again, in conjunction with the Major Commands, AFDSDC, and Headquarters USAF, two additional measures of supply performance were selected and developed. A measure of Reasons for Non-Availability was selected as a compliment to the mandatory measures of Gross and Net Availability. The purpose of this measure is to provide some insight into the reasons for the levels of support reflected in the Gross and Net Availability figures. As a second additive measure, an indicator of Average Inventory Investment was developed. The purpose of this measure is to provide a dollar value indication of the cost in the changes experienced and levels achieved in the other measures of supply performance. Specific details regarding the five measures of supply performance are spelled out in the Functional Description (FD), found at Attachment 2. This FD depicts computational methodology and data stratifications for reports display purposes. These measures were approved by HQ USAF/LEYS in June 1979 and are scheduled for system implementation in May 1981.

b. Two approaches were taken toward the establishment of goals for the measures of supply performance.

(1) The initial attempt at goal establishment was to identify levels of supply performance that might be achieved based on an analysis of historical data coupled with anticipated levels of funding. This approach was eventually adopted for the establishment of the initial, tentative set of goals for those measures for which historical data were available. The historical data base used for this effort was the MAJCOM/USAF Supply Management Report maintained and published by the Air Force Data Systems Design Center. Total Air Force figures were averaged over the twelve month period, Oct 1978 through Sep 1979. Recognizing that goals are to be sought after and are not standards to be expected, these figures were then used as a baseline for goal establishment. The following are the figures selected and subsequently approved by HQ USAF in March 1980:

- (a) Gross Availability - 70% (all items)
- (b) Net Availability - 90% (non-investment items)
85% (investment spares)
- (c) Average Customer Wait Time - No Goal
(No historical data available)
- (d) Average Inventory Investment - No Goal
- (e) Reasons for Non-Availability
 - Code A (Non-Stock-First Demand)
-- 43%
 - Code B (Non-Stock-Demand History Exists)
-- 25%
 - Code C (Full Stock - Insufficient Depth)
-- 2%

- Code D (Less Than Full Stock)

-- 30%

(2) The second approach employed to arrive at goals for each performance measure was driven by a requirement levied by the Air Force Deputy Assistant Secretary (Logistics), Mr. L.K. Mosemann. His tasking was to identify those levels of supply support that would be required to achieve a specific level of operational effectiveness. This approach necessitated the identification of statistically significant correlations between levels of supply performance and measures of operational capability such as mission capable aircraft available, sorties flown, sortie hours achieved, etc. It soon became evident that this approach would require more time than this project would allow. Therefore, two actions were taken. First, the tentative set of goals depicted in para 2-1b(1) above were selected to meet the immediate DOD requirements. Secondly, the approach desired by the Air Force Deputy Assistant Secretary (Logistics) was pursued under a separate AFLMC project, Supply Performance Measures, numbered 021029. This effort is scheduled to be completed by September 1981.

c. DOD Instruction 4140.45 presents a depth calculation for the determination of the economic order quantity (EOQ). The approach presented seeks to minimize a total variable cost (TVC) equation which includes an implied shortage cost. This TVC equation is expressed as:

$$\text{TVC/yr} = \text{OC} + \text{HC} + \lambda (\text{TWRS})$$

Where:

OC = Total annual variable Order Cost (OC) for an inventory

HC = Total annual variable Holding Cost (HC) for an inventory

TWRS = Time Weighted Requisitions Short.

λ = Represents an implied penalty cost for backorders.

(1) In an attempt to fully understand the DOD depth of stock calculations and especially the rather involved equation for TWRS their development was analyzed. DODI 4140.45 refers to DODI 4140.39, dated July 1970, which presents the equations but without any references regarding development or explanations as to how they were derived. A literature search revealed that the model is similar to V.J. Presutti and R.C. Trepp's Model IV that is presented in the Naval Research Logistics Quarterly, Vol. 19, No. 2, pp 243-251 (1970). As originally presented this model does not minimize total variable costs but rather minimizes holding and ordering costs subject to a constraint on the average number of backorders outstanding at a random point in time. Presutti and Trepp used the method of Lagrange multipliers to solve the system of equations, but were only able to find an explicit form for the multiplier by assuming a normal distribution for demands. Air Force Academy Technical Report 80-6, entitled "An Analysis of Air Force Economic Order Quantity Type Inventory Data With an Application to Reorder Point Calculation", dated April 1980, by Lt Col Charles R. Mitchell and Robert A. Rappold and Mr. Wayne B. Faulkner has shown that the distribution of demands is better represented by a Constant-Poisson process. Additionally, the DOD instruction

calls for the shortage cost parameter (a Lagrange multiplier) to be used as a "tuning knob" to achieve the desired results and eliminates the constraint term from the TWRS equation. No methodology is offered for finding the value of the shortage cost parameter other than through trial and error iterations. Therefore, this particular approach was not considered appropriate or implementable.

(2) Calculations of economic order quantities as a function of a backorder penalty cost, i.e., shortage cost, were not totally rejected, however. Rather, this area was identified for further study. Initial efforts using this approach have been completed by members of the Department of Mathematical Sciences at the Air Force Academy in support of the Air Force Logistics Management Center. An approximate model, incorporating a backorder penalty cost while accommodating Constant-Poisson demand distributions, has been developed. These results have proven positive enough to warrant further study and analysis. This work will, however, entail more time than allowed by this particular project and has, therefore, been identified for continuing study with the current methodology, presented below, identified as meeting the DODI requirements.

(3) Enclosure 4 of DODI 4140.45 states that approximate solutions for both the depth and range calculations are permitted. It presents the following standard Wilson EOQ equation as such an alternative for computing depth of stock operating levels (EOQ):

$$EOQ = \sqrt{\frac{2 D A}{IC}}$$

Where:

D = Annual Demand Rate
A = Order Cost
I = Holding Cost Rate
C = Unit Price

The above approach is essentially the same as what is currently used in the SBSS today. While the TVC approach appears to be mathematically correct, the deficiencies identified with both the assumption of demand distributions coupled with the problems of determining the shortage cost parameter values resulted in the decision to maintain our current SBSS depth of stock calculations. As previously stated, Enclosure 4 of DODI 4140.45 identifies this approach as an acceptable alternate approach.

(4) The impact of the Variable Stockage Objective on the Economic Order Quantities determined by the SBSS was identified for analysis. As indicated previously the VSO will, when applied at other than the full 365 day level, reduce the level calculated to meet stockage requirements. An analysis of the impact of using a full annual demand rate, that is, not applying the VSO multipliers, was identified as necessary to gauge the impact on SBSS performance indicators and overall inventory costs.

d. The range of stock leveling computations presented in DODI 4140.45 are based on considerations of various cost factors as well as demand history. Currently, SBSS range of stock decisions are based upon a combination of the Stockage Priority Code (SPC) assigned an item coupled with the number of demands an item has experienced since the date of first demand. A Daily

Demand Frequency Rate (DDFR) is computed for each item by dividing the difference between the current date and the date of first demand into total demands. If less than 365 days of demand experience is available, 365 days is used. If an item's DDFR equals or exceeds a certain threshold value for the SPC assigned then a level is established and the item is stocked. No considerations for costs of operation, unit cost or shortage costs are made in current SBSS range of stock leveling methodologies.

