Logistics Management Institute

Quantifying and Trading Off the Benefits of Reducing Order and Shipping Times

LG501R1

September 1997

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Executive Summary

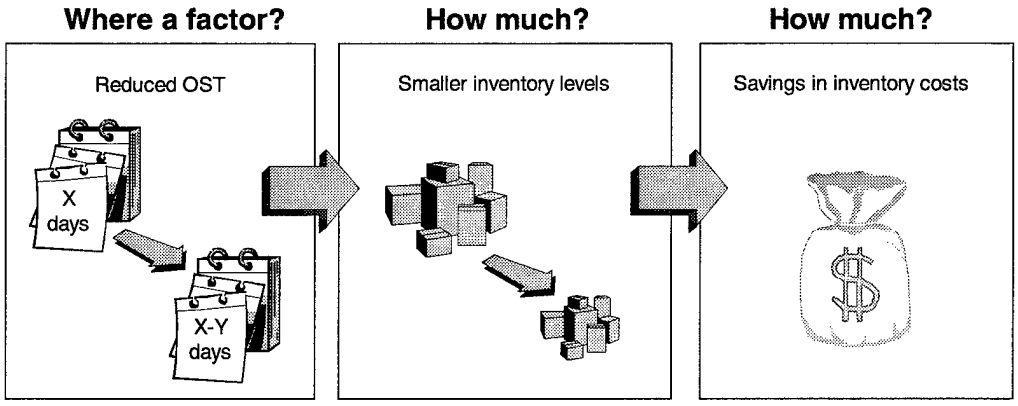
Order and shipping time (OST) is the time between when a retail supply activity initiates a replenishment requisition and when it receives the requisitioned materiel. That time is often used to compute a retail level of inventory to cover customer demands while wholesale inventories maintained by the military services and the Defense Logistics Agency (DLA) are replenishing the activity. Therefore, reducing OST offers DoD the potential for saving millions of dollars in inventory investment and in the costs of maintaining inventory.

Consequently, several ongoing and potential initiatives exist to reduce OST. Some initiatives involve changes to the supply system that would have little or no costs associated with them. Other initiatives involve changes that would have measurable associated costs. Before adopting any of the latter initiatives, DoD should first quantify the potential savings, then trade off the estimated benefits against estimated costs.

At the direction of the Office of the Deputy Under Secretary of Defense for Logistics, the Logistics Management Institute analyzed DoD retail supply activities and their procedures to determine the benefits of reducing OST. At the same time, the DLA Operations Research Office (DORO) was tasked with quantifying the costs of selected alternatives for reducing the wholesale distribution times associated with OST. Once both of these tasks were completed, we worked with DORO to develop and apply a model for trading off the benefits we discovered against the costs they derived.

Our benefits analysis started with a review of DoD retail supply. Our objectives were to determine first where retail inventory levels would be affected by a reduction in OST, then how much an OST reduction would reduce those levels, and finally how much savings would be generated by a reduction in retail levels. This approach is illustrated in Figure 1.

Figure 1. Estimating the Benefits of Reducing OST



When we examined DoD retail supply, we found over 30 different types of supply activities. The large number results from the fact that retail supply activities are less generic than wholesale activities and more tailored to the specific operations they support. We also noted almost 20 different automated systems compute retail requirements levels (i.e., inventory control levels that are designed to satisfy customer requirements and dictate basic materiel management actions, such as when to order and how much to order). However, the number of systems will decrease as each military service modernizes and moves towards standardizing its retail systems.

We found that the methods used to compute retail requirements levels range from simplistic days-of-supply rules to more complex demand-based algorithms to very complex readiness-based algorithms. Although all military services use demand-based algorithms and more than one service uses days-of-supply and readiness-based algorithms, the actual formulas differ among the services and within each one.

We reviewed retail activities that had requirements levels valued at more than $31 billion in March 1995 and found that OST directly influenced 58 percent of those activities. Saying that OST influences particular activities and their inventories means that OST plays a role in computing one or more item requirements levels for those activities. It does not mean that OST affects all items or all item requirements levels associated with the inventories at those activities.

Having determined where OST is a factor in computing requirements levels, we next estimated what 1 day of OST is worth in terms of reduced requirements levels. Working with retail computations for OST-related levels, we produced a "bottom-up" estimate of $48.8 million. Then, relying on the theory that the value of 1 day of OST should equal the value of 1 day of wholesale replenishment demand, we computed a "top-down" estimate of $84.2 million. Together, these two estimates provide a range for the value of 1 day of OST in terms of requirements levels.

We then quantified the expected one-time and recurring savings that would result from lower requirements levels. Based on our range of estimates for 1 day of OST, we computed expected one-time savings in materiel costs of between $24.8 and $40.1 million and in repair costs of between $3.2 and $5.9 million per day of reduced OST. Another way of looking at these expected one-time savings is that each dollar of reduced levels for consumable items should save 1 dollar in inventory costs, and each dollar of reduced levels for reparable items should save 45 cents in inventory costs. In addition to these one-time savings, we estimate that each day of reduced OST would generate expected annual recurring savings of between $2.9 and $5.0 million in reduced inventory holding costs associated with obsolescence and materiel losses.

Although a number of situations and processes exist that would delay or dampen actual budget savings, expected one-time and recurring savings can be used to evaluate proposals to reduce OST. We traded off the costs of expediting replenishment shipments from the 1995 DORO analysis with the benefits from our analysis. We found that expediting routine shipments for all DLA-managed items was not cost-effective. However, using a tradeoff model we designed for individual consumable items, DORO did find that expediting shipments for lightweight, high-cost items was cost-effective. We recommend that DLA and the military services pursue this change in processing routine replenishment requisitions.

Our analysis focused on the benefits of reducing the depth of retail requirements levels based on a reduction in OST. Potentially, DoD could realize even larger benefits than those quantified in this analysis if the military services instituted policies and procedures that include requisition response time in determining the range of items stocked at retail activities. Ultimately, as demonstrated by DLA's prime vendor program for pharmaceuticals and medical supplies, reducing the time to respond to retail requisitions from days to overnight eliminates the need for retail stockage of any inventory.

In addition to inventory cost reductions from reduced or eliminated stockage, intangible benefits of reducing OST are:

- a supply system that is more responsive to the needs of operating units,
- shorter time frames required for maintenance and deployment planning, and
- more accurate determination of retail levels as periods for forecasting future demand are shortened.

For all those reasons, the military services and DLA should continue to take actions to reduce OST.

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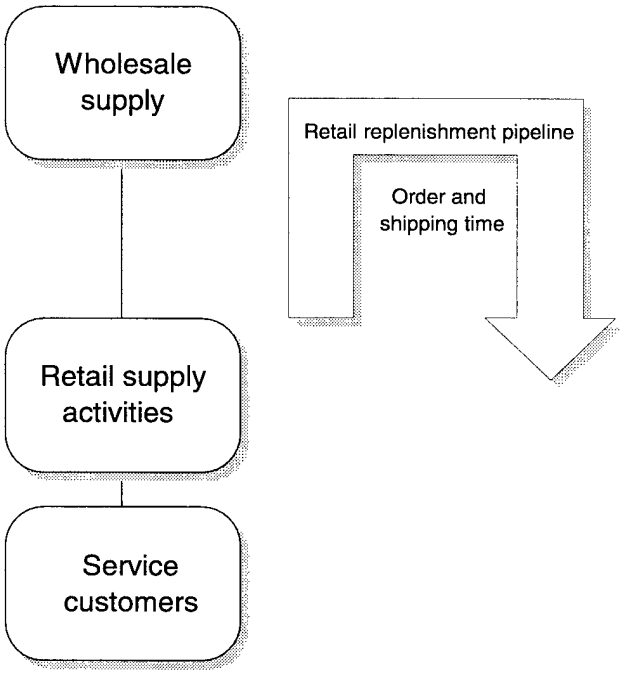
Introduction

BACKGROUND

To support its military forces, DoD manages approximately 4.8 million active secondary items in a supply system that serves several thousand military activities worldwide. Items in the supply system range from weapon system reparable assemblies and subassemblies to consumable repair parts to personnel support items, such as medical supplies and clothing. Within each military service, retail supply activities maintain inventories of these items for use by their customers. These retail inventories are resupplied either from DoD wholesale inventories or commercial sources.

The retail inventories that the services maintain directly support the operating forces, allowing them to carry out their peacetime and wartime missions. A retail supply activity replenishes its inventories by requisitioning from wholesale sources of supply. As illustrated in Figure 1-1, order and shipping time (OST) is the time between when a retail supply activity initiates a replenishment requisition and when it receives the requisitioned materiel.

Figure 1-1. Order and Shipping Time



Besides replenishment requisitions, retail activities also place requisitions with the wholesale supply system for materiel that goes directly to their customers for use. Such end-use requisitions occur when the retail supply activities do not stock the materiel or when they are temporarily out of stock. Since the priorities assigned to end-use requisitions are generally higher than those assigned to replenishment requisitions, they have faster wholesale response times. However, retail supply activities do not normally use the response times for end-use requisitions to build retail inventory levels, while they do use OSTs for replenishment requisitions.

HISTORY OF ANALYSIS

Reducing the time to replenish retail supply activities offers DoD the potential for saving millions of dollars in inventory and in the costs of maintaining inventory. Accordingly, in the fall of 1994, the Office of the Deputy Under Secretary of Defense for Logistics established a process action team to identify alternatives for reducing the logistics response time (LRT) for secondary item support. Working with the military services, the Defense Logistics Agency (DLA), and the Military Traffic Management Command, the team sought to identify new business practices that would reduce LRTs within DoD.

One effort of particular interest to the process action team was a cost analysis initiated in November 1994 by the DLA Operations Research Office (DORO). The purpose of the DORO study was to determine the costs of reducing those portions of OST associated with distribution and transportation of materiel.

In February 1995, the process action team tasked the Logistics Management Institute (LMI) to perform a companion study to the DORO study that would analyze the DoD retail supply system for the purpose of quantifying the benefits of reducing OST. That analysis and its results were presented to the process action team and are described in Chapters 2, 3, and 4 of this report.

In November 1995, the process action team directed that the results of the DORO cost study and the LMI benefits study be combined to evaluate proposals for reducing OST. The resulting analysis was not exhaustive in terms of evaluating all proposals for reducing OST, rather it focused on specific proposals for expediting depot handling and transportation for requisitions placed with the wholesale system. The follow-on analysis and its results were presented to the process action team and are described in Chapter 5 of this report.

PURPOSE

The primary objectives of the analyses documented in this report were to quantify the benefits of reducing OST for routine replenishment requisitions and to determine when it is cost-effective to expedite distribution and transportation of routine replenishment requisitions.

DISCUSSION

The benefits of quickly responding to high-priority, urgent requisitions are obvious, but the benefits of reducing the time to respond to routine replenishment requisitions are not. To quantify those benefits, we employed a four-step approach. In what follows, we discuss what we did and what we found for each of the four steps as well as for an additional fifth step that involved the evaluation of proposals for reducing OST.

Step 1: Catalog Retail Inventories

Our first step was to identify retail inventories where OST plays a role in computing requirements levels.

GENERAL APPROACH

To accomplish this objective, we collected information on the military services' retail inventories and visited retail supply activities in each service as well as activities associated with the computation of retail requirements levels. We then compiled a catalog of retail supply activities, including their materiel management systems, methods for computing requirements levels, and estimates for the dollar value of retail requirements levels.

SUMMARY OF FINDINGS

We found the following in 1995:

- The Army has 10 types of retail supply activities, has 6 automated materiel management systems involved in computing retail requirements levels, uses days-of-supply and demand-based algorithms to compute levels, and has $2.7 billion in requirements levels across all of its retail inventories, 77 percent of which have OST as a factor in one or more level computations.

- The Navy has 14 types of retail supply activities; has 8 automated materiel management systems involved in computing retail requirements levels; uses months-of-supply, demand-based, and readiness-based algorithms to compute levels; and has $16.2 billion in requirements levels across all of its retail inventories, 23 percent of which have OST as an active factor in one or more level computations. (This small percentage is due to the fact that the Navy has elected to zero out the OST factor in many of its levels computations.)

- The Air Force has 2 types of retail supply activities, has 2 automated materiel management systems involved in computing retail requirements levels, uses a readiness-based algorithm to compute levels for depot-level

reparable items and demand-based algorithms for other items, and has $10.7 billion in requirements levels across all of its retail inventories, 100 percent of which has OST as a factor in one or more level computations.

- The Marine Corps has 6 types of retail supply activities, has 6 automated materiel management systems involved in computing retail requirements levels, uses days-of-supply and demand-based algorithms to compute levels, and has $2.3 billion in requirements levels across all of its retail inventories, 99 percent of which has OST as a factor in one or more level computations. (Although Marine aviation is traditionally considered under Naval aviation, we included Marine aviation retail supplies under the Marine Corps rather than the Navy; and they account for $2.0 billion of the $2.3 billion.)

Step 2: Estimate the Value of 1 Day of OST in Terms of Reduced Retail Requirements Levels

Having identified which inventories are influenced by OST, we next sought to quantify the dollar impact on their requirements levels of reducing OST by 1 or more days.

General Approach

At the start of this effort, we knew that the development of an exact dollar impact was not possible because not all of the required data were readily available and the available data were subject to continuing change. Therefore, we developed two estimates that provide a range. We based our first estimate on how the services compute retail levels and our second on the rate that retail levels are replenishing themselves.

Specifically, to make our first estimate, we looked at those retail requirements levels having OST as part of their computations. We then used their computational algorithms and 1995 data to derive an estimate of the value of 1 day of OST. The resulting "bottom-up" estimate is quite conservative because we only cite dollars we could quantify with a reasonably sound approach. Consequently, the value of 1 day of OST would most likely be higher than this estimate.

For our second estimate, we relied on the fact that the OST level is the product of the OST and retail demands placed on the wholesale level. Therefore, the value of 1 day of OST is equal to the average value of 1 day of wholesale demand. Thus, we derived our second estimate using 1995 data on the demand placed on DoD wholesale inventory control points. Since some wholesale recurring demand does not go into the services' retail requirements determination processes, the value of 1 day of OST would most likely be lower than this estimate.

SUMMARY OF FINDINGS

For our bottom-up estimate, we arrived at the following from retail computations of requirements levels:

- Army—$5.4 million
- Navy—$10.4 million
- Air Force—$28.6 million
- Marine Corps—$4.4 million
- Total—$48.8 million.

For our top-down estimate, we have the following from wholesale demand data:[1]

- Army—$8.1 million
- Navy—$25.9 million
- Air Force—$41.4 million
- DLA—$8.8 million
- Total—$84.2 million.

As previously discussed, these two values define a most likely range for the value of 1 day of OST in terms of retail requirements levels.

Step 3: Identify the Cost Savings

With a range for the dollar reduction in requirements levels that an OST reduction would cause, we next worked to identify the cost implications of that reduction and quantify the associated cost savings.

GENERAL APPROACH

We listed all of the costs associated with maintaining an inventory within DoD and examined if and how each cost would be affected by a reduction in levels. We used our two estimates for levels reductions to estimate one-time and recurring cost savings.

[1] Marine Corps data was not readily available. Since the Marine Corps is wholesale manager for a small number of items, we felt that its omission would not significantly affect the value of our top-down estimate.

SUMMARY OF FINDINGS

For each day of reduced OST, we found that DoD could realize one-time savings of between $24.8 and $40.1 million in expected materiel costs and between $3.2 and $5.9 million in expected repair costs. For consumable items, these expected savings match dollar for dollar reductions in item requirements levels, but only amount to 45 cents on the dollar for reparable items. Besides these one-time savings, DoD would annually gain an additional expected savings of between $2.9 and $5.0 million in reduced obsolescence costs.

Step 4: Link Savings to Budget Reductions

As our final step in identifying the economic benefits of reducing OST, we examined how expected cost reductions identified in step 3 affect budgets and attempted to link expected cost savings to actual budget reductions.

GENERAL APPROACH

Since we did not have the necessary detailed data, we use results from two sources—one, an Air Force study, the other, a simple simulation model—to investigate how cost savings convert to budget reductions. This investigation identified a number of dynamic factors that would delay or negate budget reductions from the expected savings.

SUMMARY OF FINDINGS

We concluded that the savings identified in step 3 are really estimated maximums that would not immediately translate to budget reductions. High asset positions at the retail or wholesale level would cause the actual savings in budget requirements to span several years and would reduce the size of the expected savings. Rounding and the current methods for updating OST would also delay and possibly negate some of the savings, depending on the relative size of the OST reduction. And finally, other factors—such as declining future demand, increasing acquisition lead-times, and methods for forecasting demand and lead-times—could delay or negate budget savings. Given these factors, only a micro-level analysis using a sophisticated analytical model could generate more credible estimates than those given in step 3.

Step 5: Evaluate Proposals for Expediting Shipments

We traded off the cost savings identified in step 3 and the increased costs that the DORO study estimated for reducing OST to determine when it was cost-effective to expedite routine replenishment shipments.

GENERAL APPROACH

We first segmented potential savings estimates by wholesale manager and by retail user. Then, using savings estimates for DLA-managed items, we looked at the possibility of reducing OST for all items through the distribution alternatives identified in the DORO cost study. We developed a model that replicates the economic tradeoff of costs and savings for reducing OST for an item. The DORO staff incorporated this model in their distribution simulation model to assess when expediting routine replenishment shipments is cost-effective.

SUMMARY OF FINDINGS

Our tradeoff analysis showed that it was not cost-effective to expedite shipments for all items. The DORO analysis concluded that it was cost-effective for a selective price and weight category, namely, a unit price over $100 and a unit weight under 10 pounds.

Opportunities

Our analysis focused on the benefits that reduced OST would have on the depth of stock at the retail level of supply. For any OST reduction initiative that has little or no associated cost, the military services would realize the full amount of those savings. For any initiative that has some measurable associated cost, a tradeoff analysis could be done to estimate the level of savings.

If the military services instituted policies and procedures that include requisition response time in determining the range of items stocked at retail activities, the result would be even larger benefits than those quantified in this analysis because entire levels of inventory for some items would be eliminated. In particular, if the time for response to retail requisitions were significantly reduced from days to hours, the need for retail stockage of any inventory would be eliminated. DLA's prime vendor program for medical drugs is an example of a program where the need for both wholesale and retail levels of stock was eliminated because commercial suppliers provide overnight delivery on drug orders from DoD customers.

ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations governed the general conduct of this analysis:

- Given the variety of sources, data collection across the military services and across retail activities within a service was not uniform and had to be based on what was readily available.

- We collected available summary data either by type of retail activity or by activity, and our results are at a macro-level and not derived from analyses of individual items.

- Secondary items, excluding bulk food and subsistence, are the focus of this analysis. (See Appendix A for a more detailed list of what classes of items are included and excluded from the analysis.)

- All retail supply activities—with the exceptions of those associated with bulk fuel, ammunition, and subsistence and those associated with facilities engineering, except for the Navy—are part of the analysis. (See Appendix A for a more complete list of the types of activities included and excluded from the analysis.)

REPORT ORGANIZATION

Chapter 2 is the catalog of retail supply inventories. It presents an overview of activities, their supporting automated systems, their methods for computing inventory levels, and their dollar sizes.

Chapter 3 discusses the theoretical implications of reduced OST for retail requirements levels. It provides the estimates of the dollar value of 1 day of OST in requirements levels computations. It closes with a discussion of how methodologies used to update OSTs and to round levels dampen or negate the affects of reduced OSTs.

Chapter 4 addresses the budget and cost benefits of reducing OST by relating reductions in requirements levels due to reduced OST to the costs of maintaining inventories. It also discusses how the expected savings from reduced costs translate to budgets.

Chapter 5 summarizes the findings of the analysis and recommends ways in which potential alternatives for reduced OST should be evaluated. It also addresses ways to gain savings greater than those identified in this analysis.

Appendix A defines key terms used in the report (e.g., retail consumer level of supply and retail intermediate level of supply) as well as the range of items and activities considered in the study. Appendixes B, C, D, and E present the background information supporting Chapters 2 and 3 for the Army, Navy, Air Force, and Marine Corps, respectively. Appendix F addresses the algorithm used to estimate levels impacts of reduced OST on Navy and Marine Corps allowance lists. Appendix G discusses inventory costs that OST does not affect or negligibly affects. Appendix H presents the LMI model that the DORO staff used to analyze when it is cost beneficial to expedite routine replenishment shipments.

Chapter 2
Catalog of Retail Inventories

INTRODUCTION

Although OST is a factor in replenishing all retail inventories, not all retail requirements computations consider OST and not all retail inventories are replenished from the wholesale level. To assist in identifying those inventories that consider wholesale-related OST, we compiled a retail catalog that lists

- the types of military service retail supply activities within DoD's supply system and whether they are replenished from wholesale sources of supply,
- the automated materiel management systems that those activities use,
- the methods used for computing inventory requirements levels and whether they include a nonzero OST, and
- the dollar value of retail requirements levels. (Unless otherwise noted, dollar values are as of March 1995 and are in terms of standard price, i.e., acquisition cost plus surcharge.)

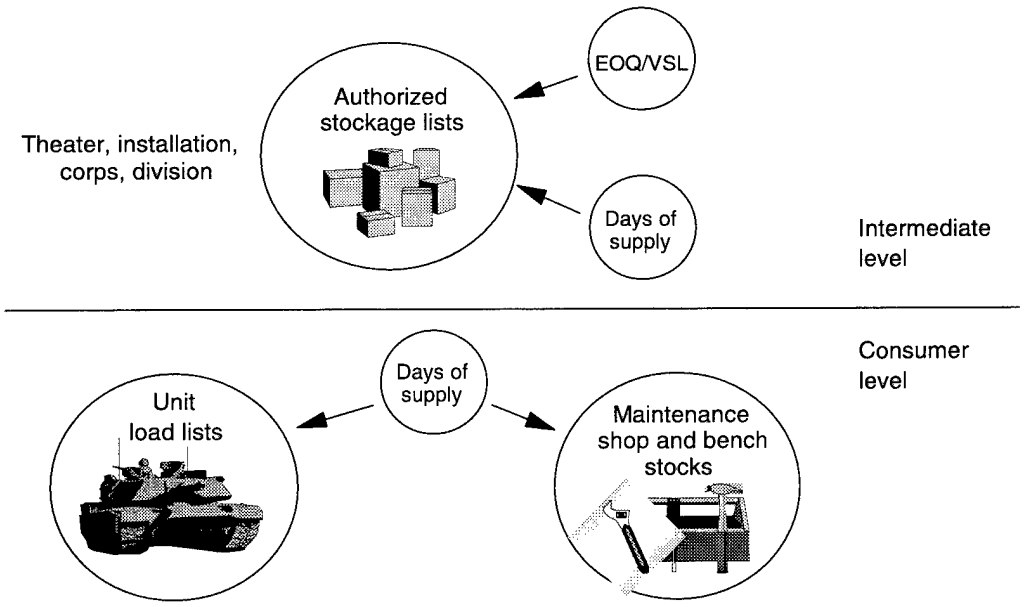
To collect this information, we had to look at individual types of retail supply activities within the military services. Although we were able to review examples of the major retail activities in each military service, we were unable to examine all DoD retail activities. Consequently, although the dollars we reported are based on the most comprehensive survey of retail activities currently available, they should be considered conservative estimates for the actual dollars involved in secondary item retail requirements levels.

ARMY RETAIL SUPPLY

The Army's retail supply for secondary items, excluding medical supplies, is illustrated in Figure 2-1. Divisional tactical units, corps tactical units, nondivisional tactical units, and installation tenant units are the customers of the system. The consumer level, or lowest level of supply, consists of the load lists that units maintain for operations and the stocks that maintenance shops use to perform field-level maintenance. This level of supply is replenished by the intermediate level of supply. The intermediate level consists of authorized stockage lists (ASLs) that theater, corps, division, or installation supply units maintain. All of

these ASLs are resupplied by the DoD wholesale system. (See Appendix B for a more detailed description of these levels.)

Figure 2-1. Army Retail Stocks and Requirements Determination



Note: EOQ = economic order quantity; VSL = variable safety level.

Types of Retail Supply Activities

All Army units—whether tank companies, division artillery companies, corps engineering companies, or echelon-above-corps maintenance activities—have inventory load lists, i.e., basic load lists covering Class I through V items and prescribed load lists (PLLs) covering Class IX items. The items of supply in these load lists represent retail consumer levels of supply. They are resupplied from ASLs that provide area support for several units (e.g., a division, a specific corps unit, a unit above the corps, or an installation). ASLs are intermediate levels of supply.

The types of Army activities that hold retail stocks are as follows:

- Maintenance and supply activities within tactical units providing consumer-level support
- Battalion aid stations that provide consumer-level medical supply support to tactical units
- Maintenance shops in divisions, in corps, above corps, or at installations

- Materiel management centers (MMCs) within divisions that provide direct support to tactical units
- Division medical supply offices (DMSOs) that provide medical supply support to divisional units
- MMCs within corps that provide support to corps units, either divisional or nondivisional
- Medical logistics battalions in corps or theater areas that provide geographical support to all units and DMSOs
- Installation supply activities collocated with maintenance depots that provide repair part support
- Installation supply activities that provide general and medical support to installation tenant activities
- Overseas regional supply support activities that provide general support for specified areas.

Retail Supply Systems

To compute retail levels of supply, the Army uses the following systems:

- Standard Army Maintenance System at maintenance shops
- Unit Level Logistics System at divisional and nondivisional tactical units
- Direct Support Unit Standard Supply System (DS4) at division MMCs
- Standard Army Intermediate Level Supply System (SAILS) at corps and theater MMCs, CONUS installations, and overseas regional supply support activities
- Standard Army Retail Supply System–Objective (SARSS-O), which will replace the DS4/SAILS configuration
- Medical supply portion of the Theater Army Medical Management Information System–Medical Logistics.[1]

The conversion of major Army retail supply activities to SARSS-O will provide for "near real-time" requisitioning, which will contribute to reduced requisition response times for Army customers.

[1] The Defense Medical Logistics Standard Support System is being developed as the future standard DoD system for all medical logistics.

Methods for Computing Retail Requirements Levels

The Army uses two methods for computing retail levels:

- Days-of-supply algorithms for unit PLLs, shop stocks, and division ASLs
- Demand-based algorithms for SAILS activities and depot maintenance installation supply activities to generate operating levels, safety levels, and OST levels for demand-based items.

Influence of OST on Computations

Although not all Army retail levels order materiel from wholesale sources of supply, all Army retail requirements determination processes use actual OST, not some type of standard.[2] The days-of-supply algorithms use actual OSTs to compute OST levels for all items. Safety levels are based upon a fixed number of days and do not vary according to an item's OST. However, if OSTs were reduced, Army management could elect to reduce the number of safety-level days accordingly.

The demand-based algorithms in SAILS use actual OSTs to compute OST levels for all items and safety levels for consumable items. Item transaction OSTs are smoothed into the old item OST averages to generate new averages each quarter. Only routine requisitions that are within a floor and ceiling have their transaction OSTs included in the averages. The floor and ceiling are derived from an item's OST variance.

The demand-based algorithms in depot maintenance installation supply activities use an average OST to compute OST and safety levels for all items.

Financial Profile

While consumer stocks are bought with operations and maintenance (O&M) funds, intermediate stocks are either bought with O&M funds or stock-funded under the Defense Business Operating Fund (DBOF). (The corps ASLs are O&M funded, while the ASLs above corps are under DBOF.) We collected Army DBOF retail stratification reports prepared by the major commands, including the Army Materiel Command (AMC), in March 1995. The total value of the retail requirements levels from those reports was $1,815 million.

The Army estimates that the value of its O&M-funded PLL and ASL inventories of secondary items is approximately $900 million. We adopted that estimate as our estimate for the value of O&M-funded requirements. Of the requirements that

[2] When computing wartime requirements where actual OSTs are unknown, the Army does use expected standard times between deployed levels of supply.

go into that estimate, wholesale-related OST only affects O&M-funded ASLs because PLLs are replenished by intermediate levels. Although Army-wide requirements data for these ASLs are not readily available, we were able to obtain dollar totals for eight ASLs at Fort Bragg. The Army has approximately 35 O&M ASLs. When we extrapolated the $62 million in the 8 ASLs to 35 ASLs, we arrived at an estimate of $272 million for all O&M-funded ASLs.

In summary, the Army has an estimated $2.7 billion in retail inventories, and OST factors in inventories valued at $2.1 billion, or 77 percent of the total. The remaining 23 percent are O&M-funded PLL requirements, which are replenished by intermediate levels and not wholesale levels of supply.

NAVY RETAIL SUPPLY SYSTEM

Figure 2-2 shows an overview of the Navy's retail supply system. Personnel charged with maintaining ships, aircraft afloat and ashore, and other equipment afloat and ashore are the customers of that system. Levels for reparable items are centrally computed by the Naval Inventory Control Point (NAVICP), which is located at two sites, and are distributed to the fleet in the form of allowance lists. Except for initial allowance levels computed at NAVICP, levels for consumable items are computed locally by afloat and ashore retail supply activities. (Appendix C provides a more detailed description of the Navy's retail supply system.)

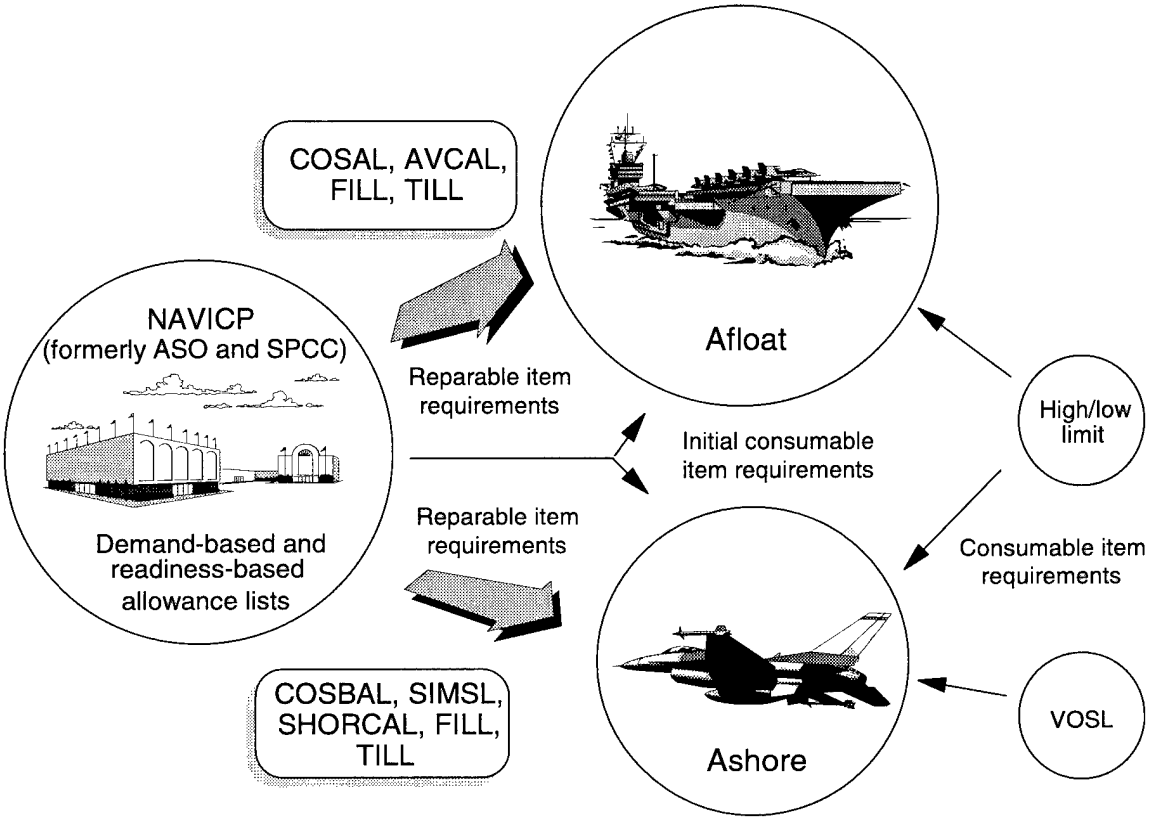
At the time of this analysis, the two sites comprising the current NAVICP were separate inventory control points, referred to as the Ships Parts Control Center (SPCC) and Aviation Supply Office (ASO). Then and now, the SPCC site manages ship-oriented materiel while the ASO site manages aviation-oriented materiel. Throughout the remainder of this report, we will use the site's former names of SPCC and ASO instead of their current respective names of NAVICP Mechanicsburg and NAVICP Philadelphia as a way of distinguishing between the different types of materiel managed at each site.