(1) The following table represents the DDFR threshold values currently used:

<u>SPC</u>	<u>DDFR</u>
1	.0082
2	.0109
3	.0136
4	.0164

The DDFRs depicted in the above table equate to the following number of demands by SPC for 365 days:

<u>SPC</u>	<u>NUMBER OF DEMANDS</u>
1	3
2	4
3	5
4	6

It is recognized that other methods are used to establish levels, such as special levels, but the requirements of the DOD

instruction apply only to demand driven leveling techniques. Current leveling techniques other than demand supported are not to be altered as a result of the DOD taskings.

(2) The basic approach in the development of a cost driven range model was to adapt the computations presented in DODI 4140.45 to current SBSS stock leveling techniques. The range model finally selected is fully described in the Functional Description found at Attachment 3. The methodology used to develop this range model is presented below.

2-2 METHODOLOGY.

a. The modifications to current depth of stock calculations and the development of a cost driven range model were completed through the use of the simulation technique. The System to Analyze and Simulate Base Supply (SASBS) was used to simulate SBSS performance characteristics under the various depth and range of stock calculations analyzed. This simulation model, developed for the Air Force by the Federal Computer Performance Evaluation and Simulation Center in November of 1976, is resident on the Honeywell 6060 and maintained by the Air Force Data Systems Design Center at Gunter Air Force Station. This model simulates the performance of the Standard Base Supply System for EOQ items only and was validated by the AFLMC in the spring of 1979. It uses actual historical demand data and actual item records obtained from the Stock Control/Transaction History Data Banks maintained by HQ AFLC. Simulation results are reflected by the following supply performance measures.

- Number of Demands
- Gross Availability (Line Items)
- Net Availability (Line Items)
- Gross Availability (Units)
- Net Availability (Units)
- Number of Receipts
- Dollar Value of Receipts
- Average On-Hand Inventory Dollar Value
- Average On-Order Inventory Dollar Value
- Average Due-Out Inventory Dollar Value
- Net Average Due-Out Inventory Dollar Value
- Due-Outs Established (Priority Groups One, Two, and Three)
- Due-Outs Filled with Average Fill Time (Priority Groups One, Two, and Three)
- Requisitions Placed and Dollar Value (Priority Groups One, Two, and Three)

Additionally, to meet the objectives of this project the model was modified to record supply caused MICAP incidents for the following categories:

- Non-Mission Capable Aircraft
- Partially Mission Capable Aircraft
- Vehicle Down for Parts
- Non-Mission Capable Critical Engines

Besides the modification to add MICAP incident reporting, the project required numerous other changes to the SASBS. The

initial change was the development and addition of a routine to represent the range of stock computations reflected in the DOD instruction. Further changes involved programming to guarantee leveling decisions for Stockage Priority Code One items at the first demand experienced, the elimination of the Variable Stockage Objective within the depth computations and the elimination of the current methodology for determining range of stock.

b. The Functional Description found at Attachment 3 depicts, in detail, the proposed changes to the SBSS for both depth and range of stock leveling computations. The value of each factor to be used in these computations is presented. Additionally, these factors are fully defined and the AFLMC reports that reflect their development and value derivations are indicated for further detailed research purposes. They are listed below to provide an insight into how the range computations function and also to show what data are used to arrive at leveling decisions. Factors with predetermined values are:

- Cost to Add
- Cost to Maintain
- Holding Cost Rate
- Cost to Order
- Backorder Cost
- End-Use Order Cost
- Item Line Availability Factor
- Item Essentiality Factor
- Shortage Cost Factor

Those factors with values obtained from SBSS Item Records or Routing Identifier Records are:

- Cumulative Recurring Demands
- Order and Ship Time
- Total Demands (Number Demands Current Period Plus Number Demands First Past Six Months)
- Unit Price

Finally, the factors below are derived from the depth of stock calculations:

- Reorder Point
- Economic Order Quantity

These factors are combined arithmetically as indicated in the computations and formulas at Attachment 3 to determine three possible cost conditions. They are:

- (1) $C_{\text{off-off}}$ = The costs incurred when an item is not stocked and a level will not be computed or carried against the item.
- (2) $C_{\text{off-on}}$ = The costs incurred when a level is computed for an asset and it is added to the stock list. The determination of this cost requires the computation of $C_{\text{on-on}}$.
- (3) $C_{\text{on-on}}$ = The costs incurred when an item is supported by a stock level and will be retained on the stock list.

Once determined these costs are compared to derive the most economic leveling decision. The model determines the breakeven cost of adding an asset to the list of stocked items.

If the cost to add the item to the list of stocked items ($C_{\text{off-on}}$) exceeds the cost of not adding the item ($C_{\text{off-off}}$) then the decision not to level is reached. If the reverse is true then a level is computed and the asset is supported from stock. The mathematical description of this decision logic is presented below:

- If: $C_{\text{off-off}} < C_{\text{off-on}}$ then do not compute a level or stock the asset.
- IF: $C_{\text{off-off}} \geq C_{\text{off-on}}$ then compute a level and stock the asset.

The specific methodology employed for the analysis of this economic approach to range of stock leveling decisions is presented first. Next, the analysis concerning the impact of the Variable Stockage Objective coupled with these new projected range computations is presented.

c. The range of stock computations presented in DODI 4140.45 and described above represent basically a purely economic approach to stock leveling decisions. While the original DOD calculations allow for a consideration of the mission essentiality of any given request with the incorporation of a mission essentiality classification for each item requested, the DOD instruction specifically states that such essentiality coding systems must be approved by DOD prior to implementation by the services. In the meantime, the essentiality code used in the range of stock calculations is to be held constant for all items. A value of one was selected to meet this requirement until such time as an essentiality scheme is developed and approved for

application to the range of stock computation. Given this constant value for item essentiality the computations represent a pure economic approach to leveling decisions.

d. Once the SASBS simulation model was modified to accommodate the range computations, the next major effort was directed toward a determination of appropriate values for the shortage cost factor. As developed and defined by DOD, this shortage cost factor is designed to serve as a "tuning knob" for the range model. As such, it is to be set at a level that will provide a desired level of performance. The capability also exists, conversely, to use this shortage cost as a means by which to allocate limited funds to maximize the performance that can be obtained. Since the SASBS simulation model does not possess the capability to deal with funds constraints, the shortage cost values were developed by comparing the range model performance against a desired level of performance. This desired level of performance was determined by establishing a baseline of performance representing the SBSS as it exists and functions today.

(1) The first step in this analysis was to create a data base representing new item records. To accomplish this all data relative to demand history and serviceable balances were zeroed out of actual item records from Dover AFB and Randolph AFB. Developing the new item record data base was necessary so that the performance of the range computations, both SBSS and the various cost driven variations tested, would be readily apparent. Without using only new item records most of the data driving the

simulation and, therefore, reflected in the output performance measures, would not have been affected by any range of stock computations.

(2) These new item record data files were used to establish the SBSS baselines. A sample of 5,000 item records from both Dover AFB and Randolph AFB were run through the SASBS simulation with their corresponding actual historical demands for a time frame of one year from April 1978 through March 1979. The resulting levels of performance and inventory investment were recorded for all measures and retained as the SBSS baselines.

(3) Once these baselines were established for comparative analysis, the performance of the new cost driven range computations was simulated using the same 5,000 item records and corresponding demands for each base used in the establishment of the baselines. Numerous trial and error simulation runs were completed to determine a feasible range of values for the model's "tuning knob", the shortage cost factor. This range of values was determined by selecting those values that resulted in the same, or very nearly the same, inventory investment, on-hand and on-order, as was reflected in the SBSS baseline output. While inventory investment was the key measure of comparison, other measures of supply performance such as gross and net availability, receipts, requisitions and unfilled requests affecting mission capability (MICAP) were also monitored. This was done to insure that the new computations resulted in at least equal or improved performance as that experienced with the current SBSS baseline. At this point in the research a

consideration of current Stockage Priority Coding (SPC) was programmed into the new range computations. This was accomplished by establishing separate shortage cost values for each of the Stockage Priority Codes, one through four. By developing a higher shortage cost for SPC 1 items versus SPC's 2, 3, and 4, and a higher shortage cost for SPC 2 versus 3 and 4 and so on, a consideration for the impact of the lack of an item on mission accomplishment was added to the new range computations. With this modification of a separate shortage cost value for each SPC, the new range model, while still technically representing an economic approach to stock leveling, allowed for a priority relationship to exist among items based on their assigned SPC. Given that all other variable factors, such as demands and unit price, were equal, that item with the higher priority SPC would have a level computed and carried against it before other items reflecting the lower SPC's.

(4) Using the range of values for the shortage cost selected earlier, the SASBS simulation model was exercised with the same 5,000 items for Dover AFB mentioned above to develop separate shortage costs for each Stockage Priority Code. While the range of values was known, the development of four versus one shortage cost value necessitated numerous runs to derive the best combination of these values. Once again, the dollar value of the on-hand and on-order inventory for the SBSS baseline was used to judge each combination of shortage costs analyzed. Of all combinations simulated, five were selected for further study using different data.

(5) The new item records for Randolph, with their corresponding demand records, were then used to validate the initial results obtained by the simulations using the Dover data. The five best combinations of shortage costs selected from the Dover analysis were then simulated and the results compared against the Randolph baseline. All five combinations validated the new range model performance that had been observed previously with the Dover data. For example, all combinations of shortage costs for both data bases reflected the following improvements in performance:

- Increases in Gross and Net Availability.
- Decreases in both receipts and requisitions.
- Reductions in MICAP incidents.

Of the five combinations tested, the shortage costs reflected below resulted in inventory investment figures closest to the SBSS baselines used:

<u>SPC</u>	<u>Shortage Cost Value</u>
1	35
2	25
3	10
4	4

(6) At this point in the study it was determined that the new range model would have to perform such as to guarantee a leveling decision on those items experiencing MICAP incidents. Current SBSS leveling methodology guarantees that levels are established with the third demand if the item carries a SPC of one, i.e., it has experienced a MICAP demand. Since a basic

premise of this study was the development of a new range model that performed better than our current system, a scheme to guarantee leveling decisions on the first MICAP incident (SPC 1 items) was incorporated into the new range computations. This modification removed SPC one items from any cost analysis and guaranteed a level. The economic analysis methodology was bypassed for these items while the shortage costs of 25, 10, and 4 were retained for SPC 2, 3, and 4 items. This new version of the model was then run through the SASBS using the Dover data base and the results compared with the baseline previously established. These results showed significant improvements over current SBSS performance. Availability figures improved while both receipts and requisitions decreased. Also some reductions in NMCS/PMCS/VDP incidents were experienced.

(7) To validate the results obtained with the Dover data, the Randolph data was again used to drive the simulation. The results from these simulation results validated the general improvements in supply performance experienced with the Dover data.

d. The impact of removing the Variable Stockage Objective from the depth of stock calculations was examined next. The SASBS was modified to ignore the Variable Stockage Objective and to apply a full 365 figure within the calculations for the Economic Order Quantity. This EOQ computation is presented below to illustrate the mathematical changes of this decision:

- Current SBSS Methodology:

$$EOQ = 5.9^* \sqrt{\frac{DDR \times VSO^{**} \times \text{Unit Price}}{\text{Unit Price}}}$$

* The value of 11 is used for Local Purchase Items.

** This value may be zero, 15, 30, 45, 60, 90, or 365 based on the decision logic presented at Attachment 1.

- Proposed change deleting VSO

$$EOQ = 5.9^* \sqrt{\frac{DDR \times 365 \times \text{Unit Price}}{\text{Unit Price}}}$$

* The value of 11 is used for Local Purchase Items.

(1) The Dover data was again employed first for a comparative analysis of the impact of this change against the SBSS baseline representing current stock leveling methodologies. Actual item records were used in this analysis versus the data base representative of all new item records. The results of this simulation are presented in Table 1. A review of this data indicates extremely significant improvements in all categories of supply performance. For example, reductions of up to 41 percent for MICAP incidents were recorded. Also, both receipts processed and requisitions placed were reduced by approximately 20 percent. The availability figures again showed slight increases. The cost of these very substantial improvements was an increase in total inventory investment of 5.3 percent.

(2) The Randolph data was used to validate the results of the Dover simulation runs. The results of the Randolph simulation are presented in Table 2 and they do validate the improvements in the supply performance measures experienced with the Dover data.

TABLE 1
 COMPARATIVE ANALYSIS OF THE COST DRIVEN RANGE
 OF STOCK COMPUTATIONS COUPLED WITH THE DELETION OF
 THE VARIABLE STOCKAGE OBJECTIVE (VSO)
 WITH THE SBSS BASELINE FOR DOVER AFB
 USING ACTUAL ITEM RECORDS

<u>MEASURE</u>	<u>RESULTS</u>		<u>% CHANGE</u>
	<u>DOVER BASELINE</u>	<u>NEW RANGE/ VSO DELETED</u>	
Gross Avail (Line)	85.88%	88.49%	+ 2.61
Net Avail (Line)	90.21%	91.66%	+ 1.45
Gross Avail (Units)	84.89%	86.30%	+ 1.71
Net Avail (Units)	87.06%	87.78%	+ .72
Receipts	14,175	11,348	-19.9
Requisitions (Total)	13,071	10,054	-23.1
Pri 1	1,446	1,231	-14.8
Pri 2	976	790	-19.1
Pri 3	10,649	8,033	-24.6
NMCS Aircraft Incidents	14	12	-14.3
PMCS Aircraft Incidents	24	14	-41.7
VDP Incidents	27	23	-14.8
NMCS Engine Incidents	72	64	-11.1
Ave On-Hand Inventory	\$786,969	\$840,678	+ 6.8
Ave On-Order Inventory	\$247,429	\$251,786	+ 1.8
Total Inventory	\$1,034,398	\$1,092,464	+ 5.3

TABLE 2

COMPARATIVE ANALYSIS OF THE COST DRIVEN RANGE
OF STOCK COMPUTATIONS COUPLED WITH THE DELETION OF
THE VARIABLE STOCKAGE OBJECTIVE (VSO)
WITH THE SBSS BASELINE FOR RANDOLPH AFB
USING ACTUAL ITEM RECORDS

<u>MEASURE</u>	<u>RESULTS</u>		<u>% CHANGE</u>
	<u>RANDOLPH BASELINE</u>	<u>NEW RANGE/ VSO DELETED</u>	
Gross Avail (Line)	80.15%	82.70%	+ 2.55
Net Avail (Line)	90.14%	91.53%	+ 1.39
Gross Avail (Units)	66.85%	67.38%	+ .83
Net Avail (Units)	77.94%	78.35%	+ .41
Receipts	9,882	8,396	-15.0
Requisitions (Total)	9,262	7,695	-16.9
Pri 1	1,285	1,017	-20.9
Pri 2	908	762	-16.1
Pri 3	7,069	5,916	-16.3
NMCS Aircraft Incidents	83	64	-22.9
PMCS Aircraft Incidents	2	2	N/C
VDP Incidents	2	2	N/C
NMCS Engine Incidents	62	48	-22.5
Ave On-Hand Inventory	\$281,211	\$319,649	+13.7
Ave On-Order Inventory	\$ 81,727	\$ 84,676	+ 3.6
Total Inventory	\$362,938	\$404,325	+11.4

CHAPTER 3
CONCLUSIONS

3-1 STANDARDIZED SUPPLY PERFORMANCE MEASURES AND GOALS.