Types of Retail Supply Activities

The principal Navy retail supply activities are as follows:

- Supply departments on ships provide onboard support for
  - aviation supplies used on carriers, L class ships, and ships with the Light Airborne Multipurpose System (LAMPS);
  - equipment and general supplies used on all ships; and
  - medical supplies used by medical and dental clinics stationed onboard carriers and tenders.

Figure 2-2. Navy Retail Stocks and Requirements Determination



Note: AVCAL = aviation consolidated allowance list; COSAL = coordinated shipboard allowance list; COSBAL = coordinated shore-based allowance list; FILL = fleet issue load list; SHORCAL = shore-based consolidated allowance list; SIMSL = shore-based intermediate maintenance stock list; TILL = tender issue load list; VOSL = variable operating and safety level.

- Carriers and supply ships provide afloat area support for battle group.
- Fleet and industrial supply centers (FISCs) provide regional ashore support for such activities as shipyards, aviation depots, shore-based intermediate maintenance activities, and Naval air stations.
- Supply departments at naval air stations provide ashore support for installation activities such as aviation organizational and intermediate maintenance.
- Supply departments at CONUS and OCONUS naval stations provide ashore support to base activities.
- Supply departments at Trident refit facilities provide ashore support at Trident submarine base operations.

- Supply departments at naval training centers provide ashore support to new recruits.
- Supply departments at submarine bases provide ashore support.
- Supply departments at naval hospital and medical centers provide ashore medical support.
- Supply departments at construction battalion centers (CBCs) provide ashore support to Navy Seabee operations.
- Supply departments at public works centers (PWCs) provide ashore support to area civil engineering operations.
- Supply departments at other miscellaneous Naval activities provide ashore support.

Retail Supply Systems

To compute retail item levels of supply, the Navy uses the

- uniform inventory control point (UICP) system at SPCC and ASO to prepare most allowance lists;
- Shipboard Uniform Automated Data Processing System (SUADPS) on large ships, such as carriers and tenders, to prepare demand-based levels;
- Supply and Financial Module of the Shipboard Nontactical ADP Program (SNAP) on medium ships, such as cruisers, frigates, and destroyers, to prepare demand-based levels;
- Micro-SNAP (i.e., PC-based SNAP) on small ships, such as submarines, to prepare demand-based levels;
- Uniform Automated Data Processing System (UADPS) at ashore activities to prepare demand-based levels;
- Medical Inventory Control System at Naval hospital and medical centers;
- Supply Management Information System (SMIS) at CBCs; and
- PWC Management Information System.

Methods for Computing Retail Requirements Levels

The Navy computes retail requirements levels using

- readiness-based sparing (RBS) algorithms for aviation allowance lists supporting organizational-level removable items on carriers (approximately 75 percent of the total dollar value of those allowance lists) and allowance lists supporting LAMPS;
- demand-based sparing (DBS) algorithms for other items on carrier allowance lists and aviation allowance lists both afloat and ashore;
- RBS algorithms for selected shipboard equipment allowance lists;
- DBS algorithms for other equipment allowance lists both afloat and ashore;
- variable operating and safety level (VOSL) algorithm for ashore demand-supported requirements for consumable items at UADPS (except Naval Training Center Great Lakes) and SMIS sites; and
- months-of-supply algorithms that produce high and low limits for afloat demand-supported requirements and ashore demand-supported requirements for consumable items at non-VOSL sites.

None of these algorithms address war reserve levels that are ashore, insurance stockage, or any special levels directed by a type commander.

Influence of OST on Computations

Most Navy retail requirements determination processes treat OST as a standard parameter; they do not use an actual OST by item. Moreover, in the majority of cases, the Navy has elected to set the parameter to zero, which eliminates OST from the requirements determination process. In the following, we look at the situations in which the Navy uses a non-zero OST parameter or actual OSTs.

RBS algorithms for aviation allowance lists assign the same OST to all items. ASO currently uses an OST of 25 days for all RBS allowance computations. The 25 days are based on the median of observed values.

RBS algorithms for equipment allowance lists also treat OST as a parameter. It currently has a default value of 15 days.

With two exceptions, the demand-based algorithms for all aviation and equipment allowance lists use an OST parameter of zero. The first exception is the generic aviation allowance list computed for FISC Yokosuka, which uses 30 days. (Because the Navy includes OST in the generation of Yokosuka's Super Aviation

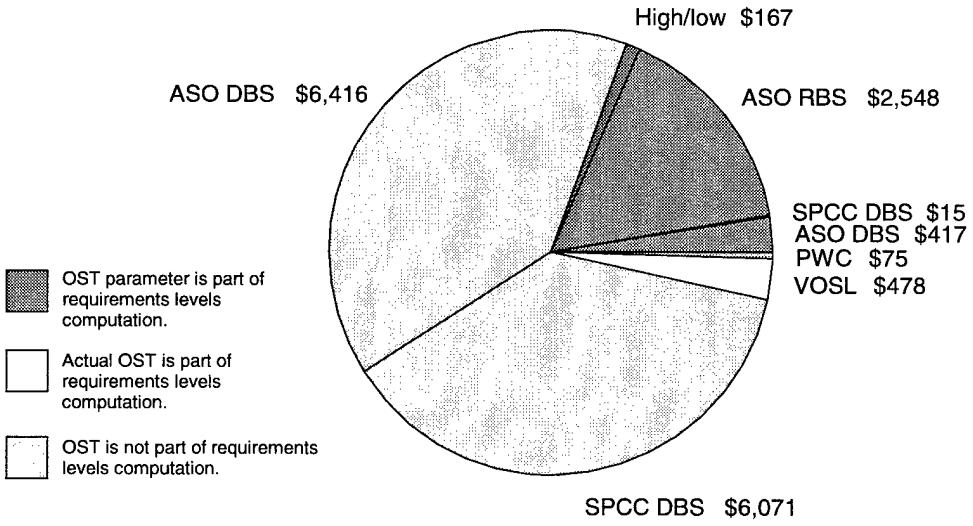
Consolidated Allowance List [AVCAL], we include it in this discussion of retail supply, although the Navy considers it wholesale stock.) The second exception is the allowance lists computed to support shore-based intermediate maintenance. Those lists are based upon an OST parameter of 18 days.

The VOSL algorithm uses an "actual" OST in computing OST levels and safety levels. This actual OST, however, is a smoothed average of observed values within specified minimum and maximum limits. This algorithm embeds OST in a reorder point level that represents either just the OST level or the sum of the OST level and safety level. Except at PWCs that use actual OSTs, the reorder point, or low limit, is based on a parameter setting.

Financial Profile

Figure 2-3 shows Navy retail requirements dollars in FY95 by method of computation and identifies those that OST affects. As previously noted, the demand-based reparable allowance lists that ASO and SPCC prepare have OST parameters set to zero, so they are shown as having no OST component in their computations.

Figure 2-3. Navy Retail Requirements Levels Determination Process and OST ($ million)

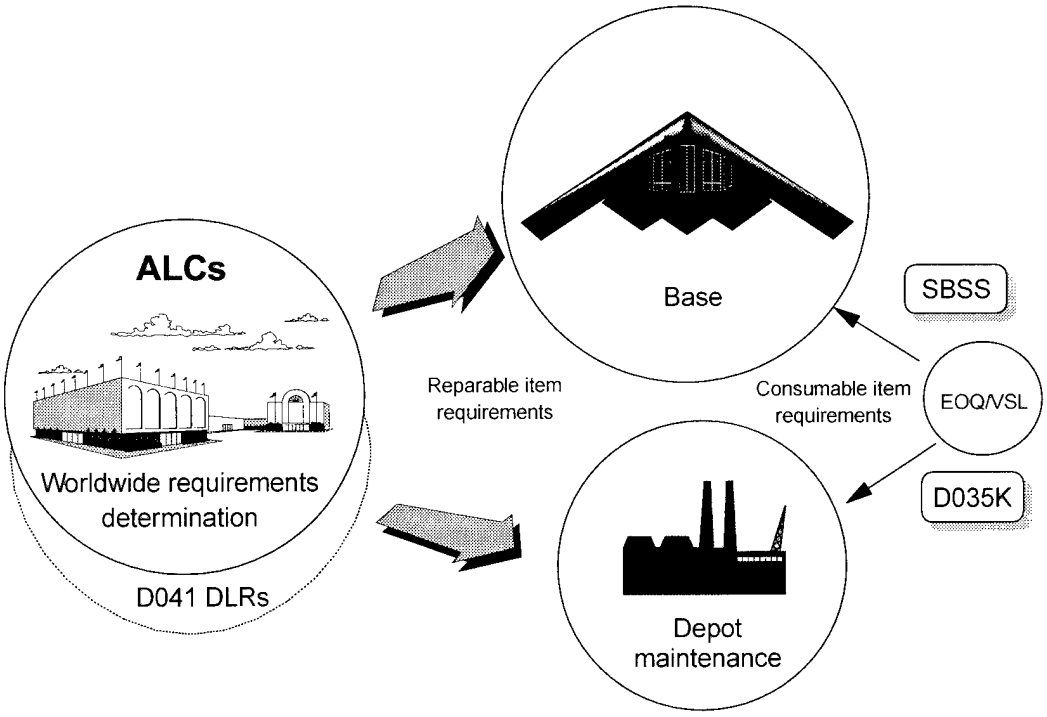


As shown, approximately $3.7 billion of the total $16.2 billion, or 22.9 percent of all Navy retail inventories, consider non-zero OST. The total retail inventory dollars are much larger than the inventory dollars shown in the supply system inventory report (SSIR) because they include inventories deployed on ships.

AIR FORCE RETAIL SUPPLY SYSTEM

An overview of the Air Force retail supply system is provided in Figure 2-4. The worldwide requirements for depot-level reparable (DLR) items are centrally computed. Requirements levels for consumable items are computed locally at Air Force bases (AFBs) and depot maintenance activities. (See Appendix D for a more detailed description of the Air Force's retail supply system).

Figure 2-4. Air Force Retail Supply and Requirements Determination



Note: D035K = Depot Supply Stock Control and Distribution System; D041 = Recoverable Consumption Item Requirements System; EOQ = economic order quantity; SBSS = Standard Base Supply System; VSL = variable safety level.

Types of Retail Supply Activities

The principal Air Force retail supply activities are

- active and reserve AFBs that provide support for Air Force combat and combat support air units, and
- supply divisions at air logistics centers (ALCs) that provide direct support to depot maintenance activities.

Retail Supply Systems

To compute retail levels of supply, the Air Force uses the

- Recoverable Consumption Item Requirements System (D041) to compute the worldwide (wholesale and retail) requirements for DLR items;
- Air Force Recoverable Central Leveling System (D028) to distribute the worldwide requirements to bases (system is not currently in use);
- Standard Base Supply System (SBSS) to compute base requirements for consumable and reparable items (the levels for reparable items are the basis for requisitions but not part of centrally computed worldwide requirements, which have precedence); and
- Depot Supply Stock Control and Distribution System (D035K) to compute requirements supporting depot maintenance at ALCs.

D041, D028, and D035K are actually subsystems of the Air Force's wholesale materiel management system. Therefore, only two systems are involved in the computation of retail requirements levels—SBSS and the wholesale materiel management system.

Methods for Computing Retail Requirements Levels

The Air Force computes its retail requirements levels using

- demand-based sparing algorithms for demand-supported requirements computed by SBSS and D035K, and
- D041's multi-echelon, readiness-based sparing algorithm for DLR items.

These algorithms do not address war reserve levels, insurance stockage, or any special levels negotiated by a base or directed by a major command.

Influence of OST on Computations

Both the SBSS and D035K demand-based algorithms use actual OSTs to compute OST levels and safety levels for all items. To ensure that the averages used are based only on requisitions that are not backordered by the wholesale system, the two systems use filters to delete extended OST observations from the averaging process.

To compute DLR worldwide requirements, the D041 algorithm also uses the actual item OST, but only when sufficient historical observations exist. However, for most items, sufficient observations do not exist, and a default value of 17 days is applied.

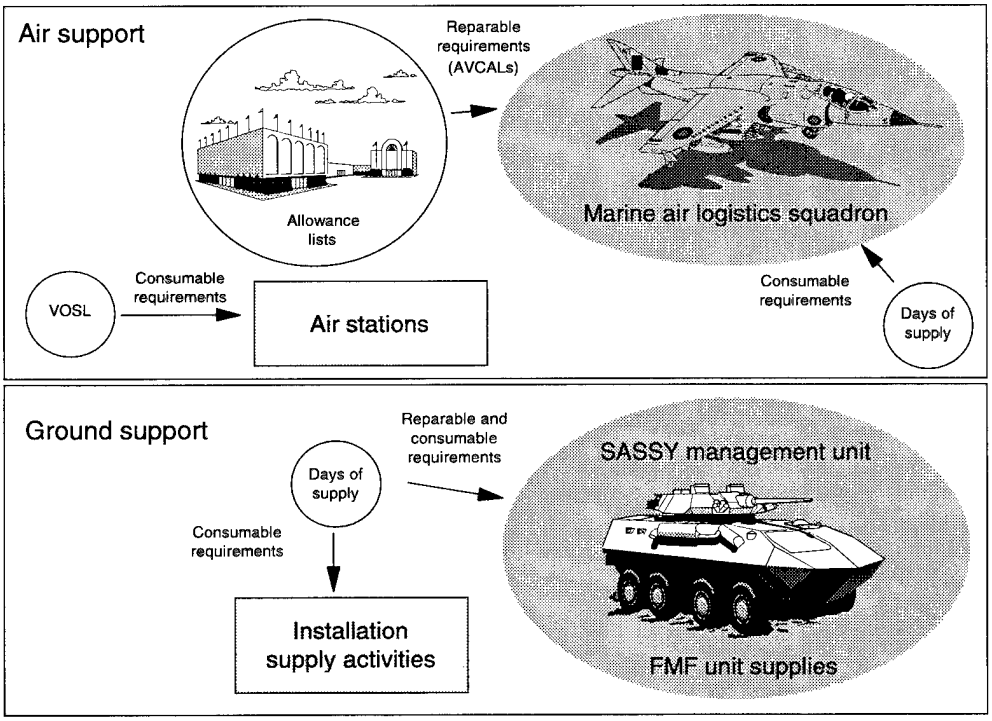
Financial Profile

Except for some investment items, the Air Force uses a revolving stock fund to manage its retail assets. The stock fund is vertical for Air Force-managed items; that is, it covers both wholesale and retail stocks. For items managed by DLA, other military services, and the General Services Administration, the stock fund is horizontal; it covers only retail stocks. Unlike the stocks of other military services, no Air Force retail inventory is O&M funded. The DoD SSIR listed Air Force retail inventories at the end of FY94 at $10.2 billion. Since the SSIR does report on all stock-funded inventories, we used its number as our source for the value of Air Force retail inventory.

MARINE CORPS RETAIL SUPPLY SYSTEM

An overview of the Marine Corps retail supply system is illustrated in Figure 2-5. The Marine Corps uses its retail supply system to support its ground forces and the Navy's supply system for Marine aviation support. Fleet Marine Force (FMF) activities and installation supply activities compute the retail supply levels for reparable and consumable items that the ground forces use. As for supplies that Marine air wings and groups use, ASO computes the levels for reparable items, and, except for initial allowance levels computed at ASO, afloat and ashore retail aviation supply activities compute the levels for consumable items. (See Appendix E for a more detailed description.)

Figure 2-5. Marine Corps Retail Supply System and Requirements Computations



Note: SASSY = Supported Activities Supply System.

Types of Retail Supply Activities

The principal Marine Corps retail supply activities are as follows:

- Marine aviation logistics squadrons (MALSs) provide direct support for Marine air groups (MAGs) afloat or ashore.
- Management units provide intermediate support to Marine expeditionary force (MEF) supply units.
- Direct support stock control (DSSC) activities provide general support at Marine Corps installations that house ground forces.
- Supply departments at depot maintenance activities (DMAs) provide direct support to Marine Corps depot-level maintenance.
- Air stations that are home bases provide direct support to Marine air wings.
- MEF supply units provide direct support to Marine Corps ground forces.

Retail Supply Systems

To compute its retail levels of supply, the Marine Corps uses the

- Navy's UICP system at ASO to prepare allowance lists for MALSs;
- Navy's UADPS at Marine Corps air stations to prepare local demand-based levels for consumable items that tenants use;
- Navy's SUADPS onboard carriers and L class ships to prepare local demand-based levels for consumable items that assigned MAGs use;
- Supported Activities Supply System (SASSY) that SASSY management units (SMUs) use to prepare levels in support of MEF ground supply units;
- Subsystem of the Marine Corps Unified Materiel Management System to compute DSSC levels supporting Marine Corps nonaviation installations; and
- Depot Maintenance Management System to compute levels supporting depot maintenance at the two Marine Corps Logistics Bases.

Methods for Computing Retail Requirements Levels

The Marine Corps computes its retail requirements levels using the

- Navy's demand-based sparing algorithm for aviation allowance lists for MALSs,
- months-of-supply algorithms that produce high and low limits used for afloat demand-supported aviation requirements and ashore demand-supported, nonaviation requirements,
- Navy's VOSL algorithm for demand-supported requirements at air stations, and
- endurance algorithms for MEF supply unit levels.

These algorithms do not address war reserve levels, insurance stockage, or any special level directed by a type commander.

Influence of OST on Computations

ASO currently uses a fixed 17 days for the OST segment of MALS allowance lists.

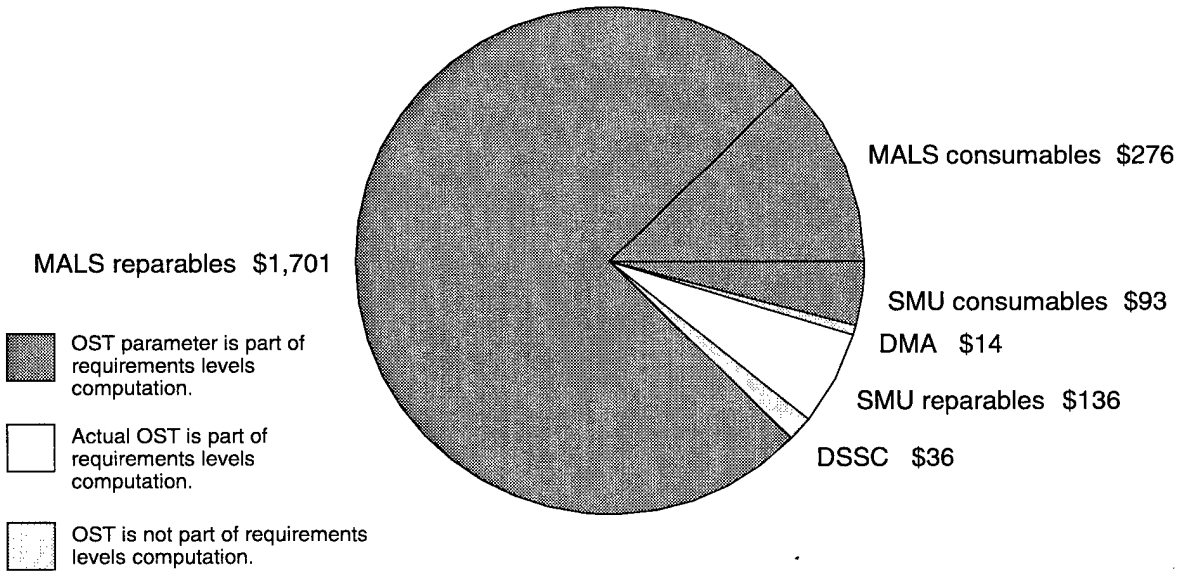
The VOSL algorithm uses an "actual" OST in computing OST levels and safety levels. The actual OST, however, is a smoothed average of observed values within specified minimum and maximum limits. This algorithm embeds OST in a reorder point level that represents either just the OST level or the sum of the OST level and safety level. The OSTs incorporated into reorder point settings follow:

- For SMU stocks, they are as follows:
  - Consumable items have a 2-month reorder point setting, with 45 days attributed to OST.
  - Reparable items use actual OSTs for the failures that are not repaired locally.
  - Newly provisioned items use an estimated OST.
- For DSSC stocks, OSTs are computed as an average of observations over a 12-month period.
- For SUADPS stocks, type commanders assign OSTs as parameters.

Financial Profile

Figure 2-6 shows the Marine Corps inventory dollars that OST affects by retail activity. (The Marine Corps provided the SMU, DSSC, and DMA data, and ASO provided the MALS reparable data.) MALS consumable statistics were computed using a ratio of consumable-to-reparable dollars derived from data provided during a site visit to a MAG. Data on Marine Corps air station inventories are not shown because they were included in the data provided for several Navy retail activities, and the dollar value of any OST reduction is part of the Navy analysis. While the data on FMF unit supplies are not readily available and not included in the $2.3 billion shown in Figure 2-6, they also are not influenced by wholesale-related OST.

Figure 2-6. Marine Corps Retail Requirements Levels Determination Process and OST ($ million)



FINDINGS AND CONCLUSIONS

In this chapter and in Appendixes B, C, D, and E, we present the results of our review of the retail supply activities of the military services. Table 2-1 summarizes our results.

Unlike the DoD wholesale level of supply, in which inventory control points are the single type of activity involved in materiel management, we found over 30 different types of activities at the retail level of supply. That number is large because we counted similar activities—such as retail activities supporting depot-level maintenance in each military service as well as Air Force bases, Naval air stations, and Marine Corps air stations—as separate activities. However, even if we

account for such similarities, the number is large because retail supply is less generic than wholesale supply, and retail activities are more tailored to the specific operations they support.

Almost 20 different materiel management systems are involved in the computation of retail requirements levels. Three of these systems are normally associated with wholesale materiel management but also produce centralized retail levels computations. Except for the Air Force, which has a single materiel management system at all of its bases, each military service has a program to modernize and standardize its retail systems.

Table 2-1. Review of Department of Defense Retail Supply Activities

Area of review	Army	Navy	Air Force	Marine Corps	Total
Number of different types of retail supply activities	10	14	2	6	32
Number of materiel management systems involved in computing requirements levels	6	8	2	6	19[a]
Methods for computing requirements levels	DOS and DBS	DOS, DBS and RBS	RBS and DBS	DOS and DBS	DOS, DBS and RBS
Total dollar value of retail requirements ($ million)	2,715	16,187	10,237	2,254	31,393
Total dollar value of retail requirements for those activities influenced by wholesale-to-retail OST ($ million)	2,087	3,700	10,237	2,240	18,264

Note: DOS = days of supply.

[a]The total is smaller than the sum since the Marine Corps uses three Navy systems.

The methods used to compute retail requirements range from simplistic days-of-supply (DOS) rules to highly complex RBS algorithms. DOS rules are normally used at the lowest levels of supply. On the other hand, RBS algorithms are normally centrally applied and the results given to the retail level for implementation.

DOS, DBS, and RBS are generic classifications for methods to determine requirements levels. Therefore, although all military services use DBS algorithms and more than one service uses DOS and RBS algorithms, the actual formulas differ across the military services and within a service. (See Appendixes B, C, D, and E for a more thorough description of the formulas used by the Army, Navy, Air Force, and Marine Corps, respectively.)

As shown in Table 2-1, we reviewed retail inventories that had requirements levels we estimated conservatively at more than $31 billion. We found that wholesale-related OST only influences 58 percent of these dollars because

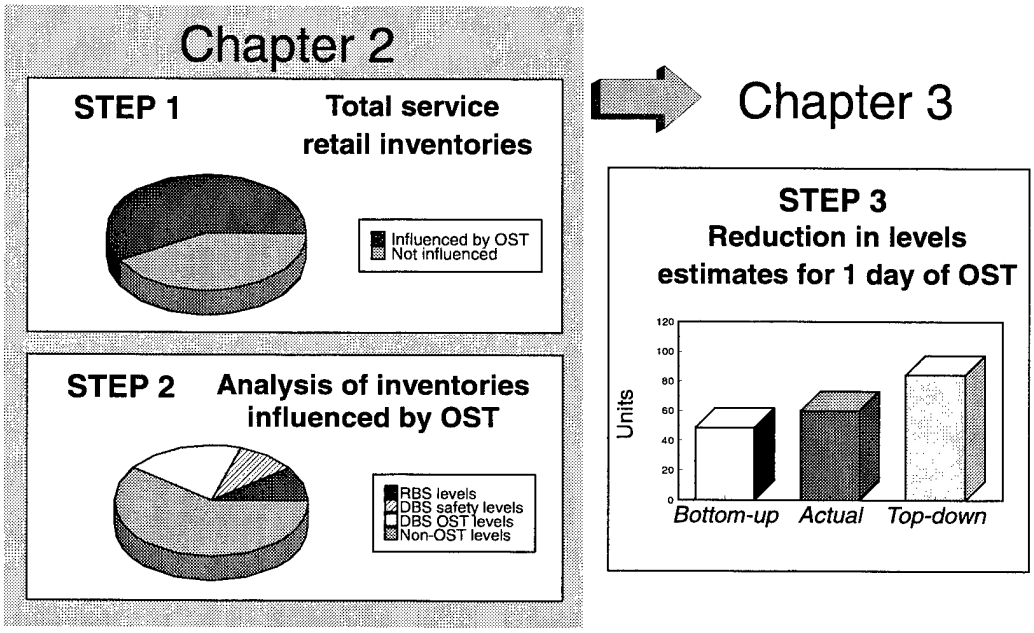
- OSTs for Army consumer levels of supply represent the replenishment times between retail levels of supply, not between the wholesale and retail levels of supply, and
- the Navy assigns zero to the OST parameter used in computing retail levels for most of its reparable items.

In saying that OST influences particular inventories, we do not mean that OST affects all of the items or all of the item requirements levels associated with those inventories. In the next chapter, we examine the specific requirements levels that OST affects to determine the value of reduced OSTs in terms of reduced requirements levels.

Chapter 3
Retail Inventories and Reduced Order and Shipping Times

In Chapter 2, we looked at which military service retail inventories are related to OST. As shown in Figure 3-1, in this chapter, we follow up on that analysis by looking at how reducing OST affects the computations of retail requirements levels in those inventories. As part of our analysis, we estimate the dollar impact on requirements levels of reducing OST by 1 day. At the end of the chapter, we review how an OST reduction translates to a reduction in levels.

Figure 3-1. Focus of Chapter 3



In developing our estimated values for 1 day of OST, we did the following:

- Except for cases involving readiness-based algorithms, we developed all of the estimates using the requirements level setting rules and data that we collected from the military services. As for readiness-based algorithms, the complexity of reproducing them and the difficulty of obtaining the data required for their execution caused us to rely on estimates from studies performed by the services.

- We prepared estimates for a range of OST reductions (normally, 1 day, 2 days, and 10 days). If the estimates were proportional, we used a straight average as our estimated value. If they were not proportional, we used either a weighted average or just selected the 2-day estimate.

- If the inventory dollars provided to us were not identified specifically for consumable or reparable items, we assumed a 25/75 percent split, respectively.[1]

- The estimates we developed used March 1995 data because they were the latest available data when this part of our analysis was originally done.

How a Reduction in OST Affects Retail Inventories

OST should affect what retail supply activities stock and how much they stock. For example, under DLA's prime vendor program for medical supplies, DLA was able to contract for 24-hour delivery of medical supplies from major vendors. The result was that DLA was able to eliminate its wholesale operating stocks for the items in the program, and retail activities supporting military hospitals were also able to eliminate their stocks.

However, the prime vendor program is based on an extreme reduction in OST. A less extreme reduction (e.g., a 15-day reduction in a 30-day OST) would affect depth of stock and, to a much lesser extent, the range of items stocked.

OST and Range of Retail Stock

OST is not a major factor in determining the range of retail-stocked items for the following reasons:

- Except for consumable items at selected Navy shore sites and all items at Air Force activities, demand-based hit rules and not OST govern the range of items stocked; that is, an item is stocked if it experiences a specified number of demands in a given period of time, regardless of OST.

- For consumable items, selected Navy shore sites apply an economic range model that considers the time difference between a retail issue and a wholesale issue, a difference that would be impacted by an OST reduction. However, model parameters that control range, workload, and investment can be adjusted to limit inventory without any change to OST or to maintain inventory when OSTs are reduced.

[1] The 25/75 split was taken from service stratification analyses. In FY94, the inventory dollars were split between 70.6 percent for reparable items and 29.4 percent for consumable items. However, fuel was included in the consumable dollars, making the split higher for consumable items.

- The Air Force worldwide computation for DLRs is a multi-echelon model that considers OST, but for the majority of DLRs, it uses an OST standard parameter rather than actual, variable OST. The Navy also uses a parameter in its readiness-based computations of retail allowance lists.

- For consumable items at AFBs, the SBSS uses a cost model that includes OST in developing shortage costs. To develop these costs, the model looks at the product of the item's demand frequency, a shortage cost parameter, and the ratio of the average OST for the item's source of supply (in years) and the average OST from the base (in years). Given this formulation and the presence of other costs in the model, any results from the model should not be highly sensitive to minor changes in OST. Moreover, SBSS range criteria also include urgency-of-need and price (and not OST) rules that limit the application of the cost model.

- Regardless of whether they consider OST, retail range criteria are used to decide if an item should be stocked demand-based or not stocked. Even if they designate that certain items should not be stocked, retail managers or other people and organizations with the authority (e.g., a major command) can override such decisions by stocking the items as non-demand-based.

Consequently, in quantifying the impacts of reducing OST on requirements levels, we concentrated on depth-of-stock impacts and not range-of-stock impacts.

OST and Depth of Retail Stock

Depth of stock is defined in terms of the size of requirements levels. However, as noted in Chapter 2, not all retail requirements levels have OST as part of their computations. One set of levels that has OST in its computations is the readiness-based levels for weapon system items. The objective of the RBS models that compute these levels is to minimize the time that weapon systems are nonoperational. Since OST affects that time, it is included in all of the models.

Another set of computations that consider OST is the demand-based algorithms for the OST levels and for some safety levels. As noted in Chapter 1, OST is the retail replenishment or resupply lead-time. To satisfy demand during that replenishment lead-time, retail activities maintain the OST level and compute it as the product of OST and demand.[2] Consequently, OST levels change in direct proportion to changes in OST.

In addition to OST levels, some retail supply activities construct a variable safety level that considers OST. Other activities use fixed safety levels that will not vary as OST is changed, while still other activities have variable safety levels that do not depend on OST. In cases where variable safety levels depend on OST, changes

[2] For example, if OST is 20 days and demand is 15 units per month or 0.5 unit per day, the OST level is 10 units.

to the levels due to reduced OSTs are relatively flat when OSTs are large. When reductions drive OSTs close to zero, safety level changes increase at an expanding rate. Since current OSTs are not close to zero, the impact on safety levels is close to linear.

In summary, unless OST is reduced to near zero, the principal impact of an OST reduction is to reduce the depth of readiness-based levels and the depth of demand-based OST and safety levels. In the analysis that follows, we focus on these levels to quantify the impact of a 1-day reduction in OST.

THE IMPACT OF A 1-DAY REDUCTION IN OST ON RETAIL REQUIREMENTS LEVELS

Our original objective in reviewing the military services' retail supply activities was to establish a basis for calculating the exact value of a 1-day reduction in OST in terms of reduced retail requirements levels. However, we were not able to calculate an exact value because all of the required data are not readily available, and the data that are available are subject to continuing changes from the normal recomputations of levels. As an acceptable alternative, we elected to estimate the actual value by using the information we were able to collect to develop a range of values that would bracket the actual value.

To calculate the lower bound on our range, we used the results of our review. Specifically, we computed an estimate for each requirements level that OST affects and summed the individual estimates to arrive at our final estimate. The resulting bottom-up estimate is quite conservative because we only cite dollars we could quantify with a reasonably sound approach. Consequently, the actual value of 1 day of OST would be higher than this estimate.

For an upper bound on our range, we used the value of 1 day of wholesale recurring demand as a top-down estimate of 1 day of OST. Since some wholesale recurring demand does not go into the services' retail requirements determination processes, this estimate would be higher than the actual value.

Development of the Bottom-Up Estimate

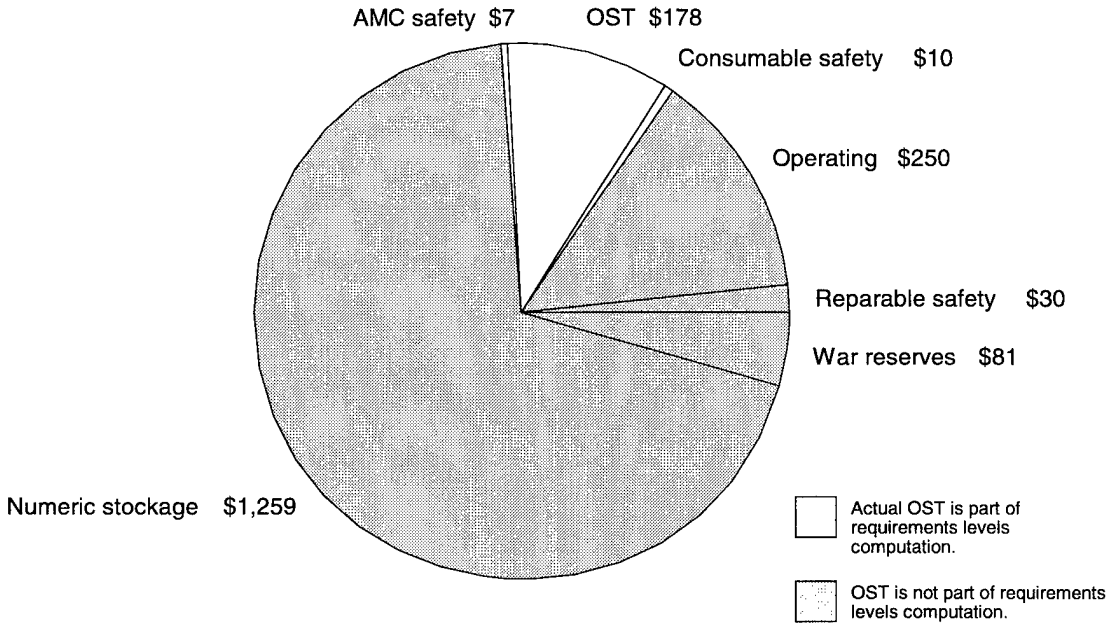
BOTTOM-UP ESTIMATE FOR THE ARMY

Installation and regional supply support activities and theater, corps, and division MMCs are all Army intermediate retail activities that routinely requisition directly from the DoD wholesale system. All of these activities, both DBOF and O&M funded, use actual OST to compute levels and are part of our Army bottom-up estimate. Units and maintenance shops are consumer retail activities that do not requisition directly from the wholesale system and, consequently, are not part of our estimate.

Army DBOF Retail Intermediate Activities and OST

Figure 3-2 shows the dollar value of requirements levels for Army DBOF intermediate retail activities (as taken from March 1995 Army retail stratification reports). It also identifies the levels affected by OST. As illustrated, OST affects only the OST level and certain safety levels, which combined account for approximately 11 percent of the total $1,815 million requirement.

Figure 3-2. Army Intermediate Retail Requirements Levels ($ million)



Based on the dollar value of retail recurring demands per day (taken from the same stratification reports), 1 day of OST is equal to $4.5 million in OST level, and that relationship is linear (i.e., the value of 10 days of OST is equal to 10 times $4.5 million, or $45 million).

For AMC activities, item safety level computations include OST. The same safety level formula is also used for consumable items by other activities that use SAILS. Although OST can be found in several places in that formula, the dormant relationship between OST and safety level is that the safety level is proportional to the square root of the OST. We can use that relationship to estimate the value of 1 day of OST in safety level.

Specifically, if the safety level is proportional to the square root of OST and if we reduce OST by 1 day, then the following development defines the relationship between the original reported safety level and the new reduced safety level:

Since

$$SL = \alpha\sqrt{OST} \text{ and } SL_{reduced} = \alpha\sqrt{OST - 1},$$

then

$$\frac{SL}{\sqrt{OST}} = \alpha = \frac{SL_{reduced}}{\sqrt{OST - 1}}$$

or

$$SL_{reduced} = \frac{SL\left(\sqrt{OST - 1}\right)}{\sqrt{OST}},$$

where

SL = dollar value of reported safety level,

OST = computed OST (i.e., OST level divided by 1 day's demand),

$SL_{reduced}$ = dollar value of safety level with OST reduced 1 day, and

α = proportional constant.

We can use this relationship to further define the difference between the original safety level and the reduce safety level, thereby defining the value of 1 day of OST in safety level:

$$SLD = SL - SL_{reduced} = SL - \frac{SL\left(\sqrt{OST - 1}\right)}{\sqrt{OST}},$$

where

SLD = value of 1 day of OST in safety level.

Although this approach is more appropriately used at an item level, we applied it at the major command level to estimate the value of a 1-day reduction in OST for safety level requirements.

For AMC activities, we estimate that a 1-day reduction equates to $0.04 million for 1 day and $0.41 million for 10 days. (Because of the square root, the relationship between SLD and OST is not linear, but it is close to linear in the cited

range.) Since some non-AMC activities are not using SAILS, we could not obtain a point estimate for SAILS activities. However, the range of possible estimates for 1 day of OST is from $0 (no activities under SAILS) to $0.13 million (all activities under SAILS). For 10 days of OST, the range would be between $0 and $1.41 million.

(Note: This approach yields only a macro-level estimate for both AMC and non-AMC activities. A more exact approach would use the same relationship but for individual items.)

Army O&M Retail Intermediate Activities and OST

As noted in Chapter 2, we were unable to obtain Army-wide retail requirements data for the 35 O&M-funded ASLs and had to extrapolate to arrive at an estimate of $272 million for their total value. To estimate the value of 1 day of OST for these ASLs, we used the same ratio of demand to requirement as we had for DBOF ASLs. The resulting value is $0.7 million for 1 day of OST.

Army Summary

Table 3-1 provides a summary of our results for the Army. It shows that the maximum value of 1 day of OST is $5.37 million.

Table 3-1. Army Requirements Levels and the Value of 1 Day of OST

Requirements level	OST	Value ($ million)	Funding	Secondary item type
DBOF ASL OST levels	Actual	4.50	DBOF	Reparable and consumable
DBOF ASL safety levels for AMC activities	Actual	0.04	DBOF	Reparable and consumable
DBOF ASL consumable item safety levels for non-AMC activities	Actual	Up to 0.13	DBOF	Consumable
O&M ASL OST levels	Actual	0.70	O&M	Reparable and consumable
Total Army bottom-up estimate		5.37	—	

BOTTOM-UP ESTIMATE FOR THE NAVY

As stated in Chapter 2, the requirements levels computations in which the Navy includes OST are

- readiness-based sparing for reparable items in selective aircraft and equipment allowance lists,

- VOSL for consumable items at ashore sites,
- selective demand-based sparing performed by ASO and SPCC, and
- high and low limits for consumable items at both afloat and ashore sites.

Navy RBS and OST

OST is a parameter in the RBS algorithms used to build allowance quantities that go into AVCALs and coordinated shipboard allowance lists. Given the complexity of these algorithms, the impact of reducing OST can only be assessed by actually executing the models with different parameter settings (which we were not able to do). Although no definitive AVCAL study is available on this subject, ASO studies suggest that 1 day of OST equates to approximately $3 to $4 million in requirements.

While ASO uses RBS for a portion of its inventory (namely, carrier AVCALs and LAMPS), SPCC continues to compute demand-based allowance quantities, but for selective items on specific equipment, it uses readiness-based rather than demand-based quantities. However, data on how allowance quantities are computed are only maintained at the ship level and not summarized Navy-wide. Therefore, no method currently exists to determine the dollar value of SPCC readiness-based allowance quantities or the impact on those quantities of reducing OST.

Navy VOSL and OST

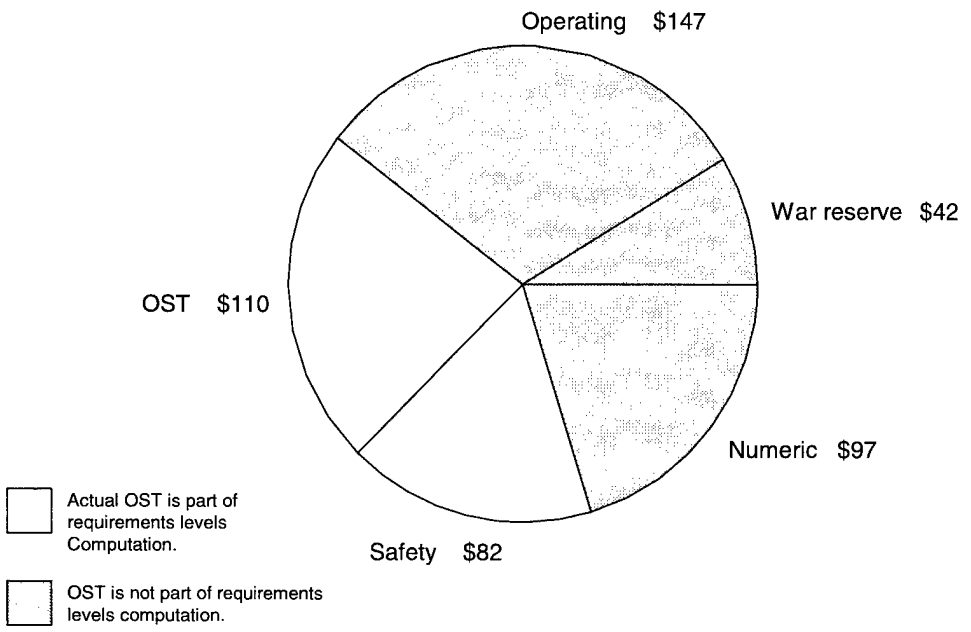
Figure 3-3 displays the dollar value of requirements levels for Navy retail VOSL activities and indicates the levels that OST affects. The source of this data was the Navy retail stratification report prepared by SPCC.

As illustrated in Figure 3-2, OST affects only the OST level and safety level for consumable items, or approximately 36 percent of the total $478 million requirement.

Based on the dollar value of monthly demand (from SPCC's retail lead-time report), 1 day of OST is equal to $2.1 million in OST level, and that relationship is linear, i.e., the value of 10 days of OST is equal to $20.6 million. The computed average OST is 31.6 days.

For VOSL activities, item safety level computations include OST. As was the case with Army activities using OST in their safety level computations, the predominant role for OST in the VOSL is in the form of its square root. Using the same approach as that for the Army, we estimate that 1 day of OST is equal to $0.8 million (again, the relationship is approximately linear).

Figure 3-3. VOSL Requirements Levels and OST
($ million)



ASO and SPCC Demand-Based Computations and OST

The Navy generally assigns a zero-value OST parameter for its demand-based allowance computations, except for the Yokosuka Super AVCAL and shore-based intermediate maintenance stock lists (SIMSLs).

Like all demand-based AVCAL computations, the Yokosuka AVCAL consists of a rotatable pool quantity and an attrition quantity; both are enhanced with safety stock to achieve an expected demand fill rate of 85 percent. The attrition quantity is the sum of an endurance period of 60 days and an OST of 30 days. Our methodology for quantifying the impact of reducing OST in this situation is somewhat complex (see Appendix C), but we estimate it has a value of $1.3 million per day of OST.

The SPCC allowance for shore-based intermediate maintenance activities is for consumable items and is based solely on OST. That is, the SIMSL demand-based allowance computation has no repair cycle quantity and an attrition quantity based on an endurance period of zero and an OST of 18 days. However, the final SIMSL allowance quantity provides for a safety level designed to achieve an 85 percent demand fill rate over the OST and could be greater or less than an 18-day OST level. Since the allowance algorithm is similar to that used for the Yokosuka AVCAL, except for parameter values, we used a similar technique to arrive at a SIMSL dollar value of $0.3 million per day of OST.

Navy High and Low Limit Activities and OST

For activities that use high and low limits, such as Navy hospitals and demand-supported shipboard stock, the low limit is a days-of-supply computation covering OST and safety level. Generally, the number of days is set through OST and safety level parameters. A reduction of 1 day for either would reduce the overall limit by 1 day, which is equivalent to 1 day of demand. Using data on the dollar value of the demand for these activities, we estimate that 1 day of OST is valued at $1.9 million.

Navy Summary

Table 3-2 summarizes the relationships between OST and Navy retail requirements levels that OST affects. It shows that the Navy-wide total for 1 day of OST is between $9.4 million and $10.4 million.

Table 3-2. Navy Requirements Levels and the Value of 1 Day of OST

Requirements level	OST	Value ($ million)	Funding	Secondary item type
RBS AVCALs	Parameter (25 days)	3.0 to 4.0	O&M	Reparable
VOSL activities OST levels	Actual	2.1	DBOF	Consumable
VOSL activities safety levels	Actual	0.8	DBOF	Consumable
Yokosuka AVCAL	Parameter (30 days)	1.3	DBOF	Reparable and consumable
SIMSLs	Parameter (18 days)	0.3	DBOF	Consumable
High/low	Parameter (varies)	1.9	DBOF and O&M	Consumable
Total Navy bottom-up estimate		9.4 to 10.4	—	

BOTTOM-UP ESTIMATE FOR THE AIR FORCE

To estimate the value of 1 day of OST in the Air Force, we divided our analysis between the centralized computations of worldwide requirements for DLRs and the base-level computations of retail requirements for field-level reparables (FLRs) and consumable items. (See Appendix D for a detailed description of all computations.)

Air Force DLR Worldwide Requirements Computation and OST

As noted in Chapter 2, the Air Force uses an RBS model to compute worldwide requirements for DLRs.[3] In that model, an item's OST affects both wholesale and retail stock levels, specifically, its wholesale safety level, retail safety level, and retail OST level. In 1994, the Air Force used its model to examine the impact of reducing OST.[4] According to that examination, reducing OST to 15 days lowered worldwide requirements levels by $49.7 million, while reducing OST to 9 days lowered requirements levels by $254.2 million. If we assume a baseline of 17 days (i.e., the Air Force OST default value), then the $49.7 million estimate represents a 2-day reduction, or an average value of $24.9 million per day. The $254.2 million estimate represents an 8-day reduction, or an average value of $31.8 million per day.

These results demonstrate that, for Air Force DLRs, the effects of reducing OST are nonlinear. For the other services, the results are either linear or nearly linear. The difference for the Air Force is that its OSTs are smaller and DLR requirements levels are targeted at readiness.

To develop a point estimate for the value of 1 day of OST for Air Force DLRs, we selected the $24.9 million from the 2-day reduction because it represents the likely range of an OST reduction. The 31 March 1995 *Air Force Central Secondary Item Stratification (CSIS) Report* shows $409.7 million for the base OST level against a standard of 17 days. Dividing $409.7 million by 17 days yields $24.1 million per day, so we conclude that $24.1 of the $24.9 million is due to a reduced OST level, while the remaining $0.8 million, or 3.2 percent, is due to reduced wholesale and retail safety levels. We believe that $0.8 million is a conservative estimate if the reductions are greater than 2 days (e.g., the estimate for an 8-day reduction would be approximately $7.7 million per day).

All of the estimates for Air Force DLRs are based on data that use forecasted acquisition cost versus standard price.

Air Force Consumable and FLR Item Computations and OST

Figure 3-4 displays the dollar value of consumable item requirements levels by reason-for-stockage codes for Air Force retail base supply activities and indicates the levels that OST affects. As the figure shows, only the stock demand requirements levels, which account for 56.5 percent of the total, are affected by an OST reduction.

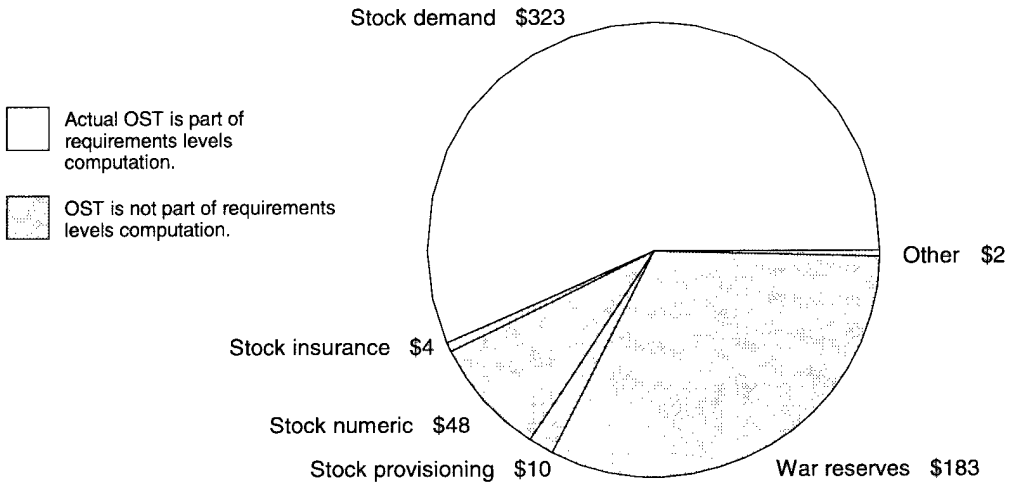
Figure 3-5 displays the dollar value of FLR requirements levels by reason-for-stockage codes for Air Force retail base supply activities and identifies the levels

[3] The Aircraft Availability Model.

[4] In Chapter 4, we use results from the same analysis to look at the impact of reducing OST on buy and repair funding requirements and on long supply.

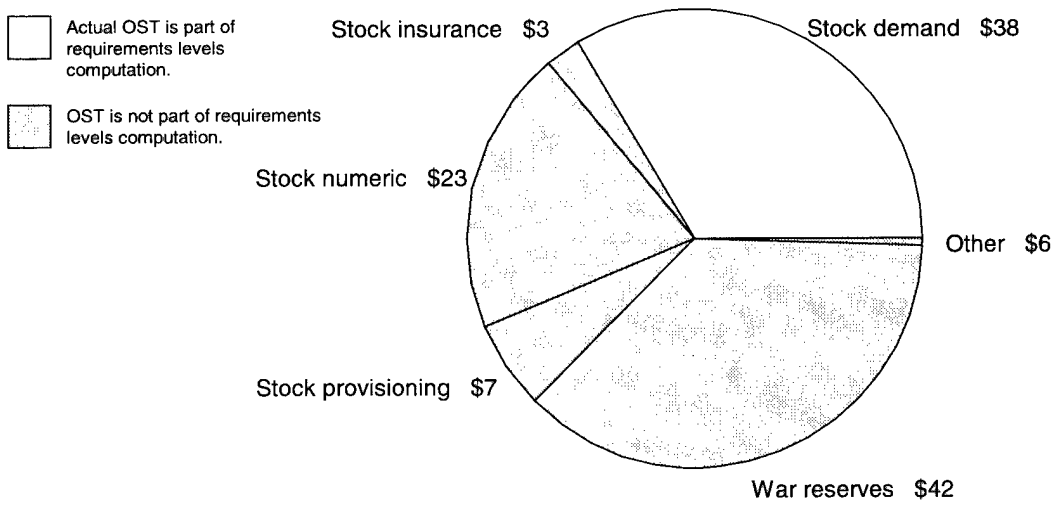
that OST affects. (The Air Force Logistics Management Agency also provided these data, dated March 1995.) Only the stock demand requirements levels, which account for approximately 33.5 percent of the total, are affected by an OST reduction.

Figure 3-4. Air Force Consumable Retail Requirements Levels and OST ($ million)



The Air Force also conducted an analysis of the impact on demand levels if OSTs were reduced. Drawing from the results of that analysis, we estimate a 1.11 percent reduction per day for CONUS sites and a 0.58 percent reduction for OCONUS sites.[5] Applying these percentages to our dollar estimates, we arrive at approximately $3.73 million as the value of 1 day of OST.

Figure 3-5. Air Force FLR Retail Requirements Levels and OST ($ million)



[5] See Appendix D for more information on the Air Force analysis.

Air Force Summary

Table 3-3 summarizes the relationships between OST and the Air Force retail requirements levels that OST affects. The total 1-day value is estimated at $28.6 million.

Table 3-3. Air Force Retail Requirements Levels and the Value of 1 Day of OST

Requirements level	OST	Value ($ million)	Funding	Secondary item type
Worldwide computation	Parameter (17 days) and actual	24.9	DBOF	Reparable
Consumable and FLR demand levels	Actual	3.7	DBOF	Consumable and reparable
Total Air Force bottom-up estimate		28.6	—	

BOTTOM-UP ESTIMATE FOR THE MARINE CORPS

To estimate the value of 1 day of OST for the Marine Corps, we examined the computation of reparable AVCALs for the MALSs, reparable and consumable item requirements computations in the SMUs, and DSSC requirements computations. (See Appendix E for a detailed description of all computations.)

MALS Reparable AVCALs and OST

The allowance quantity for a reparable item in a MALS AVCAL is subdivided into the following categories:

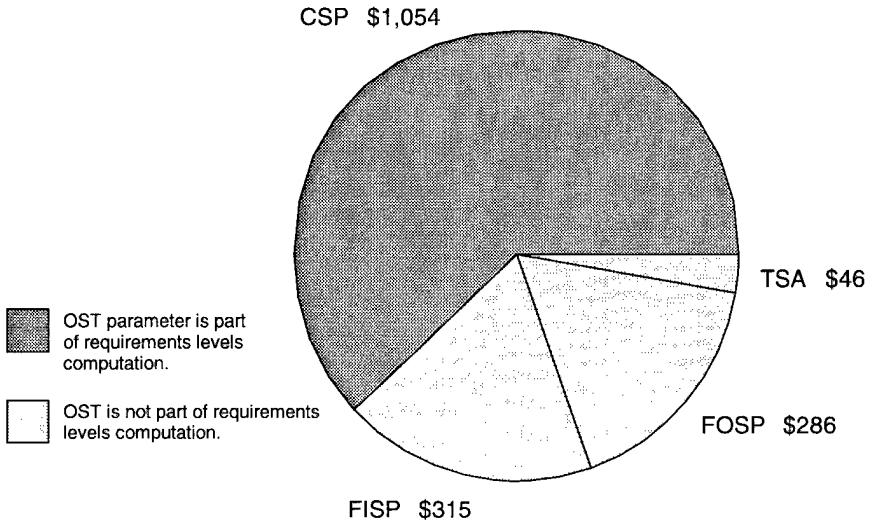
- Contingency Support Package (CSP)
- Fly In Support Package (FISP)
- Training Squadron Allowance (TSA)
- Follow On Support Package (FOSP).

Figure 3-6 shows how the reparable dollars in the MALS AVCALs are divided between the four categories. As shown in the figure, OST is only considered in the preparation of the CSP.

The CSP can be subdivided into a rotatable pool or repair quantity, an attrition quantity, and a safety level quantity. The rotatable pool quantity does not consider OST because it supports the repair pipeline, so it is based on local repair cycle time rather than OST. The attrition quantity includes an OST that is fixed at 17 days and an endurance period set at 90 days. The safety level indirectly

considers OST because it is based on the sum of the rotatable pool and attrition quantities.

Figure 3-6. MALS Reparable AVCALs and OST ($ millions)



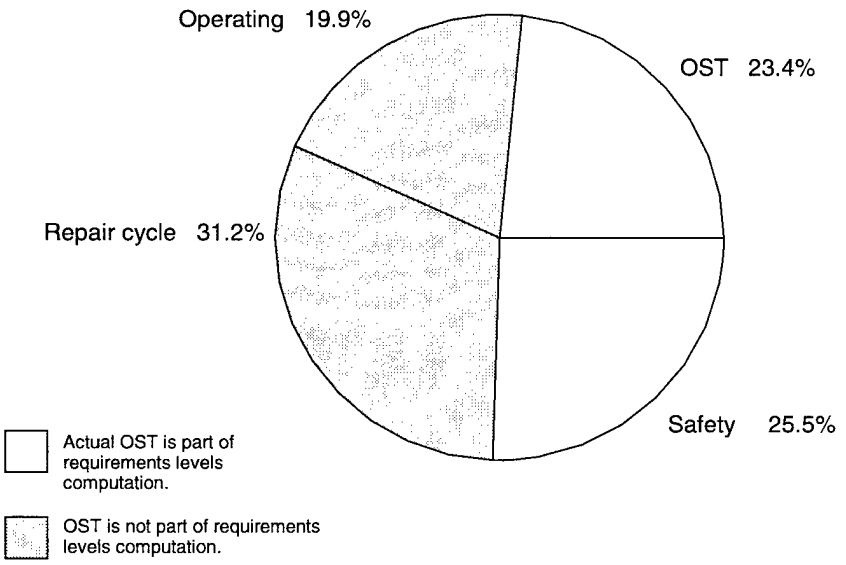
To determine the value of 1 day of OST, we applied the same technique as we did with the Yokosuka AVCAL and Navy SIMSLs. (The key factors were the 90-day attrition, the 17-day OST, an average repair cycle time of 5.02 days, and a rate of 14.66 percent for beyond-capability-of-maintenance, with the latter two taken from the results of an analysis of MALS 29 data.) We estimate that the value of 1 day of OST is $1.8 million.

Marine Corps SMU Reparable Item Computations and OST

A reduction in OST affects both OST and safety levels for reparable items in an SMU reparable issue point (RIP). Item data from Camp Lejeune's SMU provide a detailed breakdown of RIP requirements levels. Figure 3-7 shows how SMU demand-based reparable requisitioning objectives are divided among repair cycle level, operating level, OST level, and safety level.[6] Using this data, we estimate that the changes in OST and safety levels if OSTs were reduced 1 day would be 0.6 percent and 0.4 percent, respectively. We applied these changes across all SMUs to arrive at corresponding reductions of $1.2 million in OST levels and $0.7 million in safety levels.

[6] We omitted special levels (i.e., fixed levels) from our analysis because they are not demand-based or related to OST.

Figure 3-7. SMU Reparable Requirements Levels and OST



Marine Corps SMU Consumable Item Computations and OST

SMUs manage both non-demand-based and demand-based items. The stockage quantity for non-demand-based items has no OST component, while the stockage quantity for demand-based consumable items is the sum of an operating level, a safety level, and an OST level. To estimate the value of 1 day of OST, we divided the demand-based requirements by their respective days of operating level, safety level, and OST level. Since the value of 1 day of demand is the same as the value of 1 day of OST, we estimate the value of 1 day of OST at $0.5 million.

Marine Corps DSSC Computations and OST

DSSCs manage demand-based consumable items. To estimate the value of 1 day of OST at the DSSCs, we used the same technique as we used for the SMU consumable items, which yielded $0.2 million per day.

Marine Corps Summary

Table 3-4 summarizes the relationships between OST and the Marine Corps retail requirements levels that OST affects. The total value of 1 day of OST is approximately $4.4 million.

Table 3-4. Marine Corps Retail Requirements Levels and the Value of 1 Day of OST

Requirements level	OST	Value ($ million)	Funding	Secondary item type
MALS AVCALs	Parameter (17 days)	1.8	O&M	Reparable
SMU OST level	Actual	1.2	O&M	Reparable
SMU safety level	Actual	0.7	O&M	Reparable
SMU OST level (consumable)	Parameter	0.5	O&M	Consumable
DSSC OST level	Actual	0.2	DBOF	Consumable
Total Marine Corps bottom-up estimate		4.4	—	

FINAL BOTTOM-UP ESTIMATE

Table 3-5 summarizes the impact of OST reduction on the retail requirements levels of the military services presented in Tables 3-1 through 3-4.

Table 3-5. Dollar Value of 1 Day of OST Based on Military Service Retail Requirements Levels

Military service	Value ($ million)
Army	5.4
Navy	10.4
Air Force	28.6
Marine Corps	4.4
Total bottom-up estimate	48.8

The value of $48.8 million per day heavily depends on the following:

- Because the estimate is built on the major retail activities in the military services, some retail activities were probably excluded.
- The portion of the estimate dealing with Air Force DLRs is based on forecasted acquisition price data; the other military service estimates are based on standard price data.
- The individual military service estimates are based on several assumptions and on average population values that may be incorrect if individual items were considered.

- In instances where the military service is using fixed days of supply to set safety levels, a reduction in OST may cause the service to make a policy change in the number of days; our estimates do not consider any such policy changes.

Development of the Top-Down Estimate

To estimate the top-down value of 1 day of OST, we looked at demand placed on the wholesale level of supply. The problem with this approach is that, besides the replenishment demand in which we are interested, wholesale demand also includes non-Defense demand and nonreplenishment demand as well as replenishment demand for items that do not have levels influenced by OST (e.g., demand for insurance items).

Non-Defense demand is demand from other federal agencies, foreign allies, and contractors involved in Defense manufacturing or repair. Nonreplenishment demand is demand for items that are not stocked at the retail level or demand that is associated with special projects (e.g., a maintenance overhaul program) or with a need that cannot be filled at the retail level due to an out-of-stock condition.[7] Although wholesale response time is important to the customers placing either of these types of demand, it is not used to compute a DoD retail requirements level. Therefore, to develop our estimate, we wanted to exclude such demand and had to try to identify what portion of total wholesale demand was solely for replenishment of DoD retail levels influenced by OST.

Unfortunately, available data on wholesale demand do not provide for this type of breakout. However, data are available that break out wholesale demand between recurring and nonrecurring demand. By definition, replenishment demand is recurring demand, although not all recurring demand is replenishment demand. Since this breakout was the only one available, we opted to use recurring demand as a surrogate for replenishment demand.

Specifically, we summed the forecasted recurring demands from March 1995 stratification reports. We then compared the dollar value of 1 day of demand for the last 6 months of 1995 and for all of 1996. As shown in Table 3-6, the results were almost identical.

[7] If any such nonreplenishment demand is operationally critical, it is assigned a high priority and is processed through the wholesale level as rapidly as possible.

Table 3-6. Dollar Value of 1 Day of OST Based on Wholesale Demand

Wholesale component	Dollar value of 1 day of recurring demand ($ million)	
	Half of 1995	1996 projected
Army	7.7	8.1
Navy	26.4	25.9
Air Force	41.2	41.4
DLA	8.8	8.8
Total	84.1	84.2

This estimate has two primary qualifications:

- DLA's data and the DLR portion of the Air Force's total are based on acquisition cost data rather than standard price data; the bottom-up estimate of the DLR portion was also based on acquisition cost.
- Recurring demands include more than replenishment demands for items that have OST as part of their requirements levels; they also include demands for items with levels that are unrelated to OST, thus causing the estimate to be greater than the actual value of 1 day of OST requirements levels.

These two sets of estimates suggest that the total value of each day of reduced OST is between $48.8 million and $84.2 million in retail requirements levels. In Chapter 4, we examine how smaller requirements levels affect costs and budgets. First, however, we investigate how an OST reduction translates into reduced requirements and some factors that delay, and in some cases negate, the transition from reduced OSTs to reduced requirements.

REDUCING OST-DRIVEN REQUIREMENTS—WHAT IS INVOLVED

While deriving our bottom-up estimates, we reduced OSTs and compared the results with the baseline numbers. However, requirements levels do not change instantaneously as OSTs change because the actual OSTs and the OSTs used to compute requirements levels are not necessarily the same. The OSTs used to compute the levels are either mathematical representations, such as a mean or smoothed average of actual item OSTs, or parameters that represent averages. Until these values are updated, retail requirements levels will not change.