Standardized retail level supply performance measures for both consumable and reparable items have been developed and approved for use Air Force-wide. The Standard Base Supply System (SBSS) will be modified by May 1981 to depict these new measures of supply performance. They are presented below with their tentative goals where applicable:

- a. Gross Availability - 70% (all items)
- b. Net Availability - 90% (non-investment items)
- 85% (investment spares)
- c. Reasons for Non-Availability
 - Code A (Non-Stock - First Time Demand)
-- 43%
 - Code B (Non-Stock - Demand History Exists)
-- 25%
 - Code C (Full Stock - Insufficient Depth)
-- 2%
 - Code D (Less Than Full Stock)
-- 30%
- d. Average Customer Wait Time - No Goal
- e. Average Inventory Investment - No Goal

3-2 COST DRIVEN RANGE OF STOCK COMPUTATIONS. Range of stock computations for consumable items that consider various costs of operation and unit price as well as historical demand data, as prescribed by DODI 4140.45, have been developed. The impact of

these computations on the performance characteristics of the SBSS were simulated for a period of a year using data from two bases, involving 10,000 items records and over 70,000 transactions. These new range of stock computations proved both more effective and efficient than the current system. With essentially an identical inventory investment, performance improved across all measures from gross and net availability, to receipts and requisitions and, most importantly, MICAP incidents.

3-3 DEPTH OF STOCK COMPUTATIONS.

a. The exact depth of stock computations suggested in DODI 4140.45 were not adopted for systems modification since they are based on an assumption of normality for the distribution of customer demands. Research conducted by members of the Mathematical Sciences Department of the Air Force Academy, in support of this project, indicates that the Constant-Poisson distribution more closely reflects the actual demand patterns experienced within the SBSS.

b. An alternate approach is identified within DODI 4140.45 for obtaining depth of stock, that is, the Economic Order Quantity. The standard Wilson EOQ formula is identified as an acceptable approach for determining the EOQ level. The current SBSS EOQ computations are based on the Wilson formula. However, it is, in some cases, altered by reducing the annual demand rate used within the Wilson formula. This is done by using a daily demand rate and multiplying it by varying days of stockage represented by the Variable Stockage Objective. The impact of removing the Variable Stockage Objective and applying the Wilson

formula in its original configuration was simulated in conjunction with the application of the new range of stock computations. Extremely significant improvements in all areas of supply performance were experienced. Availability figures increased slightly while receipts and requisitions were reduced up to twenty percent. While these results were derived from the simulation of consumable items only, these type assets account for over 85% of all items stocked at our base level supply accounts. Therefore, it is projected that these improvements in stock availability and the reductions in requisitions would basically hold for an entire supply account with reparable assets included. The most significant improvements are, of course, the projected reductions in aircraft, engine, and vehicle grounding incidents. Reductions in these incidents ranged from 11 to 41 percent with the average, by incident, presented below:

<u>TYPE INCIDENT</u>	<u>AVERAGE REDUCTION</u>
Non-Mission Capable Aircraft	21%
Partially-Mission Capable Aircraft	38%
Non-Mission Capable Engines	16%
Vehicle Down for Parts	13%

Again, these projections apply only to consumable items. However, these assets account for approximately 60 percent of all grounding incidents experienced. Therefore, it is projected that the reductions experienced from the simulations would result in reduced NMCS/PMCS and VDP incidents ranging from 7 to 24 percent for all items of supply including reparables. The cost of these improvements was projected by the SASBS simulation runs to be a one time increase in EOQ inventory investment of approximately 7

percent. The actual increases experienced were totaled for both bases and compared with the baseline investment figures to derive the average percentage increase. When applied to the total Air Force on hand EOQ inventory, averaged over a full year, this increase would amount to about 20 million dollars. A cost avoidance of approximately 6 million dollars per year would be experienced from the reductions in requisitions placed resulting in a pay back period of just over three years. No cost avoidance figures are obtainable for the significant reductions in aircraft and vehicle grounding incidents.

CHAPTER 4
RECOMMENDATIONS

4-1 STANDARDIZED SUPPLY PERFORMANCE MEASURES AND GOALS.

a. The modification of the Standard Base Supply System by the Air Force Data System Design Center to incorporate the new standard supply performance measures should continue as scheduled.

b. The tentative goals selected should be retained. However, they should be thoroughly reviewed once the SBSS has been modified with the new range and depth of stock calculations recommended below. Since these goals are based on historical data they should be reviewed for validity once a years worth of historical data from the new range and depth computations is available for analysis. Additionally, at that time a goal for Average Customer Wait Time should be selected.

c. Efforts should continue in the establishment of goals through the identification of statistically significant correlations between levels of supply performance and operational capability. This effort, conducted under AFLMC project number 021029, Supply Performance Measures, would result, if successful, in permanent goals to replace the tentative goals selected previously.

4-2 COST DRIVEN RANGE OF STOCK COMPUTATIONS. The cost driven range of stock computations developed through this project and fully described at Attachment 3 should be adopted for use Air Force-wide in all Standard Base Supply Systems. This

modification should be completed by at least December 1981 to meet DOD established milestones.

4-3 DEPTH OF STOCK COMPUTATIONS.

a. The efforts to develop more optimal Economic Order Quantities, initiated by members of the Department of Mathematical Sciences at the Air Force Academy, should continue. This approach incorporates a backorder penalty cost while accommodating the Constant-Poisson demand distribution.

b. The use of the Variable Stockage Objective (VSO) within the SBSS depth of stock computations should be discontinued. An annual demand rate should be substituted for the VSO and the daily demand rate within the EOQ equation. It is recommended that this modification to the depth computations be completed concurrently with the adoption of the new cost driven range of stock computations described in this report.

c. The twenty million dollars in additive funds required to support these changes must be made available if the projected improvements in supply performance are to be realized. Additionally, it is recommended that additional data bases be used with the SASBS simulation model to further refine the actual amount of additive funds needed.

4-4 OTHER MODIFICATIONS TO THE STANDARD BASE SUPPLY SYSTEM STOCK LEVELING TECHNIQUES. Recommend that other modifications to the stockage techniques used within the SBSS be considered as a continuation of this current effort. One area has already been

identified for just such an effort. This is the work directed toward the development of a more optimal Economic Order Quantity. Another candidate for further analysis would be an examination of the criteria currently used to delete items from stock and the impact this methodology might have on the generation of excesses.