Actual OST

The use of actual OSTs introduces the problem of how to forecast. The traditional approach for forecasting pipeline times (i.e., OSTs, lead-times, and repair times) is to use historical observations to calculate a time that goes into the item record for computing levels. This approach, however, has several difficulties, including the following:

- Since the OST of record is derived from historical observations, any effort to reduce present and future OSTs will not be immediately felt until new observations are experienced (the length of the delay will depend on how and when the OSTs are updated).
- Some observations, which include extended backorder times, may not be representative.
- Lower limits on observations will exclude valid OSTs unless these limits are lowered or eliminated.

Computational methods, such as exponential smoothing, which are selected to dampen the effects of extreme observations in OSTs, also tend to be less responsive to reduced OSTs. For example, Table 3-7 shows the number of observations required for a recorded OST of 30 days to become the new OST with a smoothing constant of 0.20. As that table shows, if we have an item that is ordered once a year, then 7 years would be required to see the result of a 2-day reduction if the OST of record is rounded to the nearest integer, 18 years if it is rounded to the nearest tenth. Ideally, if process improvements are made that will significantly reduce future OSTs, then a one-time change should be made to OSTs of record, lower limits on future observations should be eliminated, and only future observations should be a part of any modification to those OSTs.

Table 3-7. Updating the OST of Record with Exponential Smoothing

OST reduction	Number of observations required for OST of record to equal new reduced OST	
	OST rounded to nearest integer	OST rounded to nearest tenth
1 day	4	14
2 days	7	18
10 days	14	25

Note: Smoothing constant of 0.20.

OST as a Parameter

If OST is a standard parameter, then a reduction in actual OSTs will not impact the OST level unless the value of the parameter is decreased. Tables 3-1 through 3-4 list the situations where the military service retail OST levels are parameter driven. Using a parameter to set OST levels is less desirable than using actual item OSTs because of the following:

- Actual OSTs will differ by the location of retail supply activities and their sources of supply; the use of one or two parameter values does not consider these differences.
- Actual OSTs will differ by item and, while a parameter value may be based on an average, the average itself may not be representative of a large portion of the items; a nonrepresentative OST means that pipeline levels will be too large or too small.
- The computation of requirements levels using fixed OSTs will not automatically adjust to actual changes in OST.

For these reasons, DoD guidance calls for the use of actual OSTs versus parameters wherever possible. Nonetheless, use of a parameter does have the advantage of not being influenced by extreme observations, and it can easily be updated to reflect an actual reduction in OST.

Rounding

Since the data that goes into the computation of requirements levels usually involves fractions, the resulting levels are fractions if they are not converted to whole numbers. Depending on the system, the method of conversion is either truncation or rounding. Truncation simply drops any fraction. For example, 3.1 and 3.6 would both become 3. Standard or half rounding adds 0.5 and then truncates, so that 3.1 and 3.6 would become 3 and 4, respectively. High rounding adds 0.999 and then truncates, so that 3.1 and 3.6 both become 4.

Normally, the effects of rounding are ignored in analyzing changes to requirements levels. However, since a number of systems compute retail requirements levels and these systems use different rounding techniques, rounding must be considered in defining the benefits of reducing OSTs, except where the computation of levels is a discrete process, such as for naval aviation reparable allowance quantities.[8]

To illustrate the effects of rounding, we constructed a simple example involving 30-day OST levels reduced by 1, 2, and 10 days. Table 3-8 shows how the basic

[8] Wherever we computed levels for our bottom-up estimates, we used the rounding technique associated with those levels.

30-day levels computed with each of the three different rounding techniques are related to each other across different ranges of demand. As would be expected, truncated levels are less than half-rounded levels, which are, in turn, less than high-rounded levels. However, as Table 3-8 shows, the differences between the techniques decreases as demand increases.

Table 3-8. OST Levels Under Different Rounding Techniques

Comparison	Demands per year		
	1–100	101–1,000	1,001–10,000
Half-rounded level as a percentage of truncated level	113%	101%	100%
High-rounded level as a percentage of truncated level	127%	102%	100%
Truncated level as a percentage of half-rounded level	88%	99%	100%
High-rounded as a percentage of half-rounded level	112%	101%	100%
Truncated level as a percentage of high-rounded level	79%	98%	100%
Half-rounded level as a percentage of high-rounded level	89%	99%	100%

Table 3-9 shows how the three different rounding techniques affect the impact of reduced OSTs on levels for items with different ranges of demand. It demonstrates the following:

- For items with high demand, rounding does not affect the number of items impacted or the impact on requirements levels of reducing OSTs.
- For items with low demand, rounding reduces the number of items impacted by an OST reduction.
- For items with low demand, truncation amplifies the impact of an OST reduction while half rounding or high rounding do not amplify or dampen the impact.[9]
- For items with low demand, as the size of the OST reduction increases, the number of items impacted increases but the distortion caused by rounding also increases.

[9] This amplification should not be grounds for converting to high rounding because, as Table 3-8 shows, high rounding produces the highest initial level.

Table 3-9. Impacts of Rounding on Reducing a 30-Day OST

Demand	Percentage change in levels for given range of demand per year			Percentage of items with changed levels for given range of demand per year		
	1–100	101–1,000	1,001–10,000	1–100	101–1,000	1,001–10,000
Expected percentage for 1-day reduction	3.3%			100%		
Actual with truncation	4.1%	3.4%	3.3%	15%	89%	100%
Actual with half rounding	3.1%	3.3%	3.3%	13%	89%	100%
Actual with high rounding	3.0%	3.3%	3.3%	14%	89%	100%
Expected percentage for 2-day reduction	6.7%			100%		
Actual with truncation	8.2%	6.8%	6.7%	30%	98%	100%
Actual with half rounding	6.3%	6.7%	6.7%	26%	98%	100%
Actual with high rounding	6.2%	6.6%	6.7%	29%	98%	100%
Expected percentage for 10-day reduction	33.3%			100%		
Actual with truncation	37.4%	33.7%	33.4%	82%	100%	100%
Actual with half rounding	33.8%	33.3%	33.3%	82%	100%	100%
Actual with high rounding	29.5%	33.0%	33.3%	82%	100%	100%

In summary, rounding and different rounding techniques only affect the computations of OST levels and the impact of OST reductions on those computations for items with low demand. Consequently, items with high demand would be the most likely benefactors from OST reductions regardless of the rounding technique.

FINDINGS AND CONCLUSIONS

The impact of reducing OST on the computation of retail requirements levels varies from no impact to reductions in both readiness-based levels and demand-based OST and some safety levels. An OST reduction would have no impact on non-demand-based levels and demand-based operating levels and some safety levels.

High-demand, high-value items are most likely to benefit from reduced OST because of the following:

- When demand-based levels are reduced, the dollar value of the reduction is based on item demand and price; the same is true of readiness-based levels except that the relationship is not as linear.

- The methodologies employed to update the OST used to compute requirements levels and the rounding used in those computations tend to dampen the impact of reduced OST on requirements levels, particularly for slow-moving items.

Aggregating the impacts of reducing OST across the major service retail activities produces an estimated reduction in requirements levels of $48.8 million for each day of reduction. Summing the dollar value of 1 day of recurring demand placed on wholesale managers produces another estimate of $84.2 million for the value of 1 day of OST.

These two estimates define a wide range for the actual value of 1 day of OST. Owing to their development, we suggest that the actual impact on retail requirements levels of reducing OST by 1 day is closer to the lower estimate than the upper one.

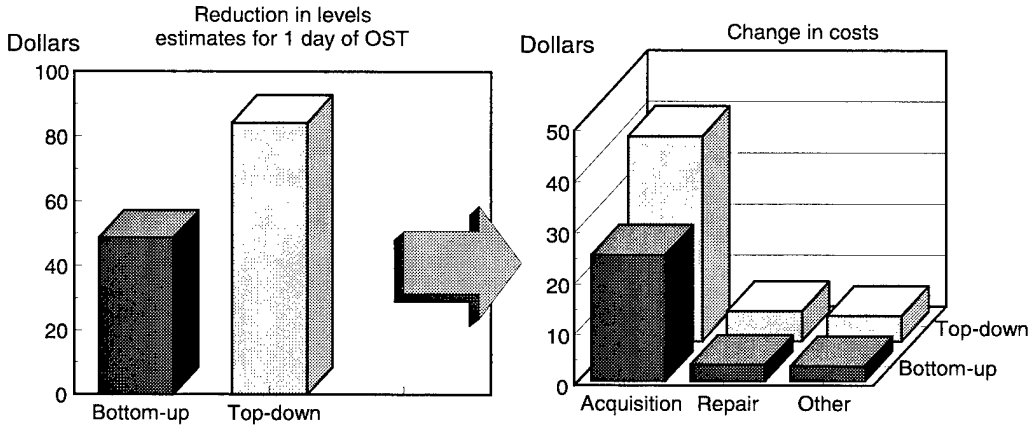
However, inventory control theory states that, for stocked items, a supply activity will always have on-hand or on-order stock equal to demand over the OST. Therefore, retail supply activities invest in an OST level even if they do not compute and maintain an official OST level. This logic suggests that the actual value is closer to the upper estimate, but the theory is directed primarily at high-demand items with sizable stockage versus slow-moving items with minimal stockage at the retail level.

Since we cannot definitively state which estimate is best, we will continue to use them to define a range for the actual value. In the next chapter, we use that range to define a range of expected savings from reducing OST.

Chapter 4
Financial Incentives for Reducing Order and Shipping Times

In Chapter 3, we identified service requirements levels related to OSTs and the value of 1 day of OST in terms of reduced requirements levels. As illustrated in Figure 4-1, we review in this chapter how a reduction in levels affects costs and budgets.

Figure 4-1. Levels Reductions to Cost Changes



SAVINGS IN INVENTORY COSTS FROM REDUCING OST

To estimate the potential savings from reducing OST, we need to review the costs associated with maintaining an inventory. They include the

- *cost of materiel*—the price paid to acquire materiel from a source of supply (i.e., a vendor, distributor, or manufacturer);
- *cost of acquisition*—the direct labor cost of purchasing or otherwise ordering materiel and receiving and stowing the ordered materiel;
- *administrative cost of repair*—the direct labor cost of determining the need for a repair order and administering that order through completion;
- *maintenance cost of repair*—the direct labor and materiel costs of repairing an unserviceable unit;

- *cost of storage*—the annual variable cost of storing an item, which includes the costs associated with preserving and caring for stock in storage, inventorying, and rewarehousing;
- *cost of capital*—the opportunity cost associated with investing money in inventory;
- *cost of obsolescence*—the recurring nonlabor cost of purchasing or repairing materiel that will not be used due to technological obsolescence, overforecasting of requirements, and deterioration beyond usefulness;
- *cost of inventory losses*—the recurring nonlabor cost of losing materiel;
- *cost of a backorder*—costs associated with not having materiel available when needed by the customer; and
- *cost of management*—labor and administrative costs of managing an item.

We analyzed each of these costs to determine if they would be affected by a reduction in levels due to reduced OST and what savings could be realized. We found that, of the costs listed above, only the cost of materiel, the maintenance cost of repair (at the depot level), the cost of capital, the cost of obsolescence, and the cost of inventory losses have significant savings. In the following sections, we summarize our analyses of these costs.[1] Appendix G presents our analyses of the other costs on the list and why they would produce no or negligible savings.

Cost of Materiel

The cost of materiel refers to the price paid for inventory at the time it is brought into the DoD system. Over its life, an item may be procured several times. Although the materiel cost of each procurement depends on the order quantity and negotiated unit price, the lifetime materiel cost of an item is the sum of the materiel costs of all procurements where the total quantity procured equals, in theory, the total quantity demanded over the item's life. (Any quantity bought in excess of the demand adds to the cost of obsolescence, which is discussed later in this chapter.)

Although the previous paragraph applies directly to consumable items, it must be modified for reparable items. Since the retail demands for reparable items can either be satisfied through procurement or depot-level repair, the total quantity procured equals the total quantity demanded that cannot be satisfied by repair. That quantity is referred to as attrition demand. In the discussion that follows, references to demands will mean all demands for consumable items but only attrition

[1] These savings are maximum estimates because the actual savings will vary depending on the asset position of the item. (We discuss the effects of asset position in the section on how savings and budgeting interact, which is provided later in this chapter.)

demands for reparable items. (Later in this chapter under the cost of repair, we discuss how a reduction in OST affects repair costs.)

A reduction in OST should not affect retail demand for an item and, therefore, should not change the item's lifetime materiel cost. However, it does affect future expenditures for materiel as well as the timing of procurements.

When an item is first added to the system, the initial procurement generally buys enough items to fill all pipelines, including an estimated OST. After the initial procurement, follow-on procurements should occur at regular intervals year after year. Inflation will affect the unit price paid for an item, and the period between procurements will increase or decrease in response to variances in demands and procurement quantities (and repair rates for reparable items).

Unless an item's inventory position is already short, a reduction in OST will cause the quantity in the system to exceed the amount needed to cover pipeline requirements. The one-time imbalance will disappear as demands draw down stock levels. However, until that drawdown occurs, the imbalance should cause a one-time reduction in materiel expenditures. This affect is illustrated in the two theoretical graphs in Figure 4-2.

For Figure 4-2, we used the example of a $1 item with a constant annual demand of 50 units and an average inventory level of 70 units. Its normal levels of expenditures, dollar demand, and dollar inventory are displayed in the graph at the top of Figure 4-2. As shown, when the first expenditure establishes the inventory level for the item, future expenditures keep pace with demand. However, if an OST reduction occurs in period 4 and it reduces the required average level to 60 units, then the resulting expenditures, dollar demand, and dollar inventory are shown in the graph at the bottom of Figure 4-2.

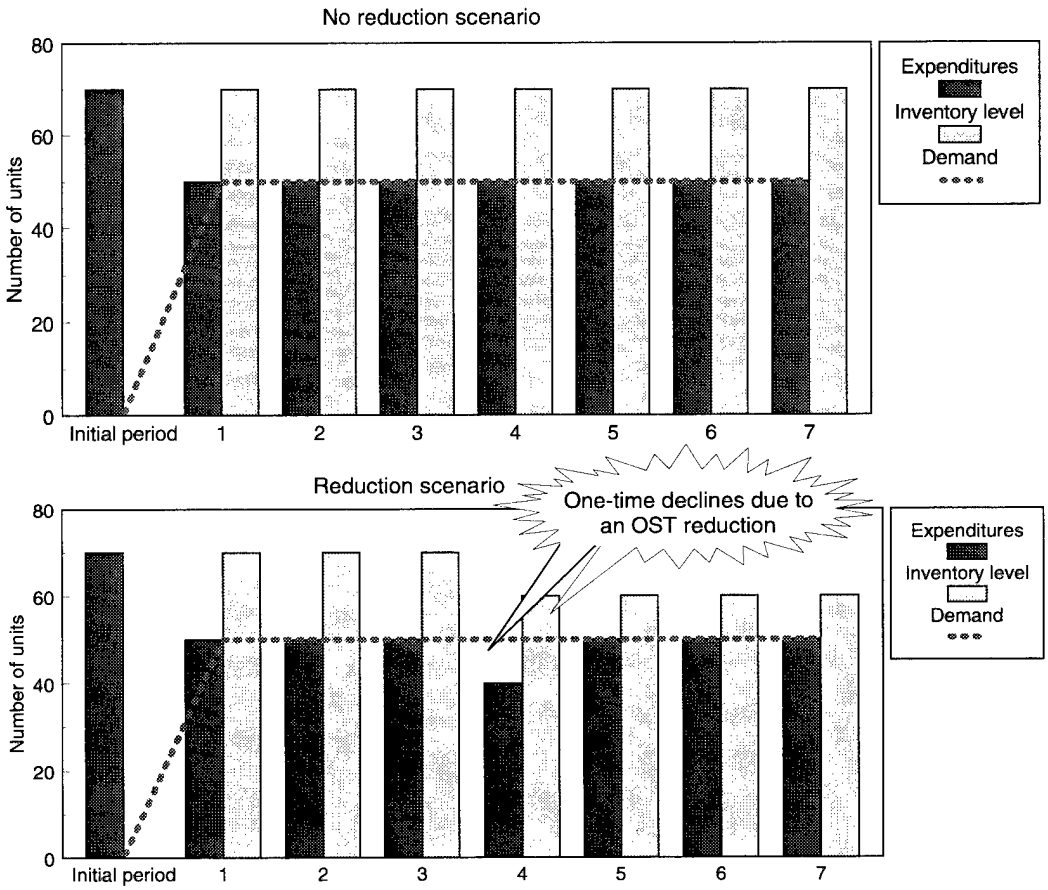
The declines shown in Figure 4-2 are the consequence of buying the inventory level for an item and later having that inventory level decrease. The cost of materiel over the life of the item will remain the same, but the progression of expenditures changes.[2] In this case, the altered progression has a one-time decline in expenditures equal to the decline in requirements levels. As such, the decline in expenditures is a one-time savings in the cost of materiel.

In summary, although the total cost of materiel should not change over the life of an item, a reduction in OST would produce a one-time savings in the cost of materiel. For consumable items, the expected savings would be equal to the reduction in requirements levels. For reparable items, the expected savings would be less than the reduction in levels because the one-time surplus would manifest itself in

[2] This discussion assumes that demands remain constant. If demands drop to the point where future expenditures are unnecessary, then the reduced requirements levels would result in increased materiel for disposal. This situation is addressed under the topic of obsolescence costs.

both delayed procurements and repairs. In the following section, we discuss how this one-time reduction generates savings in repair costs.

Figure 4-2. Effect of One-Time Reduction in OST on Requirements Level and Materiel Expenditures



Cost of Repair

A reduction in OST has no effect on field maintenance for reparable items because OST occurs after field maintenance determines that reparable unserviceable assets are not locally repairable. However, an OST reduction does affect the cost of repair at the depot level. This includes two costs—the administrative cost of directing the repair of unserviceable assets of an item and the maintenance cost of repairing an unserviceable asset. Of these two costs, only the maintenance cost of repair is significant and is discussed in what follows.

A reduction in OST, as noted previously, will cause a temporary asset surplus at a retail activity. If that surplus is redistributed to another retail activity, it will have no impact on local repair costs although the assets may help to satisfy the requirements at the other retail activity.

However, an undistributed surplus would delay repair if repair actions were tied to the inventory level. But within DoD, this situation seldom occurs at the retail level. Unserviceable assets are generally delivered to maintenance and a repair action is initiated without considering an item's asset position. Under these circumstances, a reduction in OST would not affect repair costs, but supply performance would improve because more serviceable assets would be available to fill demands. However, the effect would be temporary because the surplus would be consumed over time.

If the retail surplus is passed on to the wholesale, either as a redistributed serviceable asset or an unserviceable asset with no associated demand for a serviceable asset, the wholesale system will experience a temporary surplus. At the wholesale level, unserviceable assets are inducted into repair based on an item's serviceable asset position. In this case, the surplus from the reduction in OST would cause a one-time delay in repair actions. This delay would extend throughout the remaining life of the item. Therefore, the result would be a one-time reduction in the number of repair actions.

Earlier, when we addressed the savings under the cost of materiel, we noted that the savings for reparable items would be split between procurement and repair. To estimate the amount of repair savings, we used the following three-step approach:

1. We developed a ratio of the acquisition price of a reparable item to its unit repair costs.

2. We used the ratio to estimate the percentage of reduced reparable requirements levels that would affect repair.

3. We used the ratio from step 1 and the percentage from step 2 to transform our bottom-up and top-down estimates for levels reductions to savings in materiel and repair costs.

STEP 1

To develop the ratio of acquisition price to repair price, we used the March 1995 Air Force buy and repair stratification reports. Specifically, we derived the ratio by dividing the dollars under "serviceable on hand" listed in the buy stratification by the dollars under "serviceable on hand" listed in the repair stratification. The resulting average ratio was 7.48:1.[3]

[3] The actual ratio varies by item. However, for our analysis, we concluded that the use of an average was reasonable.

STEP 2

To obtain an estimate of what portion of the total savings was in repair, we relied on a 1994 analysis of the impacts of a reduction in OST on Air Force DLRs.[4] That analysis used Air Force item data in its worldwide requirements model. The analysis of reduced OSTs produced a breakout on how the one-time savings in acquiring materiel would be split between procurement and repair. We used that breakout and the 7.48:1 ratio to create Table 4-1.

Table 4-1. Breakout of Savings in Acquiring Reparable Materiel Between Procurement and Repair

OST days (reduction from 17-day standard)	Buy ($ million)	Repair at acquisition price ($ million)	Total at acquisition price ($ million)	Percentage of repair
15 (2)	6	7	13	53.8
5 (12)	147	539	686	78.6
3 (14)	171	1,279	1,450	88.2
Weighted by OST days				63.7

Since the repair percentages differ by the size of reduction, we also developed the 63.7 percent weighted average shown in the table. In developing this average, we weighted each percentage by OST days instead of the OST reductions because the range of likely reductions is closer to 2 days than to 14 days.

STEP 3

In the first two steps, we were working solely with Air Force data, but the third involved reductions in requirements levels for all the military services. However, since the other military services lack the data to repeat the analysis used in step 2, we applied the Air Force estimates from steps 1 and 2 to their data. Specifically, we used the Air Force's 63.7 percent to estimate repair savings and 36.3 percent to estimate the savings in the cost of procured materiel to segment the cost of acquiring materiel between procurement and repair costs. The results are given in Table 4-2.

As Table 4-2 shows, our original $48.8 million bottom-up estimate for reduced requirements levels becomes a savings of $24.8 million in buy requirements (i.e., materiel costs) and a savings of $3.2 million in repair requirements (i.e., maintenance costs of repair). Similarly, the $84.2 million top-down estimate becomes savings of $40.1 million in buy requirements and $5.9 million in repair requirements. For consumable items, the savings in buy requirements match dollar for

[4] LMI Memorandums for HQ USAF/LGSW, from Virginia (Ginny) A. Mattern, *Savings from Decreases in Order and Ship Time*, 19 September 1994; 6 October 1994, *Expedited Transportation Costs*; and 10 October 1994, *Reduction in OST Causing Long Supply*.

dollar to the reduction in requirements levels. For reparable items, the combined savings in buy and repair requirements are approximately 45 percent of reduced requirements levels.

Table 4-2. Materiel Acquisition Savings from One-Time Reduction in Requirements Levels Based on Reduced OST

DoD component	Item type	Bottom-up estimate of one-time savings ($ million)			Top-down estimate of one-time savings ($ million)		
		Buy	Repair at acquisition price	Repair at repair price	Buy	Repair at acquisition price	Repair at repair price
Army	Reparable	1.4	2.5	0.3	2.2	3.9	0.5
	Consumable	1.4	–	–	2.0	–	–
Navy	Reparable	1.8	3.2	0.4	8.6	15.1	2.0
	Consumable	5.4	–	–	2.2	–	–
Air Force	Reparable	9.0	15.9	2.1	14.3	25.1	3.4
	Consumable	3.7	–	–	1.9	–	–
Marine Corps	Reparable	1.3	2.4	0.3	–	–	–
	Consumable	0.7	–	–	–	–	–
DLA	Consumable	–	–	–	8.8	–	–
Total (rounded)		24.8	–	3.2	40.1	–	5.9

Cost of Capital

Inventory is an investment made to provide supplies to customers when they need them. A smaller inventory means a smaller investment, usually at the expense of lower effectiveness. When government and private-sector activities make inventory or other investment decisions, they consider the cost of capital. For example, DoD supply activities use an investment rate when formulating economic order quantities. Traditionally, they use a 10 percent rate for the cost of capital, with the exception of Air Force wholesale activities, which use 6 percent.

The reduction in requirements levels resulting from reduced OSTs is a reduction in the total DoD inventory investment. Therefore, if we apply the standard 10 percent rate to the $48.8 to $84.2 million estimates for 1 day of OST requirements levels, we have an annual reduction in the cost of capital of between $4.88 and $8.42 million.

However, because the cost of capital is the government's cost of obtaining revenue either through taxation or by borrowing, it is not reflected in any DoD budget requirement. Consequently, DoD and non-DoD agencies often treat it as an

opportunity cost and not an area of real savings. One argument for this treatment is that any savings in Defense logistics would not trigger a tax cut or less borrowing, rather such savings would be reallocated to fund training or other operational programs. Or, at a national level, it would be reallocated to fund non-Defense programs.

Another argument, which may be more relevant to this analysis, is that when evaluating any proposed change to DoD business practices, it is incorrect to include the cost of capital when developing savings without doing the same when developing costs. For example, suppose a proposal offered to reduce materiel costs by $100 by spending $105 to change an automated process. It would not be correct to say that the proposal is cost-effective because the savings are $110 (i.e., $100 plus $10 for the cost of capital) and the costs are $105. The correct conclusion is that the proposal is not cost-effective because the government would have to spend $5 more if it were implemented.

Since we are developing the benefits of reducing OST for the purpose of evaluating proposals to reduce OST, we conclude that savings in the cost of capital do not apply. Therefore, we have listed the recurring savings of $4.88 to $8.42 million as opportunity savings that would apply to only no-cost proposals and then would not reflect a reduction in DoD budgets.

Cost of Obsolescence

Obsolescence cost refers to the cost of losses of materiel superfluous to need. These include the losses due to technological obsolescence, excessive forecasts of requirements, and deterioration beyond usefulness. The obsolescence rate is the value of annual disposals over the value of on-hand assets. Within DoD, obsolescence rates range from 1 to 12 percent (2 to 5 percent for Army-managed items, 10 to 12 percent for Navy-managed items, 3 to 6 percent for Air Force-managed items, and 1 to 7 percent for DLA-managed items).

A reduction in retail requirements levels will also result in lower obsolescence costs because the amount of inventory that can become obsolete will be smaller. For example, if we currently stock an average inventory level of 100 units for an item that has a 5 percent obsolescence rate, we would dispose of 5 units per year due to obsolescence. If we reduce the average level to 80 units because of a reduction in OST, we would dispose of 4 units per year. The associated savings would be 5 percent of 20 units or 1 unit per year.

If we assume that, for the most part, the military services manage the retail reparable items and DLA manages the retail consumable items, we can apply average military service and DLA obsolescence rates to estimate the obsolescence savings. (For the Marine Corps, we applied the Army's rate for ground supplies and the Navy's rate for aviation supplies.) Using this approach, we arrived at the annual estimates shown in Table 4-3.

Table 4-3. Obsolescence Cost Reductions

Service	Type of inventory	Reduction ($ million)	Average percentage rate	Annual savings ($000)
Army	Reparable	3.93	5	196
	Consumable	1.40	7	99
Navy	Reparable	4.97	12	597
	Consumable	5.43	7	380
Air Force	Reparable	24.9	4	996
	Consumable	3.7	7	259
Marine Corps	Reparable (ground)	1.9	5	95
	Reparable (air)	1.8	12	216
	Consumable	0.7	7	49
Total	Based on reductions in bottom-up estimate			2,887
	Scaled up to top-down estimate			4,991

In developing Table 4-3, we did the following:

- For the Army and Navy reparable reductions, we used 75 percent of their Chapter 2 reductions that were attributed to reparable and consumable items.
- For the Army and Navy consumable reductions, we used 25 percent of their Chapter 2 reductions that were attributed to reparable and consumable items plus 100 percent of the reductions attributed to consumable items.
- The Air Force's reduction in reparable items is based solely on DLRs, while its consumable reduction is based on FLRs and consumable items.

The estimates in Table 4-3 are gross annual savings.[5] To obtain the net savings, we need to subtract the return on disposal, which can be computed using DoD's standard return rate of 2 cents on the dollar. The resulting net annual savings would be between $2.9 and $5.0 million.

These savings are not based upon stocks currently in the inventory; they are derived from future procurements. In our example, when we went from an average inventory level of 100 units to 80 units because of reduced requirements, we would initially have a surplus of 20 units. Over time, demands would reduce that surplus to zero, unless they were too low to consume the surplus, which would

[5] We assume no change in the number of disposals, so disposal costs do not change.

result in a need to dispose of some of the surplus. This potential for disposal introduces the possibility of a one-time savings due to the sale of disposable assets.

The 1994 Air Force analysis of the impact of reducing OST assessed how reduced requirements would cause items to exceed their worldwide requirements level. The analysis considered three cases. The first case was when an item had no buy or repair requirement and any reduction in OST would probably result in assets exceeding the item's requirements. The second case was when an item had a buy or repair requirement, but the reduction eliminated the requirement and some assets might be candidates for excess. The third case was when an item had a buy or repair requirement and the reduction did not remove the requirement, so no assets would be excess. The results of the 1994 analysis are shown in Table 4-4.

Table 4-4. Reduction in OST Causing Long Supply

OST days (reduction)	Reduced requirements ($ million)	Probably excess to requirements percentage	Excess candidate percentage	Not excess percentage
15 (2)	49.7	7	1	92
9 (8)	254.2	8	1	91
7 (10)	350.8	9	1	90
5 (12)	471.9	8	1	91
3 (14)	587.0	8	1	91
Weighted average	–	8	1	91

Since the percentage of assets exceeding requirements was not the same for all levels of reductions, we developed a weighted average of 8 percent, which is shown at the bottom of the table.[6]

If we applied the 8 percent to our estimates of requirements levels reduction, we would have a potential long supply of between $3.9 million for the bottom-up estimate and $6.7 million for top-down estimate. If we then assumed that all of the long supply would be potentially excess and disposed of at the rate of return of 2 cents on the dollar, we would have a one-time return of between $0.1 and $0.2 million, which is relatively small.

Thus, for each day of reduced OST, DoD would reap a negligible one-time savings from disposal of materiel and a large annual savings of between $2.9 and $4.9 million in avoiding future procurements.

[6] We used the reductions in OST to weight the percentages.

Cost of Other Inventory Losses

In addition to obsolescence, pilferage and inventory shrinkage are other types of inventory losses. Like obsolescence, their cost is expressed as a percentage of the average inventory value. Only the Army tracks this cost separately from that of obsolescence; its rates range from 0 to 2 percent. Since the other military services and DLA combine all losses in their obsolescence rate, we did the same for the Army (i.e., we used 5 percent—4 percent for obsolescence and 1 percent for other losses) when we made our obsolescence computations.

Summary of Cost Impacts

Table 4-5 summarizes the expected savings from reducing OST.

Table 4-5. Impacts of OST Reduction on the Costs of Maintaining Inventory

Cost	Impact	Expected savings
Materiel	One-time reduction in procurement of assets to fill inventory levels	$24.8 to $40.1 million per day of reduced OST
Acquisition	Slight potential for one-time delay in procurements	None
Repair—maintenance	One-time delay in depot-level maintenance costs	$3.2 to $5.9 million per day of reduced OST
Repair—administrative	Slight potential for one-time delay in repair orders	None
Storage	Recurring reduction in storage requirement	Negligible
Capital	Recurring reduction in overall investment in inventory	Annual savings of $2.5 to $4.0 million per day of reduced OST in opportunity costs only (i.e., not applicable to cost/benefit analyses of proposals to reduce OST or estimates of budget reductions from OST reductions)
Obsolescence and other inventory losses	Recurring reduction in acquisition of materiel that would be lost	Negligible one-time savings and $2.9 to $5.0 million annual savings per day of reduced OST
Backorder	Potential for increase and decrease in number of backorders	Nonquantifiable, because backorder change cannot be quantified, and the cost of a backorder is an unknown variable (cost is a function of the individual item being backordered, its application, and expenses incurred if that application is not available)
Management	No change	None

SAVINGS IN FUNDING REQUIREMENTS FROM REDUCED OST

In Chapter 2, we identified the retail inventory requirements funded with O&M budgets and those funded under the DBOF. In this section, we examine how retail and wholesale budgets would be affected by reductions in levels. We begin by discussing how an item's asset position influences the size and timing of savings.

Asset Position and Savings from Reduced Levels

Expected savings from reduced requirements levels may not materialize if an item has an asset position that already exceeds its original requirements levels. If an item has sufficient serviceable assets to satisfy future demands without procurement or repair actions, then any reduction in requirements levels will not result in savings. As demonstrated in the 1994 analysis of the impacts of OST reductions on Air Force DLRs, a reduction may merely cause some assets to become excess.

Table 4-6 shows the results of this analysis in terms of reduced requirements levels and reduced buy and repair budgets.

The two primary observations that can be made from Table 4-6 are listed below:

- Savings from reduced requirements levels will accrue over several years.
- The total budget savings will be less than the reductions in requirements.

Table 4-6. Results of OST Reduction Analysis on Air Force Levels and Buy/Repair Requirements ($ million)

OST days (reduction from 17-day standard)	Reduction requirements levels	1st-year reductions		2nd-year reductions		3rd-year reductions	
		Buy	Repair	Buy	Repair	Buy	Repair
15 (2)	49.7	4	1	2	0	0	0
5 (12)	471.9	88	70	40	1	19	1
3 (14)	587.0	104	89	48	7	19	1

With regard to the first observation, the extended time frame occurs even though the change is affected by a parameter change. When actual OSTs are used to compute requirements levels, the extension will be longer unless a one-time change is made to all item records.

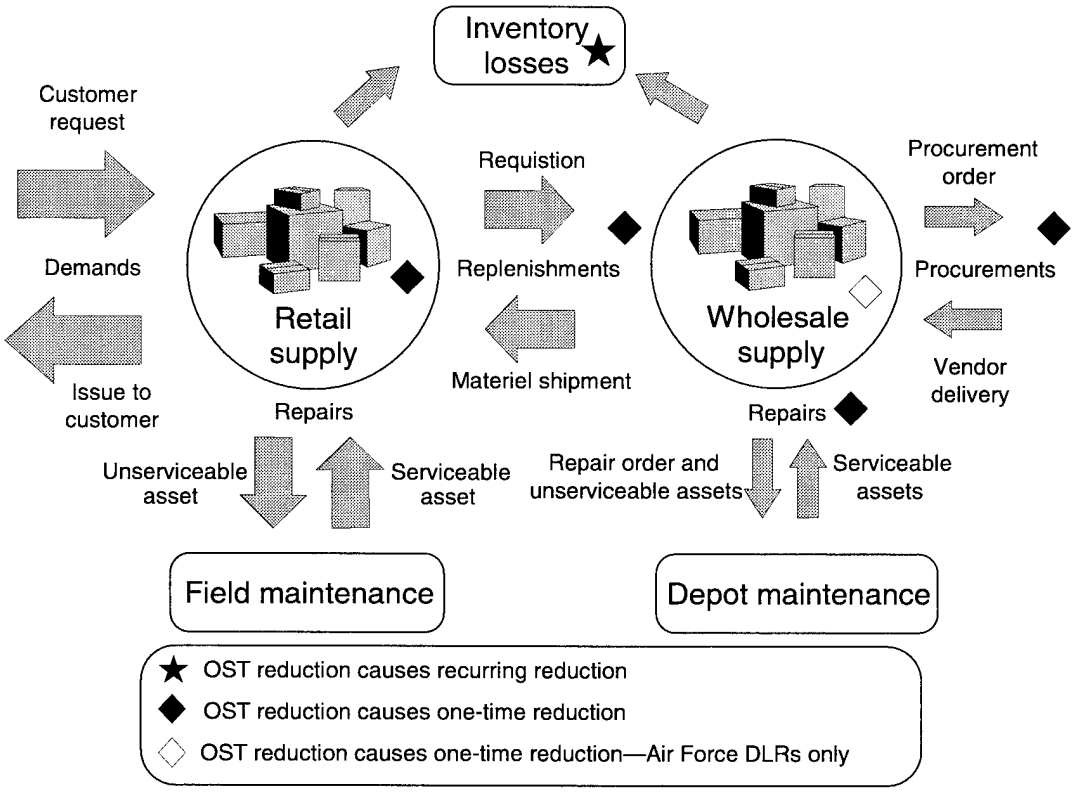
The second observation results from high asset positions and reduced return on maintenance costs. Asset positions not only influence whether savings will occur but also the buy or repair mix of those savings. In these situations, the items with potential repair savings have smaller buy-repair ratios than the Air Force's average of 7.48 to 1 (otherwise the total savings would exceed the reduction in requirements levels).

The Air Force's requirements computations for DLRs include an item's asset position in the computation of its level of stockage.[7] The computations of the other military services do not consider asset position. As a consequence, while the above observations should apply to the other military services, the actual values for the ratios between reductions in levels and budgets may not be applicable.

Overview of Cost and Budget Impacts

Figure 4-3 provides a schematic that summarizes the effects on costs of reducing OSTs.

Figure 4-3. Summary of Impacts of Reducing OSTs



[7] Specifically, the computation considers assets up to an item availability of 0.99999 as the minimum level of stockage for the item. This approach minimizes buy and repair requirements by considering the contribution of existing assets.

The recurring reduction in inventory losses shown in Figure 4-3 translates into savings in the combined cost of obsolescence and other inventory losses. The O&M or DBOF budgets that finance the requirements levels being reduced would benefit from these savings.

Progression of Events Leading to Cost Savings

The one-time reduction in retail inventory that stems from reduced requirements levels would result in lower budget requirements. (Since the Air Force performs a multi-echelon computation for its DLRs, the reduction would occur at both the retail and wholesale levels of supply, which are under DBOF.) The one-time reduction in requirements levels would produce a temporary asset surplus that would result in a one-time reduction in replenishment, which, in turn, would cause one-time reductions or delays in wholesale procurement and repair actions. The savings associated with these delays are the materiel and maintenance cost savings that we summarized in this chapter.

Processes or Situations That Delay or Negate Savings

In Chapter 3, we demonstrated how the slow updating of the OSTs used to compute levels will delay savings and how rounding will negate some savings for low-demand items. Other factors that delay or negate savings are high asset positions, declining demand, increasing lead-times, and the methods used to forecast demand, lead-times, and carcass return rates.

To research the effect of reducing OST for a reparable item, we used a simple, deterministic, two-echelon simulation model where each echelon acted with perfect knowledge of lead-times and known future demand. We found that the initial effect was a reduction in retail demand, although carcass turn-in remained constant since it was a function of item failure and the ability of field-level maintenance to repair such failures. In response to the reduced demand, the wholesale level reduced repair inductions. And, in response to both the reduced demand and continuing turn-ins, the wholesale level reduced procurements. Later, when the reduced procurements were scheduled to arrive, the wholesale level increased repair inductions to fill all demands. The net result was no change in the number of repairs over the life of the simulation but a drop in procurement equal to the reduced OST demand.

However, when we introduced high asset positions into the simulation, the net result changed as both the number of units repaired and the number procured decreased. The same change occurred when we introduced declining demand and increasing repair and procurement lead-times. And, when we removed perfect knowledge of lead-times and demand and had the wholesale system use standard forecasting methods, the number of units repaired and procured again decreased.

These results support the findings of the 1994 Air Force analysis, in which the savings from reduced OST were smaller than the reduction in levels and were spread across buy and repair budgets. They also support the use of micro-level requirement models as the only way to accurately estimate actual budget reductions.

The following sections discuss how savings might be reflected in budget reductions—but only the types of reductions, not their size. The savings listed in Table 4-5 provide an upper limit on the size of budget reductions. However, the situations and processes presented would affect the actual size of the reductions by delaying, reducing, or negating savings.

BUDGET IMPACT FOR O&M-FUNDED RETAIL INVENTORIES

The retail inventories of the Army, Navy, and Marine Corps are O&M funded, which means they cover the OST pipeline requirements. Therefore, if OST is reduced, their O&M budgets would receive one-time benefits of reduced retail requirements levels and the recurring benefits of reduced losses. Those benefits should be equal to the sum of the reductions in requirements levels and obsolescence savings.

Since wholesale inventories are all DBOF funded, the DBOF would benefit from any one-time savings in materiel and maintenance costs. All of these savings would translate into a reduced DBOF obligational authority that would span several years.

BUDGET IMPACTS FOR RETAIL INVENTORIES FUNDED THROUGH A HORIZONTAL STOCK FUND

The Army, Navy, and Air Force use horizontal stock funds for selected retail supply activities or classes of items. If a retail inventory is stock funded, O&M budget requirements cover customer demands and the operations of the retail supply and field maintenance activities. Since a reduction in OST would not affect these budget items, O&M requirements should remain the same.[8]

Retail stock fund budgets would receive the one-time benefits of reduced retail requirements levels and the recurring benefits of reduced losses. Those benefits should be equal to the sum of the reduction in requirements levels and obsolescence savings. All benefits would translate into reduced requirements for inter-DBOF fund transfers that would span several years.

The wholesale DBOF benefits would consist of materiel and maintenance costs savings that translate to a reduced DBOF obligational authority spanning several years.

[8] A reduction in storage costs would occur, but these costs would be negligible.

BUDGET IMPACT FOR RETAIL INVENTORIES FUNDED THROUGH A VERTICAL STOCK FUND

The Air Force uses a vertical stock fund for its DLRs. As was the case when retail inventories were horizontally stock funded, O&M requirements should remain the same.

Since a vertical stock fund covers both retail and wholesale inventories, it would receive the one-time benefit of reduced retail requirements levels and the recurring benefit of reduced losses. The one-time benefit would translate into the materiel and maintenance costs savings attributed to the reduced levels. All savings would translate into a reduced DBOF obligational authority spanning several years.[9]

FINDINGS AND CONCLUSIONS

For each day of reduced OST, DoD can realize one-time savings of between $24.8 and $40.1 million in materiel costs and between $3.2 to $5.9 million in repair costs. For consumable items, these expected savings match dollar for dollar to reductions in item requirements levels, but only yield 45 cents on the dollar for reparable items. Besides these one-time savings, DoD would gain an additional annual savings of between $2.9 and $5.0 million in reduced obsolescence costs.

These savings are estimated maximums that probably will not translate to budget reductions. High asset positions at the retail or wholesale levels would cause the actual savings in budget requirements to span several years and would reduce the size of the expected savings. As noted in Chapter 3, rounding and the current methods for updating OST would also delay and possibly negate savings. Finally, other factors, such as declining demand, increasing lead-times, and forecasting, would delay or negate budget savings.

Since levels reductions and their associated savings are directly proportional to price and volume of demand, high-demand, high-value items would most likely benefit from reduced OST. This conclusion favors reparable items as the best candidates for efforts to reduce OST. However, the bulk of savings associated with reducing OST are in future costs to replenish stock either through procurement or repair. For a consumable item, those costs are at procurement price, while, for a reparable item, the same costs are divided between procurement price and the lesser repair price. Therefore, a reparable item with the same demand and unit price as a consumable item would have less savings.

[9] As previously noted, the only way to determine a valid estimate for these savings would be to perform a micro-level analysis using item data and the Air Force requirements model. The 1994 analysis performed for the Air Force used this approach.

Chapter 5
Trading Off the Costs and Savings of Reducing Order and Shipping Times

Our initial objective in performing this analysis was to quantify the savings from reducing OST. In Chapter 3, we established that a 1-day reduction in OST would reduce retail requirements levels by between $48.8 and $84.2 million. In Chapter 4, we traced those estimated reductions to expected one-time savings of between $28.0 and $46.0 million and annual savings of between $2.9 and $5.0 million. The savings for reductions of 2 or more days can be estimated by multiplying 1 day of savings by the respective number of days.

We also discussed in Chapter 4 several factors that might delay or partially negate budget reductions from OST reductions. Even though actual budget reductions may be delayed and less than anticipated, the savings from OST reduction are still worth pursuing. The estimates developed in this report can be used to evaluate proposals for reducing OST.

In this chapter, we segment savings several ways so that they can be more useful in evaluating proposals to reduce OST. We also present the results of tradeoff analyses that we jointly conducted with DLA's operations research staff.

SEGMENTING SAVINGS

Some proposals for reducing OST may only apply to particular segments of DoD's item inventories. In such instances, the tradeoff between costs and savings requires that savings be segmented in the same manner as costs. Two probable sets of segments are by the military service owning the retail inventory and by the component providing wholesale management. These breakouts will permit the evaluation of proposals that will reduce the retail and wholesale portion of OST, respectively.

Segmenting by the Military Service Owning the Retail Inventory

Segmenting the lower end estimate by military service is no problem because the final estimate of savings was the sum of service estimates. As for the top-down estimate, we can assume that the service's recurring demand is from its own retail supply activities and DLA's recurring demand is divided by service in proportion to its percentage of retail consumable item requirements levels. Table 5-1 provides a segmentation of savings by service owning the retail inventory.

Since the total savings are mere estimates of what the savings would be and additional assumptions are required to segment those savings, the resulting segmented savings are even rougher estimates. However, they represent starting points for estimating the savings for proposals that would reduce the retail portion of OST.

Table 5-1. Savings by Military Service Owning the Retail Inventory

Service	Type of item	One-time savings ($ million)	Recurring savings ($ million)
Army	Reparable	1.76 to 2.73	0.20 to 0.34
	Consumable	1.41 to 3.10	0.10 to 0.17
	Total Army	3.17 to 5.83	0.30 to 0.51
Navy	Reparable	2.23 to 7.76	0.60 to 1.03
	Consumable	5.43 to 6.20	0.38 to 0.66
	Total Navy	7.66 to 13.96	0.98 to 1.69
Air Force	Reparable	11.16 to 17.69	1.00 to 1.72
	Consumable	3.70 to 4.80	0.26 to 0.45
	Total Air Force	14.86 to 22.49	1.26 to 2.17
Marine Corps	Reparable	1.66 to 2.87	0.31 to 0.54
	Consumable	0.70 to 0.80	0.05 to 0.08
	Total Marine Corps	2.36 to 3.67	0.36 to 0.62
Total	Reparable	16.81 to 31.05	2.10 to 3.63
	Consumable	11.24 to 14.90	0.79 to 1.36
	Total	28.05 to 45.95	2.89 to 4.99

Segmenting by the Component Providing Wholesale Management

To segment savings by supplier, we assume that reparable items are primarily managed by the military services using them. For consumable items, we used the SSIR to assign wholesale management dollars. Specifically, for DLA-managed consumable items (excluding fuels and subsistence), the 1994 SSIR shows that DLA manages $3,215 million of the total $6,794 million, or 47 percent of the approved acquisition objective for wholesale consumable items. We used this percentage to segment the savings for consumable items. And finally, we placed Marine Corps savings under the Navy. Our results are shown in Table 5-2.

Table 5-2. Savings by Component Supplying the Retail Inventory

Component	Type of item	One-time savings ($ million)	Recurring savings ($ million)
Army	Reparable	1.76 to 2.73	0.20 to 0.34
	Consumable	0.74 to 1.64	0.05 to 0.09
	Total Army	2.50 to 4.37	0.25 to 0.43
Navy	Reparable	3.89 to 10.63	0.91 to 1.57
	Consumable	3.23 to 3.69	0.23 to 0.39
	Total Navy	7.12 to 14.32	1.13 to 1.96
Air Force	Reparable	11.16 to 17.69	1.00 to 1.72
	Consumable	1.95 to 2.53	0.14 to 0.24
	Total Air Force	13.11 to 20.19	1.13 to 1.96
Marine Corps	Reparable	0.00	0.00
	Consumable	5.32 to 7.05	0.37 to 0.64
	Total Marine Corps	5.32 to 7.05	0.37 to 0.64
Total	Reparable	16.81 to 31.05	2.10 to 3.63
	Consumable	11.24 to 14.90	0.79 to 1.36
	Total	28.05 to 45.95	2.89 to 4.99

TRADEOFF ANALYSES

If no additional costs are required to reduce OST, then clearly DoD has a financial incentive to reduce OST. However, if additional costs are required, then the associated savings must exceed those costs for a financial incentive to exist.

In September 1995, DORO completed a study on the costs of reducing depot processing and transportation time for DLA-managed items.[1] Depot processing time covers the time a depot requires to pick, pack, crate, and deliver a shipment to a transportation staging area. Transportation covers the time that transportation requires to schedule a shipment with a carrier and then transport the shipment to the customer.

Like the savings identified in this analysis, the costs associated with proposals to reduce OST may be one time or recurring. The primary method for trading off both one-time and recurring costs and savings of one or more proposals is a present value analysis. A present value analysis uses a discount factor to convert or

[1] DLA Operations Research Office, *A DLA Study on the Costs of Reducing Depot Processing and Transportation Time,* Report DLA-95-P50017, Benedict C. Roberts, Russell S. Elliott, and Sara P. Rudd, September 1995.

"discount" future-year dollars to this-year dollars. If the cumulative discounted dollars for future savings are greater than the cumulative discounted dollars for future costs, the proposal is economically viable. (Present value is the difference between discounted savings and costs and is used to determine if one proposal is economically superior to another.)

We joined with the DORO staff to perform present value analyses that trade off the costs and benefits of reducing OST. Those analyses are discussed in the following sections.

Reducing OST for All Consumable Items

DLA's cost study indicates that it can reduce average system response time by 2 days for an additional annual cost of $12.4 million in depot labor and second destination transportation. The study estimates a cost of $39.5 million to obtain a 3-day reduction. Using a present value analysis, we evaluated these costs against the savings (Table 5-3) for DLA-managed items.[2]

Table 5-3. Present Value Analysis of Reducing OST for All DLA-Managed Items

OST reduction	Year	Costs ($ million)			Savings ($ million)		
		Annual	Discounted	Cumulative	Annual	Discounted	Cumulative
2 days	1	12.4	11.8	11.8	15.4	14.7	14.7
	2	12.4	10.8	22.6	1.3	1.1	15.8
	3	12.4	9.8	32.4	1.3	1.0	16.8
3 days	1	39.5	37.7	37.7	23.1	22.0	22.0
	2	39.5	34.2	71.9	1.9	1.7	23.7
	3	39.5	31.1	103.1	1.9	1.5	25.2

From Table 5-3, we know that reducing OST by 2 days for all DLA-managed items is clearly not cost-effective because cumulative costs outweigh cumulative savings in year 2. Similarly, reducing OST by 3 days is not cost-effective for all items because costs outweigh savings starting in the first year.

Determining When Reducing OST Is Cost-Effective for Consumable Items

Since we cannot offset the costs of reducing OST for all DLA items across retail supply activities, our analysis next turned to OST reductions for sets of items. To do this analysis, we developed a model that looks at the cost tradeoffs at an item level. (The model is given in Appendix H.)

[2] We used the higher top-down estimate to do the analysis in Table 5-3 to determine if it was cost-effective in the case of maximum savings. If it had been, then we would have continued the analysis using the lower bottom-up estimate to determine if it was still cost-effective.

The model requires extensive data that reside at several locations within DoD's supply system. An item's acquisition price, total system demand, and wholesale asset position (key elements in estimating the savings from reducing OST) are only known by the wholesale manager. The transportation office at the shipping depot knows the additional cost of expediting a shipment. Only the retail activity can determine whether a reduction in OST actually affects the inventory level of an item. This dispersion of data hinders the application of the model in selecting individual routine replenishment requisitions for expedited OST service.

To determine when reducing OST is cost-effective for DLA, DORO sought to apply the model against a range of items instead of individual requisitions. This approach sacrifices some economic accuracy in applying the model, and as a result, some materiel might be expedited even though it is not cost-effective to do so. However, for the selected range of items, the overall savings from expediting should be greater than the overall cost of expediting.

OBJECTIVE

The objective of the DORO analysis was to use unit price and unit weight to determine the range of items that should have expedited routine requisitions. Expediting a routine requisition involves three distribution segments of the OST pipeline: depot processing, transportation hold, and CONUS in transit. To expedite a routine requisition, DLA would treat it like a priority requisition for these three segments.

MODEL PARAMETER VALUES USED IN ANALYSIS

In applying the model, DORO assigned the following values to model parameters:

- A discount period or expected remaining item life of 10 years
- A discount rate of 10 percent (DoD standard)
- A holding cost rate of 7 percent (as presented in Chapter 4)
- An expected OST reduction of 5.3 days (i.e., the current average of 8.3 days would be reduced to 3 days).

Based on the model, a 5.3-day reduction is advantageous to DoD if the following inequality is true:[3]

($ *value of expedited materiel*) > ($ *cost to expedite*) × (295).

[3] Development of the inequality is described at the end of Appendix H. The value of 295 is from linear interpolation between 314 for a 5-day reduction and 262 for a 6-day reduction.

DEVELOPING CRITERIA THAT PROVIDE FOR CONSISTENT LEVELS OF SERVICE

This inequality can be evaluated on a requisition-by-requisition basis. However, the objective of the DORO analysis was to expedite all requisitions for a set of items and not individual requisitions. Therefore, DORO needed to establish criteria that could be used to determine the range of items for which the inequality would be consistently true over time. In establishing criteria, DORO adopted the following theme: *DLA would be able to foster customer confidence and ensure a return on investment if the set of items to be expedited does not change over time and DLA were able to provide consistent levels of service for those items.*

The left-hand side of the inequality, i.e., dollar value of expedited materiel, is a function of both an item's unit price and demand volume. However, an item's unit price is less volatile than its demand. Therefore, by focusing on unit price criteria rather than demand-dependent criteria, DLA would be providing for more consistent levels of service.

The right-hand side of the inequality, i.e., cost to expedite, includes additional depot labor, packaging, and second destination transportation costs. If only a small percentage of routine depot workload would be expedited, then additional depot labor and packaging costs are negligible and only transportation costs are significant. Second destination transportation cost factors include item unit weight, demand volume, distance from the distribution facility to the customer, and geographic area of the distribution facility. Again, by focusing on unit weight, which is more constant than the other factors, DLA would be providing for consistent levels of service.

Thus, in striving for consistent application of expedited delivery for routine requisitions, DORO settled on two factors—an item's price and weight. DLA could use these two factors to control the amount of materiel expedited and the expected return on transportation cost investment. The compelling advantages of this approach overcome any additional economic accuracy that might be available by increasing the range of factors.

ESTIMATING THE COST TO EXPEDITE MATERIEL FOR A SPECIFIC SET OF ITEMS

Once DORO determined how they wanted to apply the tradeoff model, their focus turned to estimating the cost to expedite all materiel for the set of items satisfying specific price and weight criteria. To determine that cost, DORO simulated the following two alternatives:

1. *Baseline alternative—materiel shipped in accordance with original priorities on requisitions.* Routine requisitions are generally shipped by surface small parcel, less-than-truckload, or truckload. High-priority requisitions are generally shipped by air small parcel or air freight.

However, for short distances, priority requisitions may be shipped by surface small parcel.

2. *Expedited alternative—all materiel shipped as high priority.* Under this alternative, all routine requisitions are processed and shipped as if they were high-priority requisitions.

As in their original cost study, DORO used existing distribution models and transportation rates to estimate these costs when simulating each alternative. Their cost estimates covered the second destination transportation from distribution facility to CONUS customer or container consolidation point for overseas customers. They did not estimate costs for the overseas transportation leg.

Once DORO obtained the costs for the two alternatives, they simply subtracted the *baseline alternative* from the *expedited alternative,* to arrive at the extra cost of expediting routine requisitions. Then they entered that cost into the inequality to determine if expedited shipment is cost-effective for the particular set of items being evaluated.

For example, suppose DLA expedited all materiel for the set of items that have a unit price greater than $100 and a unit weight less than 5 pounds. For that set of items, the cost to expedite is $1.5 million, while the annual dollar value of materiel is $464 million. When we put these values in our tradeoff inequality, we have

$$\$464\ million - [(\$1.5\ million)(295)] = \$21.5\ million > 0.$$

RESULTS

Results for other categories of items are provided in Table 5-4. Positive values are the 10-year expected life-cycle savings in millions of dollars associated with expediting, while "N/A" (for not applicable) indicates uneconomical expediting solutions (i.e., zero savings or costs greater than savings).

Table 5-4. Savings for Different Sets of Items ($ million)

	Unit weight					
Unit price	Under 5 lb	Under 10 lb	Under 25 lb	Under 50 lb	Under 100 lb	Under 150 lb
Over $10	N/A	N/A	N/A	N/A	N/A	N/A
Over $50	N/A	N/A	N/A	N/A	N/A	N/A
Over $100	0.23	0.25	N/A	N/A	N/A	N/A
Over $150	3.63	3.53	1.05	N/A	N/A	N/A
Over $200	3.76	3.50	2.08	N/A	N/A	N/A
Over $250	3.45	3.54	2.46	0.77	N/A	N/A
Over $300	3.62	3.43	2.89	1.17	N/A	N/A

The items yielding the greatest expected life-cycle savings have a unit price greater than $200 and a unit weight less than 5 pounds. Table 5-5 provides a summary of routine requisitions for this set of items.

Table 5-5. Statistics for Set of Items with Greatest Economic Payoff

Description	Number of active items	Requisition value ($ million)	Requisition weight (1,000 lb)	Number of requisitions (1,000s)
Items (over $200, under 5 lb)	43,329	319	852	223
Percentage of total	5.5%	8.4%	0.1%	1.6%

Since it only represents 1.6 percent of the workload, expediting this set of items would create a minimal disruption in normal distribution operations. Clearly this also would satisfy DORO's early assumption that a small percentage of routine workload would be expedited.

REALIZING THE FULL BENEFITS OF REDUCING OST

Although levels reductions of between $48.8 and $84.2 million per day of reduced OST are significant, they only represent between 0.16 and 0.27 percent of the total value of the requirements levels for retail inventories identified in this analysis. These small percentages are due to the following:

- Fifty-eight percent of the inventories do not have levels influenced by OST.
- Those inventories that do have levels influenced by OST also have levels that are not involved in OST.
- A reduction of 1 day for OSTs that range from 6 days to 89 days represent reductions of 1 percent to 17 percent.[4] For the reported average logistics response time of 22 days for immediate issues of DLA-stocked items, it represents a reduction of only 4.5 percent.

As we state in Chapter 3, our analysis focuses on modest reductions of OST. This view limits the savings that can be expected from reduced OST. A broader view not only considers levels whose computations are directly affected by OST but also levels whose computations are indirectly affected by OST. Examples are fixed safety levels and Navy endurance levels. If OST were significantly reduced (e.g., to 2 days), management would undoubtedly make significant reduction to these levels, too.

[4] The OSTs for Navy items stocked at FISC Norfolk and Yokosuka ranged from 6 to 89 days.

Commercial initiatives to reduce their OSTs are not just directed at reducing inventories; they attempt to eliminate them. Insurance levels and operating levels are levels that do not have OST in their computations but could be eliminated if DoD were to change its traditional way of providing supply support. DLA's prime vendor program for medical supply is an excellent example of how traditional support can be reengineered to improve performance and reduce costs. By having customers go directly to vendors who offer next-day service, the program not only reduces OST to a minimum, but it also eliminates wholesale and retail levels of stocks.

Therefore, to realize the full benefits of reducing OST, we need to consider proposals that

- eliminate the need for both wholesale and retail levels of stock for an item;
- optimize depth of stockage across wholesale and retail levels of stock, particularly for slow-moving, high-cost items;
- affect the range of items stocked at retail activities, regardless of how the activities compute depth of stock; or
- make policy changes to reduce levels that indirectly consider OST.

FINDINGS AND CONCLUSIONS

We evaluated a proposal for reducing OST by expediting depot issue and transportation segments of OST. For DLA-managed items, we found that it is not cost-effective to expedite routine replenishment shipments for all items, but it is for selective groups of items as defined by unit price and unit weight.

All proposals for reducing OST can be evaluated by trading off their expected costs against their expected savings, the latter as estimated by this analysis. Factors exist that may delay and, in some cases, decrease the budget reductions from expected savings associated with a proposal. However, before decision-makers spend resources to determine exact reductions, they should first determine if a proposal is potentially cost-effective.

In cases where the savings do not support the costs of reducing OST for all items across all retail supply activities, decision-makers may want to pursue OST reductions for a more limited set of items. The DORO analysis shows that this approach is viable.

Finally, DoD can realize larger benefits than those quantified in this analysis by promoting changes that significantly reduce OST, such as DLA's prime vendor program. Such changes tend to eliminate inventory levels, rather than just reducing them.

Appendix A
Terminology and Scope

KEY DEFINITIONS

DoD 4140.1-R, *DoD Materiel Management Regulation*, provides overall guidance on retail inventory management. Each service augments that guidance with its unique policies. DoD 4140.1-R defines retail stock as stock held in the custody or on the records of a supply organization below the wholesale level. It also defines retail-level supply as

> Those secondary items stored within DoD intermediate and consumer levels of supply. These include supply levels down to the following: Army—to Authorized Stockage List (ASL) and installation; Navy—to resupply ships, intermediate maintenance afloat units and shore installations; Air Force—to base supply; Marines—to Marine Expeditionary Force (MEF) and base supply. Retail-level assets do not include End Use Secondary Item Materiel.

For purposes of assessing the full potential of DoD's initiative to reduce order and shipping time (OST), we identify retail inventories down to, but not including, the actual materiel in use. Consequently, we look at levels below those called out in the regulation. Specifically, for the Army, we consider not only installation ASLs but also corps and division ASLs and unit load lists. And, for the Navy, we review all shipboard levels, not just resupply ships and intermediate maintenance afloat units.

Consumer and Intermediate Levels of Supply

DoD 4140.1-R distinguishes between retail consumer and intermediate levels of inventory. The consumer level of supply is

> An inventory, regardless of funding source, usually of limited range and depth, held only by the final element in an established supply distribution system for the sole purpose of internal consumption.

The intermediate level of supply refers to any level of inventory between the consumer and wholesale level of inventory.

In our catalog of retail supply activities, we look at both levels of supply. However, in our analysis of OST, we focus on retail supply activities, whether intermediate or consumer, that are resupplied from the wholesale level. Consumer

levels of supply resupplied from an intermediate level are included in our catalog of retail supply activities, but they are not part of our analysis of OST.

Reasons for Stockage

DoD 4140.1-R further prescribes that secondary item inventories be identified with a reason-for-stockage category (RSC).[1] The applicable categories are

- stocked demand (SD),
- stocked limited demand (SL), formerly stocked numeric (SN),
- stocked insurance (SI),
- stocked provisioning (SP),
- stocked war reserve (SW),
- not stocked (NS), and
- other (NK).

However, only intermediate levels of inventory need to be identified by RSC.

Figure A-1 illustrates the relationship between DoD supply terminology and RSC categories and how they are used to characterize stocked items. Although not all of the terms in this figure are used universally by the military services, they are helpful in defining why and how a retail supply activity stocks individual items.

Recoverability

A major characteristic that governs how an item is managed within the DoD retail supply system is its recoverability, that is, whether the item is reparable or consumable. A reparable item is

> An item of supply subject to economical repair and for which the repair (at either depot or field level) is considered in satisfying computed requirements at any inventory.
>
> a. Depot Level Reparable Item. A reparable item of supply that is designated for repair at depot level or that is designated for repair below the depot level, but if repair cannot be accomplished at that level, will have its unserviceable carcasses either forwarded to the depot for repair or condemnation, or reported to the ICP for disposition.