VARIABLE EOQ STOCKAGE OBJECTIVE DAYS

SPC	<u>#DEMANDS IN 365 DAYS</u>	<u>RECURRING DEMANDS</u>	<u>DEMAND DAYS</u>	<u>DAILY DEMAND RATE</u>	<u>VSO DAYS</u>
2	4-5	4	180	NA	0
3	4-5	4	NA	NA	0
3	4-5	4	NA	NA	0
4	6	6	180	.001 - .029	0
4	6	6	180	.030 - .059	0
2	4-5	4	180	NA	15
2	6	6	180	.001 - .029	15
2	6	6	180	.001 - .059	15
3	6	6	180	.001 - .029	15
3	6	6	180	.001 - .059	15
4	6	6	180	.030 - .124	15
4	6	6	180	.060 - .179	15
1	3-5	3	180	NA	30
2	6	6	180	.030 - .059	30
3	6	6	180	.030 - .059	30
3	6	6	180	.060 - .124	30
4	6	6	180	.125 - .179	30
4	6	6	180	.180 - .499	30
1	3-5	3	180	NA	45
2	6	6	180	.060 - .124	45
3	6	6	180	.125 - .249	45
4	6	6	180	.250 - .499	45
1	6	6	180	.001 - .029	60
2	6	6	180	.060 - .124	60
3	6	6	180	.060 - .124	60
4	6	6	180	.180 - .249	60
3	6	6	180	.125 - .249	90
4	6	6	180	.250 - .499	90
1	6	6	180	NA	365
1	6	6	180	.030 or Greater	365
2	6	6	NA	.125 or Greater	365
3	6	6	NA	.250 or Greater	365
4	6	6	NA	.500 or Greater	365

DEMANDS = Minimum Number of Demands per Year (365 days) - which is equated to the DDRF as follows:

<u>#DMDS</u>	=	<u>DDFR</u>
3	=	.0082
4	=	.0109
5	=	.0136
6	=	.0164

Atch 1

FUNCTIONAL DESCRIPTION

DSC-D79-290

SUPPLY PERFORMANCE MEASURES

SECTION 1

SYSTEM SUMMARY

1.1 BACKGROUND. DOD Directive 4140.44 directed that each military department develop new measures of supply performance and establish a reporting system which allows for the continual review at DOD level of retail stockage policies. The AF Logistics Management Center was designated the primary action agency for conceptual development of the Air Force supply performance measures which would be consistent with the DOD directive. In the development of these measures the AFLMC solicited comments/suggestions from the MAJCOMs and AFSDC/LGS. The measures were finalized and submitted to HQ USAF/LEYPs who approved the new Supply Performance Measures on 4 June 1979.

1.2 OBJECTIVES. The objective of this change is to comply with DOD Directive 4140.44 which requires stratification of supply data by four (4) major categories as follows:

- (1) Gross and net availability
- (2) Reasons for non-availability
- (3) Average Inventory Investment, and
- (4) Average Customer Wait Time

This will provide for a reporting system which allows for the continual review at DOD level of retail stockage policies.

Atch 2

1.3 EXISTING METHODS AND PROCEDURES. Currently the required supply performance measures are not available except that gross and net availability are basically the same as the Issue and Stockage Effectiveness as currently displayed on the Base Supply Management Report (M32).

1.4 PROPOSED METHODS AND PROCEDURES. Change/develop the necessary programs to capture and stratify supply data by four (4) major categories and display separately on the Base Supply Management Report (M32). This data will be an integral part of the M32 report and will be consolidated at major command level and AFSDC. The four major categories are as follows:

- I. Gross and Net Availability
- II. Reasons for Non-Availability
- III. Average Inventory Investment
- IV. Average Customer Wait Time

Each of the above areas will be stratified by Economic Order Quantity (EOQ) and Repair Cycle. Within these two groupings the data will be stratified for each measure as indicated below. Categories I, II, and IV data will be accumulated and zeroed monthly. Category III data will be overlayed at least quarterly. Detailed computation and methodology for stratifying the Supply Performance Measures are as follows:

- I. Gross and Net Availability.
 - a. Computation:
 - (1) Gross Availability.

$$\frac{\text{ISSUES*} + \text{MAINTENANCE TURN-AROUNDS (TRN)**}}{\text{ISSUES} + \text{Due-Outs} + \text{TRN's**}}$$

(2) Net Availability.

$$\frac{\text{ISSUES*} + \text{TRN's**}}{\text{ISSUES} + \text{Due-Outs} - \text{Non-stocked due-outs} + \text{TRN's**}}$$

b. Expressed for:

- (1) Line Items Requested
- (2) Units Requested
- (3) Organizations
 - (a) Operational (AFM 66-1)
 - (b) Support (Civil Engineer, Vehicle Maintenance, Other)

*DODD 4140.44 specifically excludes prepositioned war reserve requirements (WRM) from the retail stockage policies. Since these measures are designed to indicate the effectiveness of these policies, WRM withdrawals will not be counted in the above formulas. The subsequent replenishment backorder against the WRM detail will be counted as an unsatisfied demand because the stockage policies/supply system did not provide peacetime operating stocks to meet the requirements. Because the subsequent WRM backorder is not distinguishable from a normal WRM backorder, the WRM withdrawal (MSI) will be counted as an unsatisfied demand. MSIs from WRM with activity code "C" will not be counted.

**The serviceable on-hand balance will be checked with each TRN transaction. This will include checking the Interchangeable and Substitute group (I&S Gp). If an on-hand balance exists the TRN represents a maintenance convenience and will be included in both the numerator and denominator of the above formulas. If the

on-hand balance is zero the TRN represents an inability of supply to satisfy a demand and will be included in the denominator only.

II. Reasons for Non-Availability. This category of data will be depicted under A, B, C or D below and not by individual cause codes.

a. Non-Stock--First Time Demand (cause code A applies).

b. Non-Stock--Demand History Exists but asset not stocked due to stockage policy or base/depot decision (cause codes B, C, and D apply).

c. Full Stock--Insufficient depth to satisfy demand or stock awaiting repair/parts or stock committed to supply points, mission support kits, etc. (cause codes F, G and R apply).

d. Less Than Full Stock - Replenishment stock not due in or due-ins not yet received (cause codes H, J and K apply).

III. Average Inventory Investments

a. Dollar Value of On-hand Assets.

b. Dollar Value of Due-Ins.

c. Dollar Value of Due-Outs.

d. Dollar Value for Each Reason for Stockage Code (RSC).

Item record on-hand balance will be stratified to a RSC from existing Level of Justification Codes (LJC) at least quarterly as follows:

Computed Level = RSC Stocked Demand (SD)

LJC 1 = RSC Stocked Insurance (SI)

LJC 2, 3, 4,
5, 6, 7

8, 9, B,

D, E, G,

H, K, L,

M, N, P,

R, S = RSC Stocked Numeric (SN)

LJC A, F, C, T = RSC Stocked Provisioning (SP)

LJC V

and type detail

Records U, W = RSC Stocked Prepositioned War
Reserve Materiel (SW)

No Demand Level/RO = RSC Not Stocked (NS)

Other - any Item Record

not identified

above = RSC Other (NK)

IV. Average Customer Wait Time

a. Computation:

(1) Average wait time per request.

$$\frac{\text{TOTAL WAIT TIME}}{\text{TOTAL REQUESTS}} = \frac{(\text{Due-Out Release (DOR) Date-Backorder Date})}{(\text{ISUs} + \text{Due-Outs} + \text{TRNs})}$$

(2) Average Wait Time Per Request (Weighted by
Units)

$$\frac{\text{TOTAL WAIT TIME (Weighted by Units)}}{\text{TOTAL UNITS}}$$

NOTE: Only Activity Codes B, R and X will be counted in the above computations. Due-outs with K in fifth position of the stock number will not be counted. See C(5) below for TRN logic.