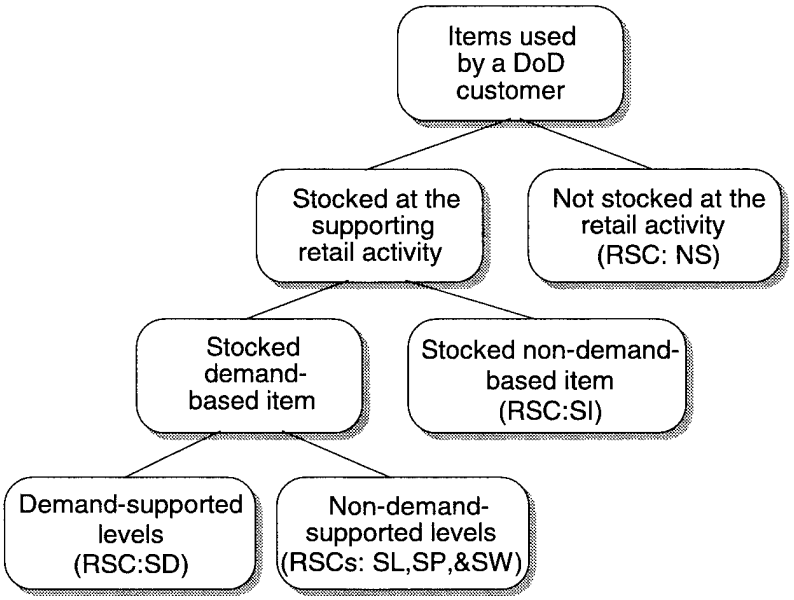
[1] See pages 3-12 – 3-14 of DoD 4140.1-R for a discussion of the reason-for-stockage categories.

b. Field Level Reparable Item. A reparable item of supply that is normally repaired below the depot level of maintenance and for which condemnation authority can be exercised below the depot level of maintenance.

A consumable item is

> An item of supply (except explosive ordnance, major end items of equipment, and reparable items) that is normally expended or used up beyond recovery in the use for which it is designed or intended.

Figure A-1. Basis for Stocking an Item



SCOPE OF ANALYSIS

Range of Items

The item commodities (supply classes) included in the analysis (except where indicated) are

- nonperishable subsistence (Class I);
- clothing, individual equipment, tentage, tool sets, tool kits, hand tools, administrative supplies and equipment, and housekeeping supplies (Class II);
- packaged petroleum, oils, and lubricants (Class III);

- construction materiel (Class IV);
- medical materiel (Class VIII); and
- repair parts and components, including kits, assemblies, and subassemblies, reparable and nonreparable, required for maintenance support of all equipment (Class IX).

The item commodities (supply classes) excluded from the analysis are

- water, perishable, and brand-name subsistence (Class I);
- bulk fuels (i.e., Class III fuels managed by the Defense Logistics Agency's Defense Fuels Supply Center);
- ammunition (Class V);
- personal nonmilitary items (Class VI);
- major end items (Class VII); and
- materiel to support nonmilitary programs, e.g., agriculture and economic development (Class X).

Types of Activities

The types of retail supply activities included in the analysis are

- supply activities providing weapon system or tactical support;
- installation supply activities at bases, forts, camps, stations, etc.;
- supply activities supporting depot maintenance activities; and
- medical supply support activities.

The types excluded from the analysis are

- fuel supply activities,
- ammunition supply activities,
- post exchanges and commissary supplies, and
- local post engineering supply support.

Appendix B
Army Retail Inventory Management

INTRODUCTION

This appendix examines the U.S. Army's retail supply operations in the areas of secondary items and medical supplies, which have an estimated value in excess of $1.75 billion in Operations and Maintenance, Army (O&MA), and $2.25 billion in Defense Business Operating Fund (DBOF) appropriations. In addition, it describes how the inventory levels are computed and how they are affected by order and shipping time (OST). A separate section at the end of this appendix discusses Army retail management of medical supplies since it differs from retail management of other secondary items.

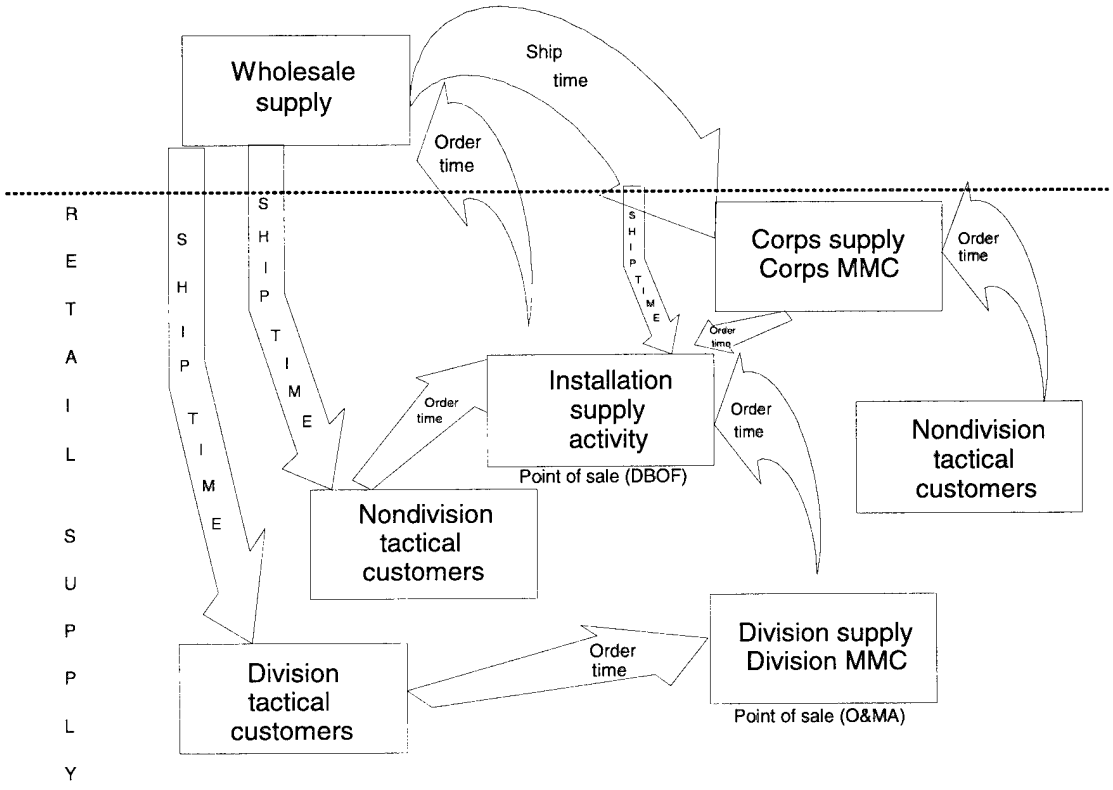
This appendix is based on interviews and research conducted at the Office of the Deputy Chief of Staff for Logistics, Department of the Army, Washington, DC; Headquarters, U.S. Army Materiel Command (AMC), Alexandria, VA; Combined Arms Support Command, Fort Lee, VA; Headquarters III Corps, 13th Corps Support Command and subordinate units, and the Installation Directorate of Logistics (DOL), Fort Hood, TX; and 1st Corps Support Command, I Company, 159th Aviation Regiment, 249th Repair Parts Company, and the Installation DOL, Fort Bragg, NC. Additional background information was obtained from Forces Command, Fort McPherson, GA; Industrial Operations Command, Rock Island, IL; and the Logistics Support Activity, Redstone Arsenal, AL.

OVERVIEW OF ARMY SUPPLY SYSTEM

As illustrated in Figure B-1, the U.S. Army maintains an extensive supply system to support soldiers and their equipment in peace and war. This overview provides a simplified picture of the organizations and requisitioning processes related to OST within the Army supply system. The retail level includes

- the tactical unit, which performs unit and operator equipment maintenance and unit supply functions;
- direct support (DS) supply and maintenance, which performs logistics support directly for tactical units and activities; and
- general support (GS) maintenance and supply activities (corps and installation), which perform logistics functions in support of theater-level and installation activities.

Figure B-1. Overview of Army Supply System



Note: MMC = Material Management Center.

The wholesale level consists of the AMC, Defense Logistics Agency (DLA), General Services Administration, the other DoD suppliers, and contractors.

Within these wholesale and retail levels of supply, the Army manages an inventory with an estimated value of $195 billion. As shown in Table B-1, that inventory consists of weapon systems, major end items, ammunition, secondary items (spares and repair parts), medical supplies, food, etc.

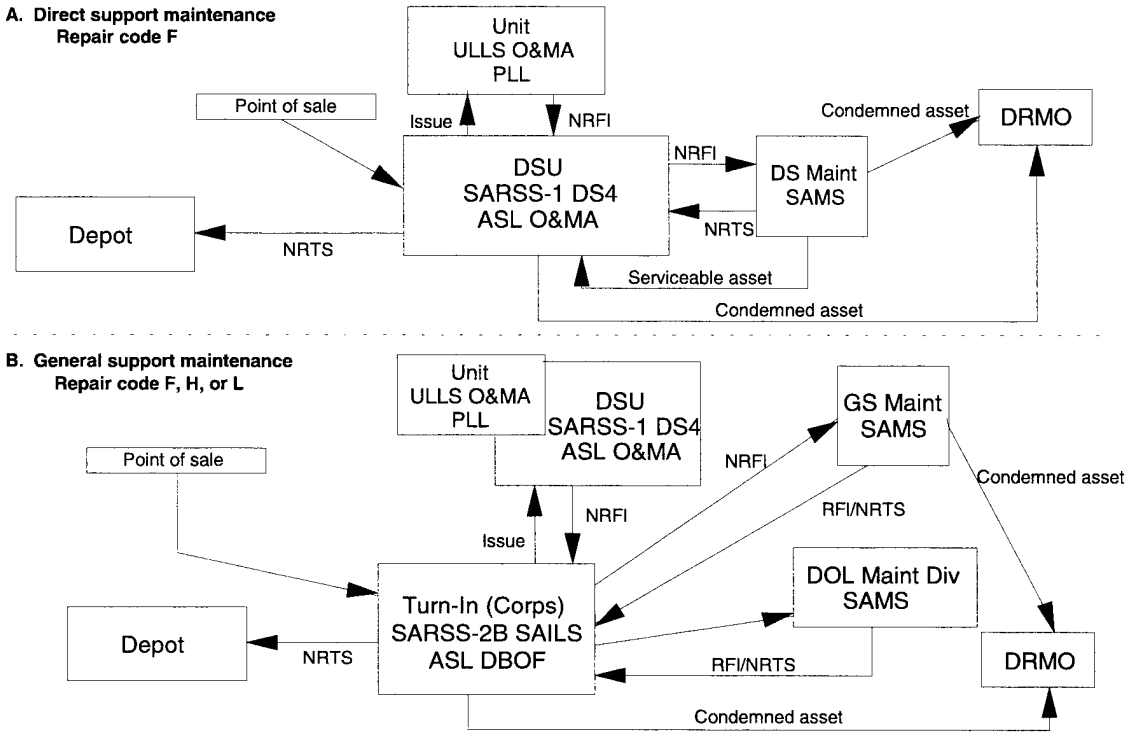
Table B-1. Total Army Inventory Value ($ billion)

Inventory	Value
Major end items	157.00
Ammunition	23.00
Secondary items (DBOF)	13.00
Authorized stockage lists/prescribed load lists (O&MA)	0.90
Medical	0.85
Total	194.75

Key Feature—Designed to Support Multiple Levels of Maintenance

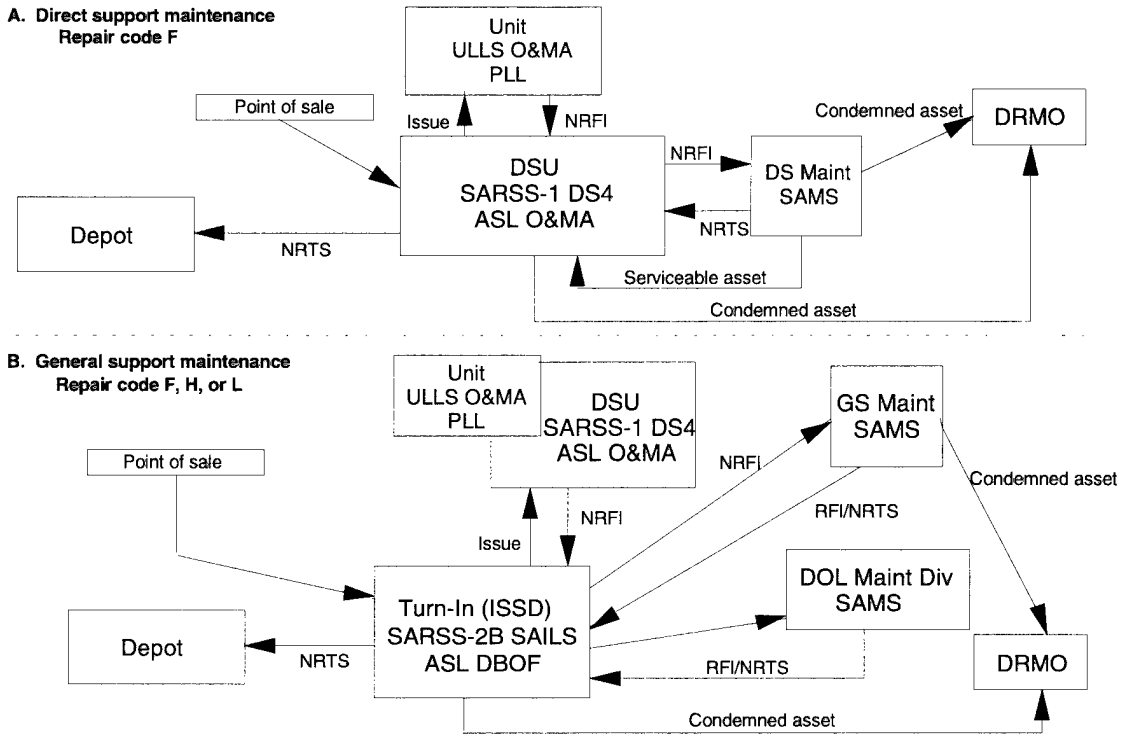
The Army supply system is designed to support the maintenance level associated with a particular level of supply. Figures B-2 and B-3 provide an overview of these maintenance levels with their supply support activities (SSAs).

Figure B-2. Overview of Army Maintenance Levels (Corps)



Note: ASL = authorized stockage list; DRMO = Defense Reutilization and Marketing Office; DS4 = Direct Support Unit Standard Supply System; DSU = direct support unit; NRFI = not ready for issue; NRTS = not repairable this station; O&MA = operations and maintenance Army; PLL = prescribed load list; RFI = ready for issue; SAILS = Standard Army Intermediate Level Supply System; SAMS = Standard Army Maintenance System; SARSS = Standard Army Retail Supply System; ULLS = Unit Level Logistics System.

Figure B-3. Overview of Army Maintenance Levels (Non-Corps)



Note: ISSD = Installation Supply and Services Division.

As a general rule, maintenance is performed at the lowest level and at the closest location to the item's operation or failure to the maximum extent possible, consistent with the tactical situation and the source, maintenance, and recoverability code contained in the equipment technical manuals. Currently, maintenance (less aviation) is performed at the following four levels of progressive complexity: unit, DS, GS, and depot. These levels are described as follows:[1]

- *Unit.* Unit-level maintenance, performed by the user, is characterized by quick turnaround based on replacement and minor repair (adjust, clean, lubricate, or tighten). The cornerstone of unit maintenance is performing preventive maintenance checks and services.

- *Direct Support.* This level is performed by DS units assigned to the division, corps, and theater level. It is characterized by high mobility, a forward orientation, and repair by replacement. Divisional maintenance units support maneuver elements, while nondivisional units provide area support and reinforcing support to the division. DS units are organized on a modular team basis to support specific systems and their auxiliary equipment, e.g., a tank battalion team or engineer battalion team. Battle damage assessment teams are assigned to the nondivisional maintenance units.

[1] U.S. Army War College, *Army Command, Leadership, and Management: Theory and Practice, 1995–1996,* June 1995.

- *General Support.* GS maintenance is characterized by semi-fixed facilities assigned at the theater level. It represents a deployable, sustaining maintenance capability. Its fundamental purpose is to support the theater supply system through the repair of components. Maintenance at this level is job- or production-line operations, as appropriate, performed by modular units composed of commodity-oriented platoons. A GS maintenance unit may work as a theater special repair activity. GS maintenance is also performed at fixed facilities by the installation DOL.

- *Depot.* Maintenance at this level supports the wholesale supply system. It is production-line oriented and is performed by commodity-oriented units, special repair activities, AMC depots, and contractor personnel.

On the other hand, aviation maintenance is performed at three levels: aviation unit maintenance (AVUM), aviation intermediate maintenance (AVIM), and depot. AVUM is a combination of organizational (unit) and some limited DS maintenance; AVIM is a combination of the remaining DS and limited GS maintenance capabilities. The third level is depot, and this level includes some maintenance normally performed at the GS level. Some DOLs and contractors also perform DS and GS maintenance at the installation level.

ARMY RETAIL SUPPLY

Activities

U.S. ARMY RETAIL COMMAND-ORIENTED SUPPLY ACTIVITIES

At echelons above corps (EAC) the Army supply system operates under a horizontal command channel revolving fund concept. Each major command has its own DBOF division to budget for and requisition its supplies. There is one DBOF account (division) for each major command, which are as follows:

- U.S. Army Forces Command, Fort McPherson, GA
- U.S. Army Training and Doctrine Command, Fort Monroe, VA
- U.S. Army, Europe, Heidelberg, Germany
- U.S. Army, 8th Army, Republic of Korea
- U.S. Army, South, Fort Clayton, Panama
- U.S. Army, Pacific, Fort Shafter, HI
- U.S. Army Materiel Command, Alexandria, VA.

The supplies held at the corps level and below are funded with O&MA appropriations.

CORPS SUPPORT COMMAND/THEATER ARMY AREA COMMAND

Logistics in the theater of operations is tailored to support the combat force requirements for each situation. The theater Army commander is responsible for providing logistics support to all Army units in the theater and executes this responsibility through one or more subordinate theater Army area commands (TAACOMs). Additionally, the theater commander manages and controls selected items through the theater Army materiel management center (TAMMC). The corps support command (COSCOM) provides maintenance, supply, transportation, health services, and field services support to an Army corps.

The COSCOM and TAACOM materiel management centers (MMCs) supervise supply operations at the supply and maintenance activities under their commands. However, no COSCOM or TAACOM authorized stockage list (ASL) backs up another ASL. The backup stockage is retained at the wholesale level. While materiel flow is from the source of supply (SOS) to the individual SSAs, the COSCOM, TAACOM, and TAMMC are kept aware of the supply situation by management information supplied by the SSAs and the wholesale system.

Corps and TAACOM MMCs operate under the DBOF concept. All O&MA user requisitions are processed through the DBOF to the SOS. When customer requisitions are routed through the retail DBOF, simultaneous obligation of O&MA and retail DBOF resources is recorded.

Systems

The following sections describe briefly each Army automated retail system.

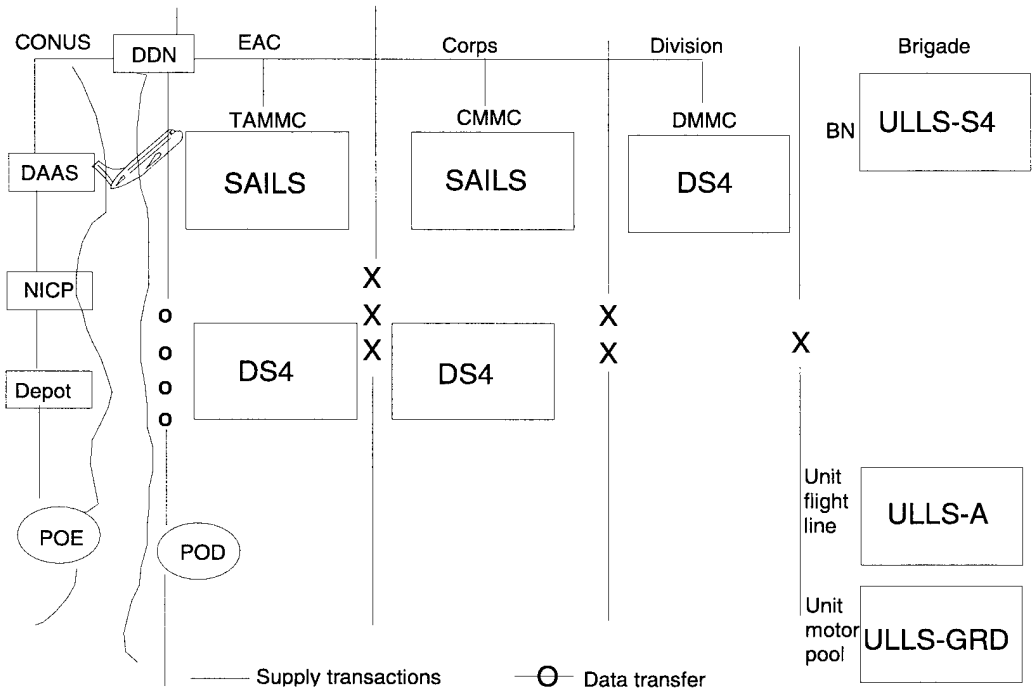
UNIT LEVEL LOGISTICS SYSTEM

The ULLS provides automated support to the unit motor pool (ground), the flight line operations (aviation), and the battalion S-4's operations. The ULLS provides automated transaction processing for prescribed load list (PLL) and maintenance functions. It also provides an automated interface with supply and maintenance management at the tactical unit level, tracks unit readiness, forecasts basic loads, provides asset visibility at the hand-receipt and sub-hand-receipt levels, maintains historical records, and assists in operational planning. The ULLS is linked but not integrated into the next level of supply automation, which is the direct support standard supply system (DS4).

STANDARD ARMY INTERMEDIATE LEVEL SUPPLY SYSTEM

SAILS is the automated supply system that operates at the intermediate level and interfaces with both the wholesale and user levels. SAILS provides automated support to the functions of supply management, stock control, and supply-related DBOF and financial inventory accounting. SAILS operates in a batch mode and supports the management of supply and related financial transactions for all classes of supply except classes I (health and welfare); IIIB (bulk petroleum); VI (personal, nonmilitary items); and VIII (medical materiel). It is located at approximately 56 sites, 12 outside CONUS. Figure B-4 is a diagram of the SAILS and DS4 configuration.

Figure B-4. Standard Army Intermediate Level Supply System/ Direct Support Unit



Note: BN = Battalion; CMMC = corps materiel management center; DAAS = Defense Automated Addressing System; DDN = Defense Data Network; GRD = ground; NICP = national inventory control point; POD = port of debarkation; POE = port of embarkation; ULLS-A = Unit Level Logistics System-Aviation; ULLS-GRD = Unit Level Logistics System-Ground; ULLS-S4 = Unit Level Logistics System-Battalion S-4 Operations.

STANDARD ARMY MAINTENANCE SYSTEM–1/2

SAMS automates the maintenance shops and provides commanders with maintenance management information. SAMS-1/2 has been operational for 5 years. SAMS-1 automates shop production functions, maintains control records, maintains shop supplies, and requisitions repair parts. It receives maintenance data from the battalion maintenance section's ULLS. SAMS-2 provides field

commanders with selected maintenance, equipment readiness, and equipment performance reports. It also provides engineering, readiness, and life-cycle management data to the AMC's Logistics Support Activity.

DIRECT SUPPORT UNIT STANDARD SUPPLY SYSTEM

The DS4 is a supply management system designed for divisional, separate brigade, and nondivisional direct support units (DSUs). It automates the routine supply and stock control procedures of the DSU and the division materiel management center (DMMC). It is used to manage supply Classes II (clothing, individual equipment, tentage, tool sets, tool kits, hand tools, administrative supplies and equipment, and housekeeping supplies); IIIP (packaged petroleum products); IV (construction materiel); VII (major end items of equipment); and IX (spares and repair parts). DS4 operates in a batch mode and is linked, but not integrated with, other retail supply, maintenance, and financial systems.

STANDARD ARMY RETAIL SUPPLY SYSTEM–OBJECTIVE

The Army is currently changing its retail automated supply system from a ULLS, DS4, and SAILS configuration to an umbrella configuration called the Standard Army Retail Supply System–Objective (SARSS-O). While ULLS will remain at the tactical unit level, DS4 and SAILS will be replaced. SARSS-1 will replace DS4, and SARSS-2A/B will replace SAILS. SARSS-O provides a vertically integrated automated process from the divisional forward DSU and nondivisional DSUs through the TAMMCs. Theater, TAACOM, and corps MMCs are provided the visibility of all stocks at DSUs and storage sites within their command. The objective system provides "near-real-time" requisitioning with the capability to run several cycles each day. The system consists of the following attributes and functions.

SARSS-1

- Operates at the DS and GS levels and interfaces with ULLS and the SAMS-1/2.
- Supports the supply management function at the SSA.
- Automates the functions of requisition processing, receipt processing, storage and issue/turn-in, and backorder release.
- Supports the functions of inventory management, location survey, excess reporting, and property book reporting.

SARSS-1 interfaces with the Defense Automated Addressing System (DAAS), ULLS, SARSS-2, and SAILS.

SARSS-2A

- Operates at the division, corps, and EAC.
- Provides automated support to supply management.
- Supports requisition routing, horizontal and vertical asset visibility, and excess disposition and controls materiel release.
- Obligates customer funds.
- Produces summary records, performance reports, and time-sensitive transaction reports.

SARSS-2A is integrated with SARSS-1, SARSS-2B, and the wholesale system. It also interfaces with SAMS-1/2 and the retail financial management systems.

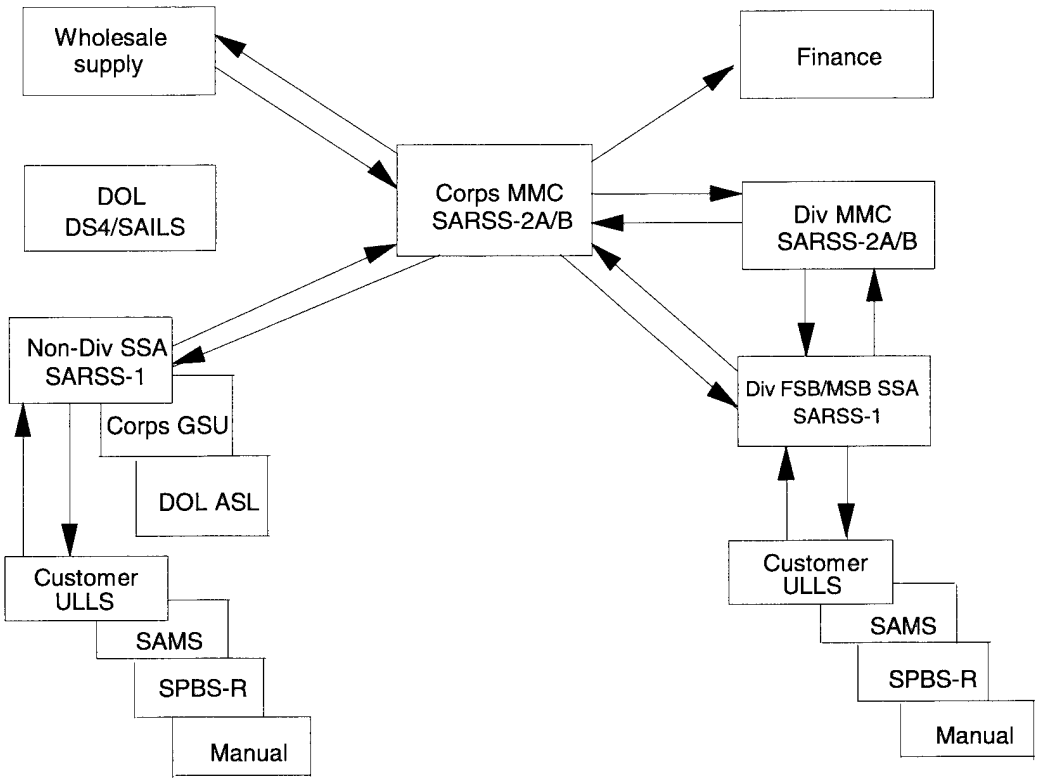
SARSS-2B

- Operates at the corps and EAC.
- Maintains demand history and performs demand analysis.
- Maintains Army Master Data File catalog support.
- Computes stockage levels.
- Provides interfaces to retail financial systems.

SARSS-2B is integrated with SARSS-2A and interfaces with SAMS-1/2.

Part of the SARSS configuration has been fielded for a few years. However, the complete system has been implemented at Fort Bragg, NC; Fort Lewis, WA. U.S. Army, South, Panama; and Fort Stewart, GA. The objective system is scheduled for fielding throughout the Army in the coming years. Figure B-5 is a view of the SARSS-O configuration at Fort Bragg.

Figure B-5. SARSS-O, Fort Bragg Configuration



Note: FSB = forward support battalion; GSU = general support unit; MSB = main support battalion; SPBS-R = Standard Property Book System–Revised.

STANDARD PROPERTY BOOK SYSTEM–REVISED

The Standard Property Book System–Revised (SPBS-R) is an interactive, on-line property accountability and reporting system that operates on the Tactical Army Combat Service Support Computer System in table of organization and equipment (TO&E) environments. SPBS-R has been operational for 7 years and has greatly improved property management and asset reporting.

SPBS-R provides on-line management information and automated reporting procedures for the property book officer and produces updated company-level hand receipts. It also provides automated interfaces with the SSAs for the request and receipt of equipment, the Continuing Balance System–Expanded for worldwide asset reporting, the Asset Control System for authorization data, and all central registries for serial number tracking.

THEATER ARMY MEDICAL MANAGEMENT INFORMATION SYSTEM

The Theater Army Medical Management Information System (TAMMIS) tracks patients and manages medical information for field (TO&E) medical units. It

supports readiness missions while in garrison and training exercises. TAMMIS is composed of the following logistics functional areas:

- Medical supply
- Medical maintenance
- Medical optical fabrication.

TAMMIS is being fielded Army-wide on the new Army Tactical Command and Control System Common Hardware Software Version One microcomputer and the new Corps Theater ADP Service Center-II computer.

Requisitioning Channels

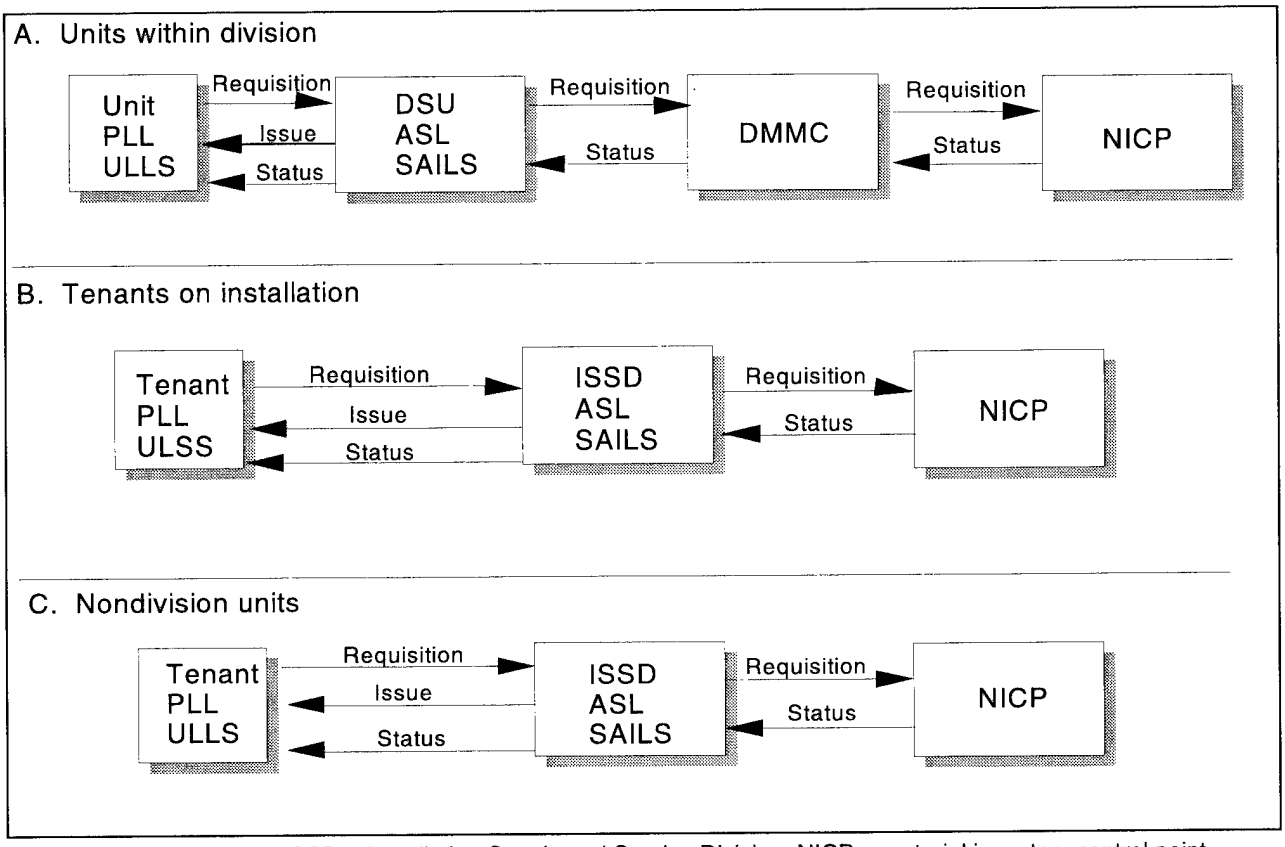
This section provides an overview of the Army's retail requisitioning process. There are several variations and some unique processes used in certain parts of the Army that will be discussed. However, the basic process is as follows:

- If the requester has an automated capability, the request is submitted by the automated means to the SSA. Otherwise, the requisition is prepared manually and is hand-carried to the supporting SSA.
- The SSA fills the request and records a demand if it has the stock on hand. If it does not have the stock on hand, the requisition is forwarded to the wholesale level, retaining the date of the original request.
- If by filling the requisition or for other reasons, the stock level is drawn below the reorder point (ROP), the SSA prepares a replenishment requisition and forwards it to the wholesale level.
- The OST begins on the date that is placed on the requisition by the originator (unit or SSA).