War Reserve Support Kit (WRSK) replenishment DORs (activity code "U") which are the result of a WRSK withdrawal (MSI) will be counted in computing customer wait time.

b. Stratified by:

(1) Organization

(a) Operational (AFM 66-1)

(b) Support (Civil Engineer, Vehicle

Maintenance, Other)

(2) Primary source of supply.

(a) AFLC

(b) DLA

(c) GSA

(3) Priority Group (Requisition).

(4) Reasons for Non-Availability (Wait time for this time will be categorized as in II above).

c. Methodology

(1) Wait time will be accumulated/recorded in whole days and expressed down to tenths of days.

(2) Issues accumulate zero wait time.

(3) Wait time for backorders will be recorded at time of due-out release (DOR) by subtracting the backorder date from the transaction date.

(4) Time Compliance Technical Order (TCTO) kit due-outs will not be included when computing customer wait time.

(5) Maintenance Turn-Arounds will be included in wait time computations. Net repair cycle days from the TRN input will be recorded as wait time if an on-hand balance is

zero. If an on-hand balance exists zero wait time will be accumulated against that satisfied demand.

(6) MEMO due-outs will be treated as any other due-out.

(7) Wait time will not be recorded for those Line Replaceable (LRU)/Shop Replaceable (SRU) unit due-out cancellations or due-outs cancelled by customer request.

(8) Due-outs cancelled as a result of asset non-availability (cancellation codes CK, CL, CU) will generate customer wait time.

(9) Due-outs cancelled during funds edits will generate customer wait time.

1.5 SUMMARY OF IMPROVEMENTS. Implementing this change will consolidate the Supply Performance Measures at both major command and AFSDC which will allow for the continual review at the DOD level of Air Force retail stockage policies.

SECTION 2

DETAIL CHARACTERISTICS

- 2.1 SYSTEM FUNCTION. No change.
- 2.1 INPUT. No change.
- 2.3 OUTPUT. No change.
- 2.4 DATA CHARACTERISTICS. No change.
- 2.5 FAILURE CONTINGENCIES. No change.

SECTION 3
DEVELOPMENT PLAN

- 3.1 REQUIRED IMPLEMENTATION DATE. Implementation will be IAW established milestones.
- 3.2 INTERFACE WITH OTHER SYSTEMS. No change.
- 3.3 MILESTONES. May 1981.

FUNCTIONAL DESCRIPTION
MODIFICATIONS OF SBSS STOCK LEVELING TECHNIQUES

SECTION 1

GENERAL

1.1 PURPOSE OF THE FUNCTIONAL DESCRIPTION. This Functional Description for the Air Force Logistics Management Center project entitled "Modifications to the Standard Base Supply System Stock Leveling Techniques," numbered 161138, is written to provide:

a. The system requirements to be satisfied which will serve as a basis for mutual understanding between the user and the developer.

b. Information on performance requirements, preliminary design and user impacts.

c. A basis for the development of system tests.

1.2 PROJECT REFERENCES. The following references are applicable to the history and development of the Modifications to the Standard Base Supply System Stock Leveling Techniques project:

a. Deputy Secretary of Defense, Memorandum for the Secretaries of the Military Departments and Director, Defense Supply Agency, 20 April 1974. Subject: Establishment of Joint Working Group on Retail Level Stockage Policy for Secondary Items.

b. Working Group Report, DOD Retail Inventory Management and Stockage Policy (RIMSTOP), Office of the Assistant Secretary of Defense (Installation and Logistics), Washington, D.C., September 1976.

ATCH 3

c. DOD Directive 4140.44, Supply Management of the Intermediate and Consumer Levels of Inventory, Office of the Assistant Secretary of Defense, Washington, D.C., 28 February 1978.

d. DOD Instruction 4140.45, Standard Stockage Policy for Consumable Secondary Items at the Intermediate and Consumer Levels of Inventory, Office of the Assistant Secretary of Defense, Washington, D.C., 7 April 1978.

e. DOD Instruction 4140.46, Standard Stockage Policy for Repairable Secondary Items at the Intermediate and Consumer Levels of Inventory, Office of the Assistant Secretary of Defense, Washington, D.C., 7 April 1978.

f. Headquarters USAF/LGYP ltr (U), 4 May 1978. Subject: General and Detailed Implementation Plans for DOD Directive 4140.44 and DOD Instruction 4140.45. This letter tasks the Air Force Logistics Management Center with primary responsibility for development of the Air Force general implementation plan for DODD 4140.44 and DODI 4140.45 requirements.

g. Deputy Assistant Secretary of the Air Force (Logistics) Memorandum for Deputy Assistant Secretary of Defense (Supply, Maintenance and Services), 12 September 1978. Subject: Air Force General Implementation Plan for DOD Directive 4140.44 and DOD Instructions 4140.45 and 4140.46.

h. Headquarters USAF/LEYPS ltr (U), 15 November 1978. Subject: Air Force General Implementation Plan for DOD Directive 4140.44 and DOD Instructions 4140.45 and 4140.46. This letter forwarded the approval of the general implementation plan by the

Assistant Secretary of Defense for Manpower, Reserve Affairs and Logistics and tasked the AFLMC with development of the detailed implementation plan and the execution of the general implementation plan.

i. Deputy Assistant Secretary of Defense (Supply, Maintenance and Services) Memorandum for the Assistant Secretary of the Air Force (Research Development and Logistics), 14 September 1979. Subject: Retail Inventory Management and Stockage Policy (RIMSTOP). This memorandum granted authorization to proceed with the implementation of the detailed plan.

1.3 TERMS AND ABBREVIATIONS (ACRONYMS).

a. Cost to Order. This factor is set at \$15.84 for Local Purchase items and \$4.54 for all others. It represents the costs incurred within the SBSS for processing routine stock replenishment orders (See AFLMC Report #761138-2).

b. Holding Cost Rate. This factor is set at 26% (of inventory value). It represents the costs incurred with holding levels of inventory at the retail level (See AFLMC Report #761138-1).

c. Cost to Add. This factor is set at \$3.38. It represents the costs incurred to compute a level of stock to support an asset (See AFLMC Report #761138-3).

d. Cost to Maintain. This factor is set at \$11.20 and represents the costs incurred to maintain an item with a level of stock support (See AFLMC Report #761138-3).

e. Backorder Cost. This factor is set at \$2.55 and represents the costs incurred to establish a routine Due-Out.