Figure B-6 portrays the Army requisition flow for tactical units within a division, tenant activities on an installation, and nondivisional units.

A unique new automation initiative instituted by the Army that affects OST is the objective supply capability (OSC). The OSC application process is used in certain parts of the Army to improve the communication and automation techniques for placing requisitions on the SOS the same day that they originate. OSC also maintains information on all assets in a defined geographical area. It provides for lateral distribution of assets, asset visibility, near-real-time status to the user, and a reduction in the processing segment of OST. OSC has a direct interface with ULLS, DS4, and SAILS.

Figure B-6. Division/Installation Army Requisition Flow



Note: ISSD = Installation Supply and Service Division; NICP = material inventory control point.

OSC operates on a gateway computer at the St. Louis, MO, Defense MegaCenter. The customer enters the requisition into the local automated system, which forwards the request to the gateway. Each of the Army's automated supply systems provides a daily update to the asset balance file (ABF) in OSC. If OSC determines that the requisition can be satisfied by the requester's SSA, the requisition is returned to the customer with instructions to submit the requisition to the SSA. If the SSA cannot fill the requirement, OSC searches the ABFs of all other SSAs in its designated geographical area. If there are redistributable assets available, OSC creates a materiel release order for the materiel and sends status to the customer. If there are no redistributable assets, OSC forwards the requisition to the inventory control point (ICP) and provides status to the customer, the SSA's automated system, and SAILS. OSC issues to a zero balance for requisitions on the supporting SSA. However, if the item is in another SSA, the system will issue to the ROP for a high priority (Priority 1–8) requisition and to the requisitioning objective (RO) for all others.

RETAIL INVENTORY LEVELS AND OST

Stockage Policies and Practices

The Army stores retail-level stocks in many locations and configurations. The basic purpose of these stocks is to support unit operations, unit and intermediate maintenance activities, and AMC depot maintenance.

ARMY RETAIL SUPPLY STOCKS

There are four types of stockage levels authorized for the Army retail level of supply: PLL, ASL, shop stocks, and bench stocks.

Prescribed Load List

The lowest level of stockage maintained in the Army retail supply system is the PLL. These stocks are primarily demand supported and are used to support tactical unit operations.[2]

Authorized Stockage List

An operational unit's PLL is supported by an ASL maintained by the SSA designated to support the unit. The SSA also provides backup bench and shop stocks utilized in the intermediate maintenance activities. Each SSA is assigned a specific set of customers, and no retail-level SSA backs up another SSA. The backup support is provided by the wholesale-level ICPs. For items that are repaired at EAC, i.e., at GS maintenance companies and the DOL at an installation, a portion of the repair cycle quantity may be positioned in the repair parts company at the corps level.

Shop Stocks

Shop stocks are demand-supported repair parts and consumables stocked within a support-level maintenance activity. They are used internally to accomplish a maintenance request or a programmed repair.

Bench Stocks

Bench stocks are low-cost, high-use, consumable Class II, III (packaged), IV, and IX (less components) items used by maintenance personnel at an unpredictable rate. Bench stocks include items such as common hardware, resistors, transistors, capacitors, sears, triggers, extractors, ejectors, wire, tubing, hose, ropes, webbing, thread, welding rods, sandpaper, gasket materiel, sheet metal, seals, oils, grease, and repair kits.

[2] Commanders are authorized to add mission-essential and seasonal items that are not demand supported.

Approval of the bench stock list by the maintenance officer is required semiannually. This stock level is not subject to demand-supported criteria.

RANGE OF STOCK

The Army retail stocks are funded by DBOF or O&MA appropriations. When a new piece of equipment is fielded, an engineering estimate is used to determine what items and quantities are needed to maintain the item. These items remain in stock under stockage list code P until the end of the demand development period (up to 24 months). At the end of the demand development period, there are several ways an item can be added or retained on the stockage list as demand-supported stock:

- Ground support items
  - Six demands in 360 days to add an item
  - Three demands in 360 days to retain an item.
- Aircraft support items
  - Three demands in 360 days to add an item
  - One demand in 360 days to retain an item.

In addition to the above criteria, an item may be added to the ASL either under the economic order quantity (EOQ) process or by the commander designating the item essential (either for readiness or seasonal requirements).

DEPTH OF STOCK

Each item on the stockage list has an RO. The RO is the maximum quantity of the item that is authorized to be on hand and on order at any one time. Table B-2 shows requirements levels authorized in the RO for both consumables and reparables.

Table B-2. Army Retail Requisitioning Objectives Levels

Requisition objective levels	Consumables	Reparables
Protectable war reserves level	X	X
Safety level	X	X
Reason-for-stockage category level[a]	X	X
Repair cycle level		X
Order and shipping time level	X	X
Operating level	X	X

[a] The reason-for-stockage category level is for initial fielding plus the commander's discretionary items.

The ROP, which includes the OST and the safety level based on forecasted demand, is established for consumables. Each time the inventory level reaches the ROP, a replenishment requisition is submitted for a quantity to increase the item's balance to the RO. For reparables, the reorder point is based on the net demand (demand minus anticipated repairs).

SUPPORT LIST ALLOWANCE/TOTAL PACKAGE FIELDING CONCEPT

The initial stockage for new weapon systems utilizes a sparing-to-availability model, the Selected Essential Stockage for Availability Method (SESAME), to compute support list allowance quantities. These quantities are used to determine which items will be provided for the new equipment's support during the demand development period. Tactical unit and aviation unit maintenance initial issue stockage is limited to essential parts expected to meet the retail stockage "add" criteria for SSAs. Intermediate DS, intermediate GS, special repair activities, and AVIM initial stockage is limited to essential, safety, legal, and climatic parts that are expected to meet the retail stockage add criteria for SSAs.

Initial issue requirements are fielded with the equipment under a concept called total package fielding. Under this concept, the complete support package for the receiving unit is shipped by the fielding ICP with the end item. Support packages for GS units supporting the receiving unit are provided by the ICP to the GS unit and the installation DOL.

Computation of Requirements Levels

Selected supplies are acquired and stored at the unit, installation, and corps levels to fill authorized operational requirements. Supply control studies are completed at each level to determine what items meet the criteria for stockage and how much will be stocked. Demands are recorded on the stock record account and demand files for all items requisitioned. These demands (plus other known requirements) are used to compute the requirements levels for that activity. For those items that meet the criteria for stockage, an RO is computed using either days of supply (DOS), the EOQ, or a combination of both. The following sections review the Army retail requirements determination process and highlight those portions that relate to OST.

DAYS OF SUPPLY

The Army retail supply levels are primarily based on DOS. The DOS authorized for each of the consumable demand-supported items are shown in Table B-3.

Table B-3. Number of Days of Supply Authorized for Demand-Supported Items

Level	CONUS	OCONUS	AMC	ALOC
Operating level	15	30	15/30[a]	30
Order and shipping time level	Actual	Actual	Actual	Actual
Safety level	5	15	15	5

Note: ALOC = air lines of communications.
[a] CONUS/OCONUS.

For reparables, the stockage level is computed at the supporting SSA for that level of repair. For example, items that are repaired at the DS level (maintenance repair code F) will have their stockage levels computed by the division materiel management center or the corps materiel management center (CMMC). The following levels are authorized for this computation:

- Repair cycle level based on the average annual repair for the item
- Operating level based on the average annual condemnations
- OST level based on the net demand
- Safety level of 5 DOS based on net demand.

INTERMEDIATE-LEVEL OST DETERMINATION

Low-priority receipts are used to update the OST. Only routine replenishment receipts are considered. After selecting the routine receipts, a determination is made whether the receipts' days are within an acceptable range by comparing them to a floor and a ceiling. Once this determination has been completed, the OST is calculated. The three-step process is as follows.

Step 1. The allowable deviation is computed.

allowable deviation = (1.25) (*old OST variance*) (*number of standard deviations*).

Note: The *old OST variance* is obtained from the demand master file (DMF), and the *number of standard deviations* is obtained from the values loaded in the Demand Analysis System Control (DASC).

Step 2. A floor and a ceiling are established using the allowable deviation.

floor = *old average OST – allowable deviation*;
ceiling = *old average OST + allowable deviation.*

Note: The *old average OST* is obtained from the DMF.

Step 3. The OST on the incoming receipt is compared with the floor, ceiling, and system constraints to arrive at the final transaction OST.

After selecting routine replenishments and applying the floor and ceiling, the average OST and the average OST variance are updated. A smoothing technique, a mathematical procedure used to combine a large number of transactions into a single number without affecting the accuracy of the data, is applied. The average OST and the average OST variance are smoothed figures.

The average OST is updated by a two-step process.

Step 1. The OST smoothing factor (*OSTSF*) is computed.

$$OSTSF = \frac{2}{REPL+1}.$$

Note: *REPL* is the number of replenishment receipts to be used when computing the average OST in the DASC OST system.

Step 2. The *new average OST* is computed.

new average OST = (OSTSF) (transaction OST) + (1 – OSTSF) (old average OST).

Note: The *old average OST* represents the previous average OST from the DMF.

Updating the average OST variance involves a three-step process to compute a different smoothing factor and a transaction variance (TV) before determining the new average OST variance.

Step 1. The OST variance smoothing factor (*OSTVSF*) is computed.

$$OSTVSF = \frac{2}{\frac{REPL}{2}+1}.$$

Step 2. The *TV* is computed.

TV = transaction OST – old average OST.

Step 3. The new average *OST* variance is computed.

new average OST variance = (1 – *OSTVSF*) (*old OST variance*) + (*OSTVSF*) (*TV*).

Note: The *old OST variance* represents the previous *OST* variance obtained from the DMF.

KEY FEATURES OF THE SARSS DEMAND ANALYSIS SYSTEM

In the SARSS Demand Analysis System, demand history information is consolidated for an entire corps, TAACOM, and installation on SARSS-2B. The history is maintained for each SSA by stock number and end item code. The system maintains up to 24 months of demand history and computes the standard deviation of the quantity demanded for use in safety level computations. The system also maintains up to the last 12 observations of OST and the standard deviation of OST for use in safety level computations. In addition, the system maintains up to the last 12 observations of repair cycle time for reparable level computations.

Demand analysis is performed in SARSS-2B for each SSA using parameters established and maintained in SARSS-2A. The parameters include both breadth and depth constraints:

- ASL breadth constraint parameters for each SSA (except the general supply support base) include the following:[3]
  - Maximum cube allowed in ASL
  - Maximum dollars for additions and increases minus deletions and decreases
  - Separate essential and nonessential add and retain demand criteria by class of supply
  - Order of merit, consisting of
    - end item essentiality,
    - item essentiality,
    - standard unit price,
    - cube, and
    - demand frequency.
- Items that pass the breadth constraints are processed through the depth constraint parameters for each SSA. The depth constraint parameters are as follows:
  - EOQ operating level (OL) with a minimum (floor) and a maximum (ceiling) DOS OL parameter by class of supply

[3] The general supply support base is a corps-managed forward supply point that stores part of the theater war reserves. The stocks are a set quantity and are used to fill only emergency requisitions.

- Safety level, based on a standard deviation of demands in OST computed with a minimum (floor) and a maximum (ceiling) DOS.

SARSS-O Stockage Levels

To compute the RO for an item, SARSS-O uses a combination of EOQ and DOS with a controllable parameter for days of stockage. The computation is made using the following two steps, which results in the selection of the RO to use at the end of step 2.

Step 1. An EOQ RO and a DOS RO are computed. The EOQ RO is compared to the DOS RO using a minimum number of days (15-day parameter). The greater RO is selected for use in step 2.

Step 2. The DOS RO for a maximum period (90 days) is compared to the RO computed in step 1. The smaller RO is used.

In these calculations, an exponential smoothing technique is used for demands over a 24-month period to determine the stockage level. To compute the safety levels, an algorithm is applied that uses 5 DOS based on one standard deviation of demand and one standard deviation of OST. The determination of lines to be stocked is based on demands, item essentiality, end item code, cost, weight, and cube.

Dollar Value of OST in Requirements Levels

The dollar value of retail DBOF inventory, as of the 31 March 1995 stratification, is shown in Table B-4.[4]

Table B-4. Army Inventory Data—Retail Stratification ($ million)

Activity	Requisitioning objective	OST level	Safety level reparable	Safety level consumable	Annual demand
U.S. Army Forces Command	239	57	7	2	422
U.S. Army Training and Doctrine Command	169	42	15	5	235
U.S. Army Materiel Command	Not available	13	not available	7	29
U.S. Army, Europe	397	29	3	1	76
U.S. Army, Pacific	77	9	3	1	24
U.S. Army, South	12	3	1	1	9
U.S. Army, 8th Army	823	25	2	1	20
Total	1,716	178	30	17	815

Note: The total is less than the sum due to rounding.

[4] Dollars are not revalued to latest acquisition cost.

We used the data in Table B-4 to compute the value of 1 day of OST as follows:

- *OST level.* We divided the OST level by the annual demand to arrive at the value of 1 day of OST.

- *Safety level.* We divided the OST level by the annual demand to arrive at an average OST and then used the square root relationship to calculate the effect of a 1-day reduction in OST.

Data on the dollar value of assets in the retail O&MA inventory was not available. We developed an estimate for the value of 1 day of OST for O&MA activities by

- multiplying the dollars for the 8 activities from which we collected data by 35 (our best estimate of the number of total O&MA activities) to arrive at an estimate for O&MA total requirements;

- using our DBOF estimates to compute ratios for the value of 1 day of OST compared to value of total requirements; and

- applying the ratios to our O&MA total requirements estimate to arrive at the value of 1 day of OST in O&MA requirements.

FUTURE PLANS

Several Army inventory management initiatives are being pursued that will affect OST for retail customers. These initiatives include central asset management (CAM).

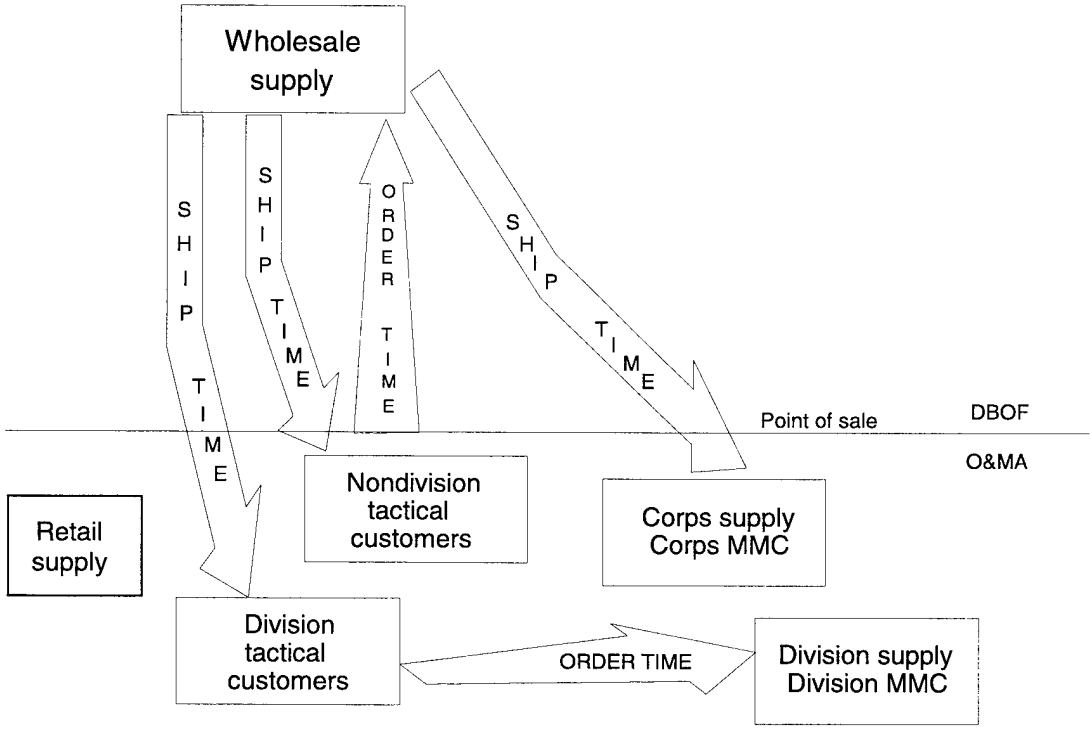
CAM, formerly the single stock fund, is a set of business practices that will integrate centralized inventory management at the Army wholesale level with the intermediate supply practices at the corps and installation levels. Implementation of these changes will link the wholesale level more closely with the tactical units.

The infrastructure requirements for supply and financial inventory accounting will be reduced by CAM. Redistribution of assets will be directed by the ICPs with access to the total national requirements, assets, and priorities. This will permit redistribution from the point of origin to the point of required consumption without redundant intermediate- and depot-level materiel handling and transportation. It will also eliminate the numerous billing and financial inventory accounting transactions currently processed under the horizontal command channel of DBOF now in operation.

This concept of operations will allow the item manager to position assets closer to the user and allow the DS and operational units to submit their requisitions directly to the SOS, eliminating simultaneous obligation of O&MA and retail

DBOF resources. CAM should result in a much shorter OST for Army customers. Figure B-7 is an overview of the retail supply system under the CAM concept.

Figure B-7. Supply Under the CAM Initiative



RETAIL MEDICAL INVENTORY MANAGEMENT

Medical Activities

The Army has an extensive supply system in support of its medical operations. Medical supplies (Class VIII) are stored at various echelons of supply.

DIVISION MEDICAL SUPPLY OFFICE

The division medical supply office (DMSO) stores items to support the forward medical companies that support the battalion aid stations and field medics positioned with the front line forces. These stocks are O&MA funded. Supplies issued to the battalion aid stations are issued on an informal basis rather than by the standard requisitioning process.

Supplies are issued to the customer as needed and, in most cases, in preconfigured sets. The DMSO uses the TAMMIS–Medical Logistics (TAMMIS–MEDLOG) to request supplies from its support unit, the medical logistics battalion (MLB). If

supplies are not available at the MLB, then the requests are passed by the MLB to the SOS in CONUS.

Medical Logistics Battalion

The MLB is located in the corps area (behind the division rear boundary) and EAC. Depending on the tactical situation, the MLB will locate as far forward as possible. The MLB provides both supply and maintenance, optical fabrication, and blood support to all units (field hospitals, battalion aid stations, etc.) in a geographical area and provides supply support directly to the DMSO. MLB requisitions are passed via TAMMIS through the theater medical materiel management center to the SOS. The items stored in the MLB are also O&MA funded.

Installation Medical Supply Account

The installation medical supply account (IMSA) provides supply and maintenance support to all medical and authorized nonmedical organizations on an installation and in a geographical area. In a CONUS environment, it is the link between the MLB and the SOS. The IMSA operates using the installation retail stock fund and resells acquired medical supplies to the customers, who use O&MA funding to reimburse the stock fund.

U.S. Army Medical Materiel Agency

The U.S. Army Medical Materiel Agency (USAMMA) is the national maintenance point during peacetime for all Class VIII reparables. During contingency operations, medical maintenance support is provided by the servicing MLB or organizational medical equipment repairers with backup support from USAMMA. This agency is the manager for all medical war reserves, currently valued at $294.9 million ($108.7 million in sustainment, $1.5 million in prepositioned, $63.7 million in operational projects, and $121 million in Reserve component hospital equipment). These stocks are located afloat (prepositioned ships), OCONUS (forward-deployed MLBs), or in CONUS DLA depots. These stocks are primarily configured in sets for specific contingencies or operations and are O&MA funded.

Army Retail Medical System

The Army currently uses TAMMIS for supply management and other functions, such as patient regulating. The supply module, TAMMIS-MEDLOG, operates at each of the supply points (DMSO, MLB, and IMSA) and can interface with DAAS and the local financial management system when appropriate. TAMMIS calculates the stockage levels for the supply points and has the capability to run multiple cycles each day.

The Health Affairs and Logistics offices within the Office of the Secretary of Defense are developing, in conjunction with the military services, a new joint automated medical logistics management system known as the Defense Medical Logistics Standard System. This system, when fielded during 1998–2002, will become the standard DoD system for all medical logistics.

Medical Stockage Policies and Practices

The DMSO, operating under the oversight of the division medical operations center, provides medical supplies to medical units operating in the division area. The supplies are provided to the customer as needed, and no formal requisition process is used by the supported units. The DMSO receives resupply by submitting requisitions via TAMMIS to the MLB.

The MLB provides Class VIII supply and maintenance support to all medical units and activities operating in a geographical area of responsibility (the corps area when assigned to the corps medical group or in an area in EAC when assigned to a medical brigade behind the corps). Requisitions are submitted through TAMMIS to the MLB, which either fills the requirement or passes the requisition through TAMMIS and DAAS to the SOS.

The IMSA, normally assigned to an installation medical treatment facility, operates like the MLB in that it provides medical supply support to a geographical area (the installation and surrounding area). In a garrison environment, the IMSA is the activity through which all requisitions flow en route to the SOS.

Medical Requirements Levels

The stocks maintained at each echelon of supply are based on customer demand, EOQ, or the local commander's direction (seasonal, readiness, etc.). The demand-supported items are added to the stockage list when they attain six demands in 360 days and are retained on the list if they receive three demands in 360 days.

Dollar Value of OST in Medical Requirements Levels

The Class VIII stock fund inventory is approximately $36.6 million, with $20.1 million of applicable stocks, $4.3 million in war reserves, and $12.2 million of nonapplicable stocks (retention, excess, and suspended items). The Army does not maintain data on the value of the stocks located in the unit (MLB, DMSO, customer) O&MA accounts. Table B-5 shows the stock fund dollar stratification of the $20.1 million in applicable stocks.

Table B-5. Stock Fund Dollar Stratification

Category	Value (days of supply)
Operating level	$5.4 million (13 days)
Order and shipping time	$7.9 million (18 days)
Safety level	$6.8 million (15 days)

Currently, the average OST for Class VIII items in CONUS is 18 days for non-prime-vendor items and the next day for prime-vendor items. The OCONUS OST is 22 days for non-prime-vendor items and 3 to 7 days for prime-vendor items. Since the prime vendor program has just been implemented for OCONUS, the response time should improve as experience is gained in using the program.

We did not develop an estimate for the value of 1 day of medical supplies since we did not get medical data from the other services and consequently did not include this class of supply in the remainder of our analysis.

Future Plans

Two initiatives that will affect OST for medical supplies are the Single Integrated Medical Logistics Manager (SIMLM) and the prime vendor initiative.

The Army has been designated the tri-service provider of medical logistics in a theater of operations. The resources (manpower, force structure, funds, stockage levels, and functional process) needed to execute this mission have been developed and are in place in Europe and Korea. The initial implementation of this concept was accomplished during Operation Desert Shield/Storm.

The prime vendor initiative is the process of using a private enterprise as a provider of Class VIII support rather than a government organization, such as an ICP or depot. Under this initiative the customer (IMSA or MLB) sends the request directly to the pre-identified vendor, who picks, packs, and ships the item to the requisitioner. The goal is to have the item to the requisitioner within 24 hours in CONUS and 3 days OCONUS. The prime vendor process was successfully used by MLBs in operations in Cuba and Haiti. Requisitions are currently passed by modem, but satellites could be used in emergencies. Currently, the program covers pharmaceuticals and medical items, but dental and other items are being added. In 1995, the pharmaceutical prime vendor initiative was implemented at all CONUS medical activities and the U.S. Army Medical Materiel Center–Europe. The prime vendor initiative has reduced the number of line items stocked in storage locations. During operations Desert Shield/Storm, over 8,500 lines of pharmaceuticals and other medical items were stored in DLA depots, and that range has now been reduced to less than 200 lines as a direct result of the prime vendor initiative.

Appendix C
Navy Retail Inventory Management

INTRODUCTION

To support its fleet of aircraft, ships, and submarines, the Navy maintains an extensive chain of retail activities that provides the supplies needed to sustain fleet operations at sea and on shore. These supplies consist of secondary item inventories (i.e., repairable assemblies and repair parts) with a total estimated value of $14 billion. This appendix describes how these inventories are set and how they are affected by order and shipping time (OST).

This appendix is based on interviews conducted in 1995 and data collected at the Naval Supply Systems Command (NAVSUP) at Arlington, VA; the Aviation Supply Office (ASO) at Philadelphia, PA; the Ships Parts Control Center (SPCC) at Mechanicsburg, PA; the Fleet and Industrial Supply Center (FISC) at Norfolk, VA; the Naval Air Station (NAS) Oceana at Virginia Beach, VA; the U.S.S. *Dwight D. Eisenhower*; the Center for Naval Analysis at Alexandria, VA; and the Naval Management Systems Support Office at Norfolk, VA. Additional information was obtained through telephone interviews with personnel at the Naval Facilities Engineering Command (NAVFAC) at Arlington, VA; the Naval Training Center (NTC) at Great Lakes, IL; the Navy Public Works Center (PWC) at Norfolk, VA; the Naval Medical Center (NAVMEDCEN) at Portsmouth, VA; Trident Refit Facilities (TRFs) at Bangor, WA, and Kings Bay, GA; the Naval Submarine Support Facility at New London, CT; and the Naval Construction Battalion Centers (CBCs) at Port Hueneme, CA, and Gulfport, MS.

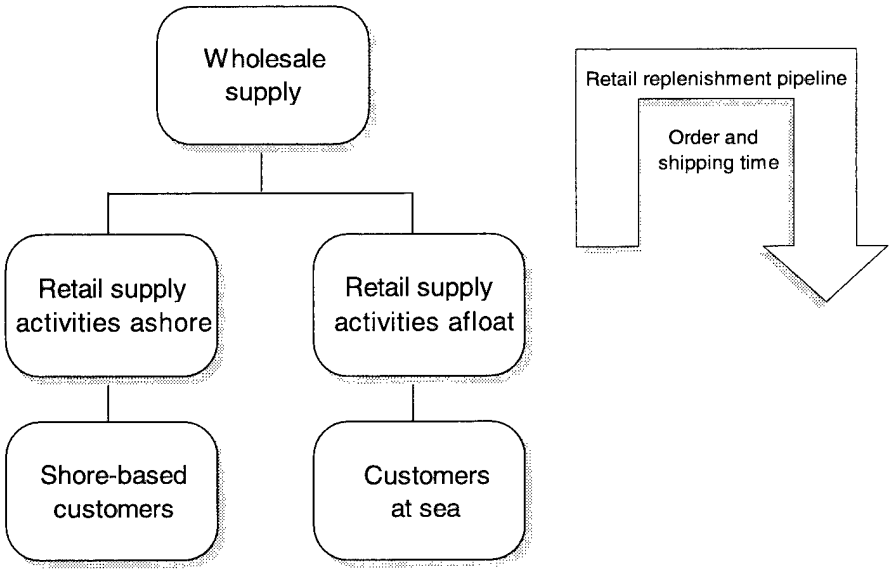
OVERVIEW OF THE NAVY SUPPLY SYSTEM

As illustrated in Figure C-1, the total inventory that supports the fleet consists of retail ashore and afloat levels of stock managed by the Navy and wholesale levels of stock managed by the Navy and by the Defense Logistics Agency (DLA), General Services Administration (GSA), and other services.

The primary sources of supply for Navy retail activities are wholesale stocks managed by the government and commercial stocks managed by the private sector. In the fall of 1995, the Navy consolidated its wholesale management at its SPCC and ASO into a single inventory control point, referred to as the Naval Inventory Control Point (NAVICP). This consolidation placed both locations under a single commander but did not change their assigned supply missions. SPCC is now referred to as NAVICP Mechanicsburg and ASO as NAVICP Philadelphia. In this

appendix, we use the old names since they were in use when this analysis was performed and they help distinguish the type of materiel managed at each site.

Figure C-1. Overview of Navy Supply System



SPCC manages items associated with ships, while ASO manages items associated with naval aviation (i.e., Navy and Marine Corps aircraft). Beside wholesale management of these items, each location also prepares retail allowance lists for retail afloat and ashore supply activities.

Navy wholesale stocks are stored at DoD distribution depots managed by DLA and at FISCs. Some wholesale stocks can be found at other retail sites in those instances where (1) a wholesale item manager has assumed ownership of stock at a site and has decided that attrition is the best way to deplete the stock from that site, or (2) a wholesale manager positions stock at a site that is the sole user of the material.

In cases where DoD is relying on direct commercial support or where the retail activities are using local purchase as their source of supply, retail stocks are replenished from stocks at commercial distribution activities and not from government-managed wholesale stocks.

Key Feature—Allowance Lists

An allowance list is a list of supplies specifically tailored to an activity for the support of the maintenance or supply mission. As previously noted, SPCC and ASO use data from the fleet to centrally prepare allowance lists that are distributed to retail supply activities throughout the fleet, both ashore and afloat.

The largest allowance lists are the coordinated shipboard allowance list (COSAL) and the coordinated shore-based allowance list (COSBAL) for ships' parts and the aviation consolidated allowance list (AVCAL) and Aviation Shore-Based Consolidated Allowance List (SHORCAL) for aviation parts. Other allowance lists are the shore-based intermediate maintenance stock list (SIMSL), the selected restricted availability stock list (SRASL), and table of allowance. In addition, load lists—that is, inventory to support combatant ships carried by selected other ships—include the fleet issue load list (FILL) and the tender issue load list (TILL).[1]

Allowance lists are key to Navy retail supply in that they are the basis for stocking reparable items at retail activities and provide initial levels for consumable items. Later in this appendix, the purpose and preparation of each of the allowance lists are discussed in greater detail.

NAVAL RETAIL SUPPLY

Ashore Activities

Figure C-2 shows the major elements of the supply system that constitute ashore support. Each of the retail supply activities shown in Figure C-2 is briefly discussed.