The Due-Out is maintained until stock replenishment is received and the customer's requirement satisfied. No special requisition other than for routine stock replenishment is submitted from the SBSS to the source of supply (See AFLMC Report #761138-14).

f. End-Use Order Cost. This factor is set at \$6.47. It represents the costs incurred when priority requisitions are submitted back to the source of supply to fill specific, high priority customer requirements (See AFLMC Report #761138-14).

g. Item Essentiality. A measure of an item's military worth in terms of how its failure would affect mission accomplishment. DOD Instruction 4140.45 specifically states that DOD must give prior approval to any essentiality rating scheme. In the absence of such approval, the item essentiality factor will be set equal for all items as directed by DODI 4140.45. The value selected is one (1).

h. Line Availability. This value represents a desired level of stock availability. Based on the goals selected for the supply performance measure of Net Availability a value of 90 percent or .9 was selected for this factor.

i. Cumulative Recurring Demands. Equivalent to our currently computed cumulative recurring demand data.

j. Mean Leadtime. Order and Ship Time expressed in years ($O\&ST \div 365$).

k. Reorder Point. The level at which replenishment stocks are requisitioned and identical to the reorder point used currently.

l. Economic Order Quantity. Identical to the EOQ currently computed (see formula on page 52), less VSO.

m. Total Demands Per Year. Determined by adding ND(CP) and ND(1PSM) data fields from Item Record.

n. Unit Price. Cost of the item in dollars and cents.

o. Shortage Cost. This is a variable factor that can be altered to drive model performance or allocate funds provided to maximize the performance that can be obtained. It is, by design, a "tuning knob" by which the inventory control model's performance may be altered.

SECTION 2
SYSTEM SUMMARY

2.1 BACKGROUND.

a. A review, conducted in 1974, of the major improvements in the management and control of secondary items of supply at the wholesale level of all Department of Defense supply systems indicated the need to extend these improvements below the wholesale level where a substantial portion of all supporting inventories are held. To accomplish this project, a small joint working group of qualified experts representing each of the services, including the Marine Corps, and the Defense Logistics Agency was formed. The charter of this group was to develop uniform criteria for a more efficient stockage policy and management of secondary items below the wholesale level. This group, which became known as the Retail Inventory Management and Stockage Policy (RIMSTOP) Working Group, operated under the direction of the Assistant Secretary of Defense (Installations and Logistics).

b. The basic report of the RIMSTOP Working Group was published in September 1976. This report proposed standard stockage policies and terminology for both consumable and reparable secondary items held at the intermediate and consumer levels of inventory. The policies and terminology were incorporated by the Department of Defense into a directive and two supporting instructions.

c. DOD Directive 4140.44, "Supply Management of the Intermediate and Consumer Levels of Inventory" dated 28 February

1978, directs that each military department and the Defense Logistics Agency develop retail level stockage policies that will provide optimum stockage while incorporating a balance between supply performance and economy of operation. Additionally, standard terminology for describing and defining levels of inventory and measures of supply performance are presented. Finally, the Directive tasked each DOD Component to develop and submit general and detailed implementation plans for the requirements of the directive and its supporting instructions plus a designation of the office responsible for overall implementation and administration.

d. The Air Force Logistics Management Center was charged with the responsibility of developing the implementation plans as well as meeting the requirements of the Directive and DODI 4140.45 entitled, "Standard Stockage Policy for Consumable Secondary Items at the Intermediate and Consumer Levels of Inventory" dated 7 April 1978. The Air Force Logistics Command was charged with meeting the requirements of the second supporting instruction, 4140.46, entitled, "Standard Stockage Policy for Repairable Secondary Items at the Intermediate and Consumer Levels of Inventory" dated 7 April 1978.

2.2 OBJECTIVES. The objective of this change is to comply with DODD 4140.44 and DODI 4140.45 which requires that depth and range of stock computations be based on considerations of cost as well as demand history. The paragraphs below provide further details on this requirement and describe other required, specific objectives.

2.3 EXISTING METHODS AND PROCEDURES. The following subparagraphs describe the methods and procedures currently used in the Standard Base Supply System (SBSS) for determining both range and depth of stock for consumable items at the retail level.

a. Current SBSS range of stock decision logic is based upon a consideration of both the number and priority of demands experienced since the date of first demand. If less than 365 days of demand experience for an item is available, 365 days is used. The following decision logic table indicates those thresholds that currently trigger leveling computations within the SBSS:

<u>STOCKAGE PRIORITY CODE</u>	<u>DAILY DEMAND FREQUENCY RATE</u>
1	.0082 (3)
2	.0109 (1)
3	.0136 (5)
4	.0164 (6)

The Daily Demand Frequency Rate (DDFR) above simply represents the number of demands experienced over time. The numbers in parenthesis indicate the number of demands that must be experienced over 365 days or less to reach the applicable DDFRs. It should be noted that leveling decisions may be made without reaching the above thresholds, such as in the case of special levels. These situations will not be changed by the application of the range computations contained in this Functional Description. Only the leveling techniques that are demand driven will be altered.

b. Current SBSS depth of stock computations consider demand history, stock replenishment order costs, an inventory holding

cost rate, unit price, and order and ship time. These factors are used to compute three separate quantities that are then summed to reach a demand level or depth of stock. The three quantities are the safety level quantity, the order and ship time quantity and the economic order quantity. Depicted below are the computation methodology for each of these quantities.

(1) Order and Ship Time Quantity (O&STQ)

$$\text{O\&STQ} = \text{DDR} \times \text{O\&ST (in days)}$$

Where: $\text{DDR} = \frac{\text{Cumulative Recurring Demands}}{\text{Current Date-Date of First Demand}}$

(2) Safety Level Quantity (SLQ)

$$\text{SLQ} = C \sqrt{3 (\text{O\&STQ})}$$

Where: C = One unless otherwise authorized by HQ USAF.

(3) Economic Order Quantity (EOQ)

$$\text{EOQ} = Y \sqrt{\frac{\text{DDR} \times \text{VSO} \times \text{Unit Price}}{\text{Unit Price}}}$$

Where: Y = Either 5.9 or 11 and is derived by applying \$4.54 cost to order and 26 percent holding cost rate or 15.84 cost to order for local purchase items and 26 percent holding cost rate.

Unit Price = Price of the item for its unit of issue.

VSO = Variable Stockage Objective. This factor varies from 365 to zero depending upon the item's Stockage Priority Code and the number of demands coupled with demand days.

2.4 PROPOSED METHODS AND PROCEDURES.

a. Range of Stock Computations. The factors and range of stock formulas spelled out in DOD Directive 4140.44 and DOD Instruction 4140.45 will be incorporated into the Standard Base

Supply System range of stock leveling methodology. The various factors involved are listed under paragraph 1.3 along with their definitions, values, and those Air Force Logistics Management Center reports that depict their development and value determination where applicable. These reports should be referred to for further detailed information regarding the development of each cost factor.

(1) The model presented in the DOD Instruction and as modified by this study applies these factors to determine which items should be stocked on a demand supported basis. The model determines the breakeven cost of adding an item to the stock list, i.e., carrying a level against the asset. This breakeven point is determined by comparing the cost of not leveling on an item versus the cost of establishing a level and supporting the item as a stocked asset. These costs are represented by the following notation:

- (a) $C_{\text{off-off}}$ = The costs incurred when an item is not stocked and a level will not be computed or carried against the item.
- (b) $C_{\text{off-on}}$ = The costs incurred when a level is computed for an asset and it is added to the stock list. The determination of this cost requires the computation of $C_{\text{on-on}}$.
- (c) $C_{\text{on-on}}$ = The costs incurred when an item is supported by a stock level and will be retained on the stock list.

(2) Listed below are the computation methodologies for determining these three costs of operation:

$$(a) C_{\text{on-on}} = F + (R - DL + \frac{Q}{2}) IC +$$

$$\frac{D}{Q} * A + S (1 - \alpha) (E \lambda L + B)$$

Where:

F = Cost to Maintain
R = Reorder Point
D = Cumulative Recurring Demands
L = Mean Leadtime in Years
Q = Economic Order Quantity
I = Holding Cost Rate
C = Unit Price
A = Cost to Order
S = Total Demands Per Year
 α = Line Availability
E = Essentiality Code
B = Backorder Cost
 λ = Shortage Cost

$$(b) C_{\text{off-off}} = S (E \lambda L + U)$$

Where: U = End-Use Order Cost

$$(c) C_{\text{off-on}} = G + C_{\text{on-on}}$$

Where: G = Cost to Add

Once the above computations are completed the values derived for each are compared to determine whether or not a level should be computed for an item. This comparison is depicted below with the applicable leveling decision.

- If: $C_{\text{off-off}} < C_{\text{off-on}}$ then do not compute a level or stock the asset.
- If: $C_{\text{off-off}} \geq C_{\text{off-on}}$ then compute a level and stock the asset.

(3) The above methodology represents a pure economic approach to range of stock leveling decisions without regard to mission impact. To accommodate mission essential requirements the influence of the current Stockage Priority Coding system was incorporated into the range computations. This was accomplished by developing separate Shortage Costs (λ) for each Stockage Priority Code 2, 3, and 4. These values are presented below:

<u>SPC</u>	<u>SHORTAGE COST</u>
2	25
3	10
4	4

Additionally, the model guarantees a leveling decision on Stockage Priority Code One items on the first MICAP demand.

b. Depth of Stock Computations. The methodology presented in DOD Directive 4140.45 is essentially identical to the SBSS computations currently used for the determination of both the reorder point and the economic order quantity. A basic difference is found in the application of the Variable Stockage Objective in the SBSS to the determination of the economic order quantity. To fully comply with the DOD Directive, the Variable Stockage Objective should be removed from the depth of stock computations. Instead, a full 365 days should be used at all times thereby converting the daily demand rate to an annual demand rate.

2.4.1 SUMMARY OF IMPROVEMENTS. Improvements that can be expected from these proposed modifications to the Standard Base Supply System stock leveling techniques fall generally into two categories. They are presented below.

a. Current range of stock decision logic, based on the Daily Demand Frequency Rate thresholds, guarantees the establishment of a level for those items experiencing their third demand if the lack of that item will result in a MICAP incident. The new range of stock computations guarantees a leveling decision with the very first demand, if a MICAP incident will result.

b. The capability of the SBSS to support mission requirements should improve across the board. This improvement has been strongly indicated through the application of simulation techniques. The System to Analyze and Simulate Base Supply (SASBS) simulation model was used to determine the impact of these changes to range and depth of stock computations. These impacts were reflected in performance measures currently used by which to gauge the mission support of the SBSS. The SASBS simulation model tracks performance with the following measures:

- (1) Gross and Net Availability
- (2) Receipts
- (3) Requisitions - Priority Groups 1-3 and total
- (4) MICAP Incidents
 - (a) NMCS Aircraft
 - (b) PMCS Aircraft
 - (c) NMCS Engine
 - (d) VDP

Gross Availability and Net Availability will increase from one to two percent. Receipts processed and requisitions placed will decrease approximately 20 percent. The breakout of requisitions by priority will reflect decreases of approximately 18, 18, and 21 percent respectively for priority group one, two, and three requisitions. Reductions in all MICAP incidents should range from 11 to 41 percent.

2.4.2 SUMMARY OF IMPACTS. The changes in stock leveling techniques described in this functional description will require both additions to and deletions from the current SBSS software

programs. These new techniques will not require any changes to existing equipment nor will it impact the SBSS organizational structure or operating environment. The software programs no longer required will be addressed first followed by those changes requiring additions to the current software.

a. The current range of stock leveling methodology will be totally replaced. The Daily Demand Frequency Rate/SPC decision logic threshold table can be deleted. Also, with the total elimination of any Variable Stockage Objective that decision logic table and approach can be deleted.

b. The new economic range of stock leveling approach will require software programming to handle the cost formulas mentioned under paragraph 2.4a(1) and 2.4a(2) of this functional description. With each demand experienced for non-stocked items the C_{on-on} , $C_{off-off}$, and C_{off-on} values must be first determined and then compared to arrive at the decision to level or not to level against that particular asset. While this will most likely involve more computer processing time than the current Daily Demand Frequency Rate threshold approach, this should be somewhat offset by the deletion of the requirement to compute the Daily Demand Frequency Rate and the Variable Stockage Objective within the depth of stock computations.

SECTION 3
DETAILED CHARACTERISTICS

3.1 SPECIFIC PERFORMANCE CHARACTERISTICS

3.1.1 ACCURACY AND VALIDITY. The values of the cost of operation formulas, $C_{\text{on-on}}$, $C_{\text{off-off}}$, and $C_{\text{off-on}}$, need not be computed beyond whole numbers with all values rounded up or down, whichever method is easiest to program, so long as the approach is the same for all values determined. This flexibility is possible because these cost figures do not represent actual costs of operation but rather establish the relationship between the costs of operation.

3.1.2 TIMING. Since the reorder point and economic order quantities are used in the range model computations, the depth of stock computation must be exercised first to determine these values prior to arriving at the range of stock leveling decision.

3.2 INPUTS - OUTPUTS. No change.

3.3 DATA CHARACTERISTICS. Data used in the new range of stock computations found at paragraph 2.4a(1) and 2.4a(2) will be obtained from four sources.

a. The following data elements are maintained on the item record:

- Unit Price
- Cumulative Recurring Demands (NOTE: Currently available on the item record.)

- Total Demands (NOTE: Determined by adding ND(CP) + ND(1PSM).)

b. The following data element is maintained on the Routing Identifier Records:

- Mean Leadtime in Years (NOTE: Determined by dividing currently maintained Order and Ship Time by 365.)

c. The following data elements are predetermined and constant for all items. Their values are as indicated.

- Cost to Add = \$3.38

- Cost to Maintain = \$11.20

- Holding Cost Rate = 26%

- Cost to Order = \$15.84 for Local Purchase items and \$4.54 for all other items.

- Backorder Cost = \$2.55

- End-Use Order Cost = \$6.47

- Item Line Availability Factor = .9

- Item Essentiality Factor = 1

- Shortage Cost Factor

= 4 for SPC 4 items

= 10 for SPC 3 items

= 25 for SPC 2 items

d. The following data elements are determined from the depth of stock computations:

- Reorder Point

- Economic Order Quantity

3.4 FAILURE CONTINGENCIES. No change.

SECTION 4

SYSTEM DEVELOPMENT PLAN

4.1 MILESTONES. Implementation milestones for the changes identified in this functional description were established with the approval of the Air Force's General and Detailed Implementation Plans for DOD Directive 4140.44 and DOD Instructions 4140.45 and 4140.46. Specifically, the system modifications identified are to be operational by 31 December 1981.

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