FLEET AND INDUSTRIAL SUPPLY CENTERS

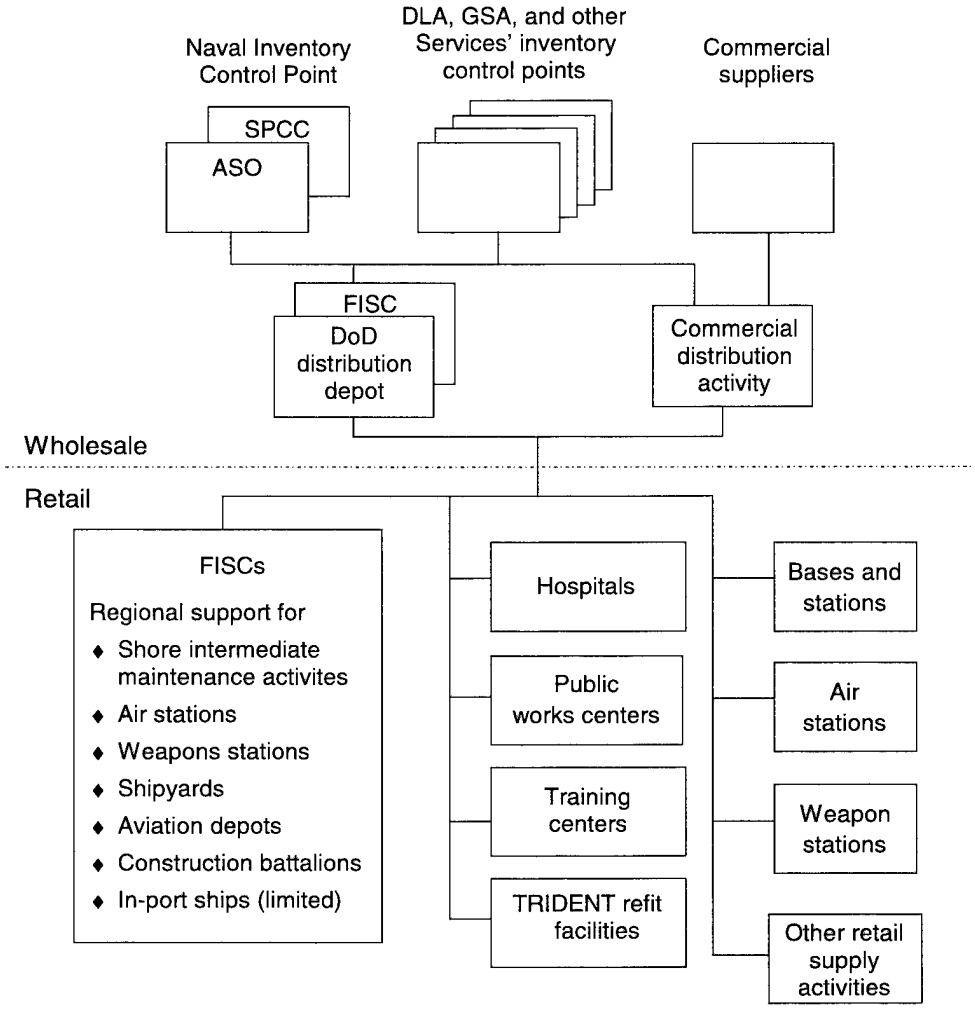
In 1993, the Navy renamed all of its naval supply centers (NSCs) and naval supply depots to FISCs. The November/December 1993 issue of the Navy Supply Corps newsletter said

> The FISC era was prompted by several studies, principally the 1992 Infrastructure Study chartered by the Vice Chief of Naval Operations (VCNO) and a series of Defense Management Review Decisions (DMRDs) which altered the mission and structure of the supply centers. The VCNO study group decided upon the Fleet and Industrial Supply Center as a way of more efficiently maintaining and managing consumer-level inventories in today's downsizing environment, and as the hub in the wheel of regionalization of many other logistics (e.g., hazardous material management, regional procurement, etc.) functions.
>
> As a result of the DMRDs and the VCNO Infrastructure Group initiatives, FISC's responsibilities now encompass the traditional NSC functions of ocean terminal operations, fuel operations, repairable material management, customer service, self-service merchandising and personal property shipments, among others. The changes also expand FISC's role

[1] Before the Navy's repair ships were decommissioned, the TILL was the tender and repair ship load list.

in geographic area logistics support, procurement management, inventory management and hazardous material management.

Figure C-2. Navy Ashore Support



The 10 current Navy FISCs are

- FISC Cherry Point, NC;
- FISC Guam;
- FISC Jacksonville, FL;
- FISC Norfolk, VA;
- FISC Oakland, CA (to be closed);
- FISC Pearl Harbor, HI;
- FISC Pensacola, FL;
- FISC Puget Sound, WA;
- FISC San Diego, CA; and
- FISC Yokosuka, Japan.

The FISC stocks are primarily either wholesale or retail consumer levels of inventory. In response to recommendations in the VCNO study, the Navy decided to eliminate (with few exceptions) its retail intermediate levels of inventories formerly at the NSCs. Exceptions to that decision include frequently used items designated for local purchase, such as compressed gases; items stocked in self-service merchandising stores (i.e., SERVMARTs); and high usage load list items, such as common shipboard paints and common general-use consumable items. Also, FISC Yokosuka maintains an intermediate level of inventory to support regional overseas consumer level requisitioners, and FISC Guam maintains an intermediate level of inventory to resupply underway supply ships.

As the CONUS FISCs eliminated their intermediate levels of inventories, they also moved to regional inventory management. Under regional management, retail inventories within the FISC's sphere of support, which were managed separately by shore commands, are now managed as a single retail level of inventory positioned at different sites. For example, the Norfolk FISC manages stocks supporting the shipyard, the air station, shore-based intermediate maintenance organizations, and other logistics activities located in and around Norfolk as a single retail level of inventory.

Wholesale stocks are at FISCs in either (1) a collocated DoD distribution depot managed by DLA, (2) a FISC warehouse (instances where the FISC is not collocated with a distribution depot include FISC Cherry Point and FISC Pearl Harbor), or (3) a detached retail site under the FISC.[2]

NAVAL AIR STATIONS

Retail activities at NASs and reserve air stations provide supply support for organizational and intermediate maintenance of the aircraft at the station and for other tenant activities. Air station stocks represent a consumer level of inventory. To support aircraft at an NAS, ASO prepares an SHORCAL. Under regional inventory management, inventories at many air stations are already or are moving under FISC management.

The principal active and reserve NASs are

- NAS Adak, AK;
- NAS Alameda, CA (scheduled for closure);
- NAS Atlanta, GA (reserve);
- NAS Barber Point, HI (partnership with FISC Pearl Harbor);

[2] In the case of SPCC-managed consumable items stored at a FISC, the local retail model computes their levels and stock is pulled to the FISC. For ASO-managed consumable items stored at a FISC, ASO computes their levels and stock is pushed to the FISC.

- NAS Bermuda (independent);
- NAS Brunswick, ME (independent);
- NAS Cecil Field, FL (partnership with FISC Jacksonville, scheduled for closure);
- NAS Corpus Christi, TX (independent);
- NAS Dallas, TX (reserve);
- NAS Glenview, IL (reserve);
- NAS Jacksonville, FL (independent);
- NAS Keflavik, Iceland (independent);
- NAS Key West, FL (independent);
- NAS Lemoore, CA (independent);
- NAS Memphis, TN (independent);
- NAS Miramar, CA (partnership with FISC San Diego);
- NAS New Orleans, LA (reserve);
- NAS Norfolk, VA (moving under FISC Norfolk);
- NAS North Island, CA (partnership with FISC San Diego);
- NAS Oceana, VA (will move under FISC Norfolk);
- NAS Patuxent River, MD (will move under FISC Norfolk);
- NAS Pensacola, FL;
- NAS Sigonella, Italy (independent);
- NAS South Weymouth, MA (independent);
- NAS Whidbey Island, WA (independent); and
- NAS Willow Grove, PA (reserve).

NAVAL STATIONS

Retail activities at naval stations (NAVSTAs) provide supply support for organizational and intermediate maintenance of the fleet forces operating out of the station and for other tenant activities.

The naval stations are

- NAVSTA Guantanamo, Cuba;
- NAVSTA Mayport, FL;
- NAVSTA Roosevelt Roads, Puerto Rico; and
- NAVSTA Rota, Spain.

SHIPYARDS

Retail activities at naval shipyards provide supplies that support depot maintenance of ships from overhauls to technical availabilities to decommissions. Shipyard stocks are a consumer level of inventory and by nature are project oriented. The Navy is moving to place shipyard stocks under the FISCs.

TRIDENT REFIT FACILITIES

The TRFs serve as ashore submarine tenders performing all three levels of maintenance. They are

- TRF Bangor, WA, and
- TRF Kings Bay, GA.

Stocks are pushed to the TRFs in the form of allowances (i.e., the TILL and stocked war reserve allowance list, and the TRFs pull stocks for demand-based items.

NAVAL TRAINING CENTERS

The NTCs are primarily recruit induction centers providing initial clothing allowances and basic training to new sailors. They also are the home of the surface schools. Currently, the centers are NTC Great Lakes, IL; NTC Orlando, FL; and NTC San Diego, CA. NTC San Diego is closing and NTC Orlando will be closed as the Navy consolidates its training activities at NTC Great Lakes.

The centers carry a consumer level of inventory in support of their training programs. Inventory items include uniforms and other clothing allowance items and repair parts for equipment used in training. NTCs do not have allowance lists.

NAVAL HOSPITALS

Like any service hospital, naval hospitals (NAVHOSPs), NAVMEDCENs, and the National Naval Medical Center (NNMC) maintain supplies of consumable items to support their patient care. They do not have allowance lists. The principal naval medical activities ashore are

- NAVHOSP Beaufort, SC;
- NNMC Bethesda, MD;
- NAVHOSP Bremerton, WA;
- NAVHOSP Camp Pendleton, CA;
- NAVHOSP Camp Lejeune, NC;
- NAVHOSP Charleston, SC;
- NAVHOSP Corpus Christi, TX;
- NAVHOSP Great Lakes, IL;
- NAVHOSP Jacksonville, FL;
- NAVHOSP Millington, TN;
- NAVHOSP Newport, RI;
- NAVMEDCEN Oakland, CA;
- NAVHOSP Pensacola, FL;
- NAVMEDCEN Portsmouth, VA;
- NAVHOSP Orlando, FL; and
- NAVMEDCEN San Diego, CA.

DLA's prime vendor program for medical items is dramatically impacting supply management at naval hospitals. Medical items in the program (e.g., drugs) are no longer stocked at the hospitals but ordered directly by the customers with overnight delivery. In NAVMEDCEN Portsmouth alone, the dollar value of its stock-funded inventory has gone from $4 million to $1.3 million in 2 years as customers buy direct with their operations and maintenance (O&M) funds.

PUBLIC WORKS CENTERS

Under the management of the NAVFAC, naval PWCs are shore-based activities that provide civil engineering support to major naval centers. They manage a consumer level of inventory to meet forecasted demand as well as specific project demand.

PWC supplies are positioned in a number of shop store sites, and inventory levels are set by site. For example, PWC Norfolk has sites that include a supply outlet for plumbers, an outlet for electricians, a general hardware store, and a shop for van construction. PWCs are located at Norfolk, Washington, DC, Pensacola, Great Lakes, San Diego, Oakland, Pearl Harbor, Guam, and Yokosuka (the PWC at San Francisco is being phased out, and the PWC at Jacksonville is contractor operated).

CONSTRUCTION BATTALION CENTERS

Also under the management of NAVFAC, the naval CBCs are shore-based activities that support Navy construction forces throughout the world. They manage a consumer level of supply that includes repair parts (e.g., vehicle parts), tools, construction materials, and consumable stocks (e.g., paper supplies). They do not have allowance lists. The two CBCs are located at Gulfport, MS, and Port Heuneme, CA.

VARIOUS OTHER RETAIL CENTERS

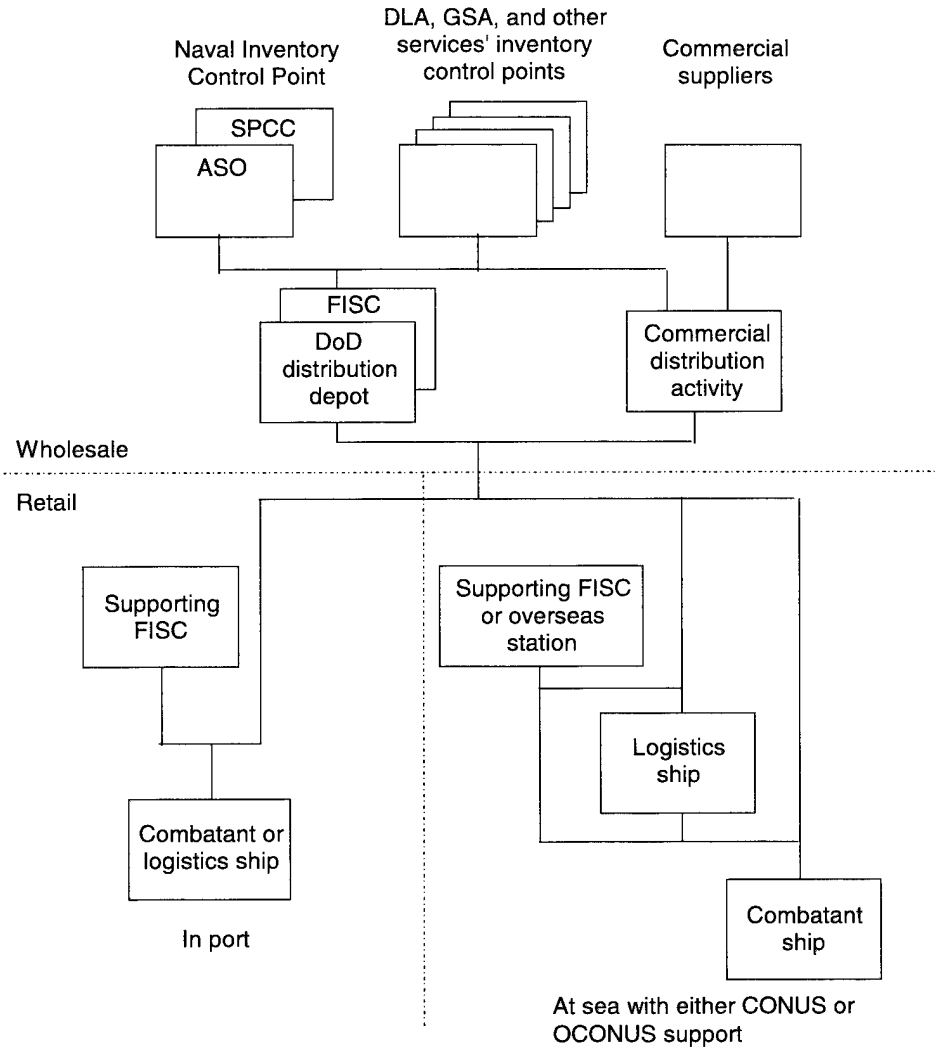
These activities are

- Naval Submarine Support Facility, New London, CT—submarine support facility;
- Naval Support Activity, Naples, Italy;
- Naval Air Weapons Station, Point Mugu, CA—weapons station;
- Naval Air Facility, Washington, DC;
- Naval District, Washington, DC; and
- Naval Air Warfare Center, Lakehurst, NJ—weapons center.

Afloat Activities

Figure C-3 shows the major elements of the supply system that constitutes ashore support.

Figure C-3. Navy Afloat Support



COMBATANT SHIPS

Aircraft carriers (CV ships), submarines (SS ships), amphibious warfare ships (L ships), mine warfare ships (M ships), and surface combatant ships, such as cruisers (CG ships), destroyers (DD ships), and frigates (FF ships), are all combatant ships. They carry a consumer level of inventory to support the operation of onboard equipment. Carriers carry an additional consumer level of inventory to support assigned aircraft.

LOGISTICS SHIPS

Logistics ships include

- ships charged with underway replenishment, such as stores ships (AF ships), oilers (AO ships), and ammunition ships (AE ships);
- tenders; and
- other support type ships.

Like combatant ships, logistics ships carry a consumer level of inventory to support operation of onboard equipment. In addition, replenishment ships ferry supplies to deployed ships and carry a level of stock for fleet support. Tender and repair ships also carry a level of stock to support underway fleet maintenance.

SUPPORTING FISCS AND OVERSEAS STATIONS

FISCs and overseas stations support combatant and logistics ships by

- filling demands when excess stock exists,
- filling high-priority demand if stock is available, and
- serving as a funnel for stocks flowing from distribution depots to ships.

Systems

For the most part, the Navy's uniform inventory control point system generates retail allowance lists.[3] In addition to this automated capability, a number of retail automated systems have evolved to manage retail inventories at Navy ashore and afloat activities. The Navy is working to reduce the number of these systems, particularly the major retail ashore and afloat systems. Each of the current systems is briefly discussed below along with plans for that system.

UNIFORM AUTOMATED DATA PROCESSING SYSTEM

The retail inventory system for ashore activities is one of several versions of the Uniform Automated Data Processing System (UADPS). Current versions are UADPS–Stock Point (UADPS-SP), UADPS–Level II, UADPS–Disk Oriented Supply System (UADPS-DOSS), and UADPS version 2 (commonly referred to as U2). Table C-1 lists the activities under each version of UADPS. Only U2 supports multiple activities on the same system, that is, a central management activity in partnership with other activities.

[3] Currently, readiness-based computations for the COSAL are made outside of the uniform inventory control point.

Except for small ashore activities not currently under UADPS, Navy ashore activities are converting to U2, which has been selected as the standard system for retail ashore supply activities.

Table C-1. Retail Activities Under UADPS

Version	Activities	Partnerships	
U2	FISC San Diego	NADEP North Island NAS North Island NAS Miramar NSY Long Beach	MCAS El Toro MCAS Yuma NAB Coronado China Lake
	FISC Jacksonville	NADEP Jacksonville	SIMA Mayport
	FISC Norfolk	Weapon stations	SIMAs
	FISC Pearl Harbor	SIMA SuBase	NAS Barbers Point
	FISC Yokosuka	SRF Yokosuka	
	FISC Puget Sound	—	
	FISC Guam	—	
	FISC Cherry Point	—	
	TRF Bangor	—	
	TRF Kings Bay	—	
Version	Activities		
UADPS-SP	NAS Norfolk NAS Whidbey Island SuBase New London	NAS Lemoore NAS Patuxent River	Point Mugu Key West
UADPS-Level II	NAS Oceana NAS Brunswick NAS Sigonella	NAS Bermuda NAVSTA Rota Reserve air stations	Keflavik NTC Orlando
UADPS-DOSS	NTC Great Lakes	NTC San Diego	

Note: MCAS = Marine Corps Air Station; NAB = Naval Air Base; NADEP = Naval Aircraft Depot; NS = Naval Station; NSY = Naval Shipyard; SIMA = ship intermediate maintenance activity; SRF = ship rework facility; SuBase = Submarine base.

SHIPBOARD UNIFORM AUTOMATED DATA PROCESSING SYSTEM

The retail inventory system for large ships is the Shipboard Uniform Automated Data Processing System (SUADPS). Those ships are carriers (CVs and CVNs), amphibious assault or L class ships (LHAs and LHDs), logistics ships (ADs, ASs,

and TAFs), Marine aviation logistics squadrons, and certain ashore sites (NAS Fallon, NV). Some key characteristics of SUADPS are that it

- handles repair parts and consumable items;
- manages store room stock and does not deal with operating space items stock;
- excludes ammunition, food, fuel, and end items, and only includes records for medical items in the Pacific;
- manages Defense Business Operating Fund (DBOF) inventory except for aviation depot-level reparable inventory on carriers (and the Navy is planning to change funding for this inventory from O&M to DBOF);
- runs on the Shipboard Nontactical ADP Program (SNAP I) hardware suite (not to be confused with SNAP II); and
- was originally written in Common Business Oriented Language (COBOL) but now has a second version designed for the future SNAP III hardware suite.

Starting in 1996, the Navy will replace SUADPS with the Relational Supply System now under development.

SHIPBOARD NONTACTICAL ADP PROGRAM II

SNAP II is the supply system for ships that do not have the space required for SUADPS and its SNAP I hardware suite. It provides support in several areas of logistics, including, under its Supply Financial Module, material management. SNAP II is found on a wide range of afloat platforms, including cruisers, frigates, destroyers, and some submarines. Some characteristics of SNAP II are that it

- handles repair parts but not consumable items;
- manages both store room and operating space items stock;
- excludes ammunition, food, fuel, end items, and medical supplies;
- manages O&M-funded inventory; and
- was originally written in COBOL but now has a second version designed for the future SNAP III hardware suite.

Starting in 1996, the Navy will replace SNAP II with the Relational Supply System now under development.

OTHER SYSTEMS ASSOCIATED WITH SMALLER INVENTORIES

Table C-2 lists other materiel management systems associated with smaller retail inventories.

Table C-2. Materiel Management Systems for Small Retail Inventories

System	Application
Micro-SNAP	Micro-SNAP is a PC-based system that automates supply for small ships (e.g., submarines) and shore activities that were previously nonmechanized. Given the small inventory investment involved at these activities, the Navy has no plans to replace Micro SNAP with the Relational Supply System.
Medical Inventory Control System	The Medical Inventory Control System is the materiel management system for naval hospitals.
Supply Management Information System	The Supply Management Information System is the materiel management system for Navy CBCs.
PWC Management Information System	The PWC Management Information System is the materiel management system for PWCs.

Requisitioning Channels

The normal point of entry for demand in the Navy supply system is at the retail consumer level of supply. The consumer level either fills the demand or refers it to another supply activity. Retail supply activities will always replenish their stock levels from and send referrals to a higher echelon of supply.

In the past, this vertical flow of demand meant that normal requisitioning channels started at the consumer level of supply and went to the retail intermediate level and then to the wholesale level. However, since the Navy has acted to eliminate most of its intermediate levels of supply, consumer levels of supply normally requisition directly on the wholesale inventory level.

An exception to standard requisitioning occurs when a combatant ship is resupplied from the FILL on a supply ship. Another exception occurs when a critical need arises at a retail activity and is manually worked and filled from stock at another retail activity.

RETAIL INVENTORY LEVELS AND OST

Stockage Policies and Practices

The major characteristic that governs how an item is managed within the Navy's retail supply system is its recoverability, that is, whether the item is reparable or consumable. (For purposes of item management, the Navy treats field-level reparable items as consumable items.) Retail inventory levels for reparable items are centrally determined at ASO and SPCC and distributed as allowance quantities. Consumable items also have allowance quantities, but these levels can be overwritten by local demand. In addition, retail activities can stock consumable items that do not have an allowance quantity but have sufficient local demand to support an inventory level.

Although an item's recoverability is given by its source, maintenance, and recoverability code, it is also reflected in its Navy cognizance (cog) symbol. Cog symbols are unique to the Navy and consist of two-digit codes—one numeric digit followed by one alpha digit. They are prefixed to national stock numbers to identify and designate the inventory control point, office, or agency that exercises supply management over specified categories of material. Table C-3 lists some of the more important cog symbols and their relationships to recoverability.

Table C-3. Cognizance and Recoverability

Cog	Manager	Description	Recoverability
1H	SPCC	Navy stock fund materiel assigned to SPCC for management	Consumable
1R	ASO	Aviation photographic and meteorological type materiel	Consumable
3 Cog	SPCC	Navy-owned stocks of field-level reparable items managed by DLA	Consumable
5 Cog (except 5R)	SPCC	Navy-owned stocks of consumable items managed by other services	Consumable
7E	SPCC	Depot-level reparable ordnance equipment repair parts and air missile parts	Reparable
7H	SPCC	Depot-level reparable shipboard and base equipment, assemblies, components, and repair parts	Reparable
7R	ASO	Depot-level reparable aviation material	Reparable
9 Cog	SPCC	Navy-owned stocks of materiel managed by DLA, GSA, and other services.	Consumable

RANGE AND DEPTH OF STOCK

For purposes of analyzing OST and inventory level setting, requirements determination is the process of determining when an item should be stocked and, if it is stocked, how much to stock. The first part of the process is the range of stockage, and the second is the depth of stockage.

Table C-4 lists the approaches used to determine demand-based retail item requirements levels within the Navy.

Table C-4. Approaches for Performing Requirements Determination

Item category	Basis for stockage	Levels computation	Approaches for aviation applications	Approaches for ship or nonaviation applications
Reparable items	Non-demand-supported	Centrally computed— ♦ ASO for aviation ♦ SPCC for shipboard	AVCAL for afloat SHORCAL for ashore	COSAL for afloat Shore COSAL and COSBAL for ashore FILL SIMSL for ashore maintenance TILL Other allowance lists
Consumable items	Non-demand-supported	Centrally computed— ♦ ASO for aviation ♦ SPCC for shipboard	AVCAL for afloat SHORCAL for ashore	COSAL for afloat Shore COSAL and COSBAL for ashore FILL SIMSL for ashore maintenance SRASL for shipyard maintenance TILL Other allowance lists
	Demand-supported	Locally computed with centrally set parameters	ERM/VOSL SIM	ERM/VOSL SIM PWC DBI

Note: DBI = demand-based item; ERM = economic retention model; SIM = selected item management; VOSL = variable operating and safety level.

A demand-based item with demand-supported levels is one for which the decision to stock, not to stock, or continue stockage is based upon actual demands previously recorded at, or transferred to, a particular activity or location. In the case of a demand-based item where the demand originates from program data or demand experienced across a community of similar activities, such as in the case of the preparation of allowance lists, the item's levels are non-demand-supported. In the Navy, only consumable items have demand-supported levels (but they also can have non-demand-supported levels). Reparable items only have non-demand-supported levels because their stockage is dictated by allowance lists.

The stockage criteria or range rules for demand-supported items vary by type of activity. For example, the range rule at NTC Great Lakes is six demands in 12 months. However, in all cases, the criterion is the number of demands experienced in a specific time period. Therefore, except for other-than-demand-supported items, OST is not a consideration in determining the range of stocked items. Moreover, of the algorithms used for non-demand-based items, only the readiness-based sparing (RBS) algorithms consider OST, and then a standard time is applied. Consequently, any reduction in OST will not impact the range of items stocked at Navy retail activities except in the cases where RBS is applied, then the RBS OST parameter must be adjusted downward.

Computation of Requirements Levels

REPARABLE ITEMS

All retail stock levels for depot-level reparable items are set as part of allowance lists prepared by either ASO or SPCC. In order to change any of their assigned allowance quantities for depot-level reparable items, retail activities must submit an allowance change request to the respective inventory control point location. Field-level reparable items are managed as consumable items. Consumable items are also included in allowance list computations but can have additional local demand-based levels.

Aviation Consolidated Allowance List

The AVCAL is a retail requirements package providing the range and depth of aviation materiel that ships are authorized to carry in order to support maintenance actions anticipated during workup and actual deployment. Allowance requirement registers (ARRs) are the basic building blocks of an AVCAL development process performed by ASO. That development uses one or more item allowance quantities from ARRs and flying hours to compute final allowance quantities.

The range of reparable items in an ARR depends on predicted item repair rates and does not consider OST. The depth of stock or fixed allowance level for reparable items is as follows:

- For depot-level reparable items that are removed onboard carriers at the organizational level of maintenance, a level is computed using the RBS model called the Aviation Retail Requirements Oriented to Weapon Replaceable Assemblies (ARROWs) model. (ASO applies a 25-day standard to all items in the ARROWs model.)[4] RBS is also used for the SH-60B Light Airborne Multipurpose System (LAMPS) program.

[4] The value of 25 days was derived from an analysis of OSTs for carriers and represents the median observation.

- For other reparable items on carriers and for all reparable items in AVCAL for amphibious ships, the level is computed with the Retail Inventory Model for Aviation (RIM-AIR) model. The RIM-AIR level is the sum of a raw rotatable pool quantity and a raw attrition quantity plus 85 percent protection computed as follows:

  - The raw rotatable pool quantity is the item's repair cycle level and is computed as the item's repair turnaround time multiplied by its failure rate (items that do not have an intermediate repair capability do not have a rotatable pool quantity).

  - The raw attrition quantity covers anticipated failures that cannot be repaired on site and is computed by one of the following methods:

    - If the product of the item's beyond-the-capability-of-maintenance (BCM) rate and a 90-day endurance period is greater than or equal to one, the attrition quantity is equal to the sum of the endurance period of 90 days and an OST parameter times the item's BCM rate (since the OST parameter is currently set to zero, the attrition quantity is the original product).[5]

    - If the product is less than one, the attrition quantity is either one or zero depending on the size of the rotatable pool quantity, the price of the item, and the size of the product.

  - The 85 percent protection quantity is based on a Poisson distribution table using the sum of the raw rotatable pool quantity and the raw attrition quantity. (Basically, it is equal to the number of spares needed to ensure that 85 percent of the demand over the pipeline represented by the rotatable pool and attrition quantities will be filled.)

ASO uses wartime flying rates for computing the anticipated failure rates used in the AVCAL computations.

The concept of endurance can be interpreted as the period of time that a ship can continue to operate before being resupplied. Obviously, OST should be one factor that goes into determining the period of endurance, but other factors, such as mission restrictions on the availability of ships to receive supplies and availability of resupply resources, also play a role in setting the endurance period.

[5] In the Navy, a failure that cannot be repaired on site is referred to as being BCM and turned into the wholesale supply system for repair or disposal. Not repairable this station is the equivalent term in the other services.

Shore-Based Consolidated Allowance List

SHORCAL is a requirements list identifying the quantity of aviation material required to support an operating-ashore site's planned operational and maintenance missions. ASO develops SHORCALs using a process similar to its process for developing AVCALs. The SHORCAL is intended to provide optimum supply support and aircraft operational readiness in a peacetime environment, unless otherwise specified in the weapon system planning document.

The SHORCAL development process differs from that of the AVCAL in that it uses peacetime item failure rates and provides for a 30-day endurance level for CONUS stations and a 60-day endurance level for OCONUS stations. As in the case of AVCALs, OST is set to zero except for FISC Yokosuka, where it is set to 30 days.

Consolidated Shipboard Allowance List

COSALs are designed to provide an endurance level of support for onboard repair parts and assemblies that the ship's force is capable of removing and replacing from shipboard equipment and components. SPCC prepares and distributes COSALs. A ship's COSAL consists of spares for stock room items and operating space items. The latter are support items required by maintenance and operating personnel to perform routine tasks (e.g., tools, test equipment, and maintenance assist modules). Quantities for these items are fixed. Quantities for stock room items are computed using a variety of algorithms. However, the results of these computations can be overridden with special quantities (e.g., type commanders' special levels).

The following algorithms are used to generate COSAL quantities for stock room items:

- Fleet Logistics Support Improvement Program (FLSIP)
- Modified FLSIP (MOD-FLSIP)
- FLSIP .5 Plus
- TRIDENT
- TIGER Availability Centered Inventory Model (only used to generate quantities for selected items)
- SEASCAPE (only used to generate quantities for selected items).

The first four algorithms are demand-based, that is, they are based on the supported shipboard population and the best replacement factors (BRFs) of the items. Their objective is to support the ship throughout the endurance period at a given

level of effectiveness (85 percent) in filling demands for carried items. Since OST is not a factor in the algorithms, resulting COSALs are not OST related.

The last two COSAL allowance algorithms are readiness based, that is, they apply marginal analysis to minimize dollars to meet a given equipment operational availability or to maximize equipment operational availability while meeting a given budget constraint. In actuality, the RBS algorithms are not COSAL generators. They merely generate allowance quantities for selected items that serve to override quantities generated by demand-based algorithms. RBS-generated quantities use a set 15-day OST based on historical observations for critical requisitions (i.e., a casualty report).

For selected equipment, COSALs are prepared for shore-based activities. These allowance lists are referred to as shore COSALs.

Coordinated Shore-Based Allowance List

COSBALs are consolidated listings of components, repair parts, and consumable items tailored to the requirements of shore activities to support organizational level maintenance for authorized equipment. COSBALs use the same demand-based algorithms used to prepare COSALs, but they have different endurance periods. Like COSALs, they are not OST-related.

Fleet Issue Load List

The FILL is a consolidated listing of items positioned on fleet ships and selected shore activities to provide resupply support of deployed fleet units, less items peculiar to submarines and those with Navy-managed aviation cognizance. FILL stocks are prepositioned war reserve material stock.

A single FILL is prepared for both Atlantic and Pacific fleet requirements and positioned on AF ships and FISCs Norfolk and Guam. The FILL provides for an endurance level of 90 days of support with a simulated unit effectiveness of 85 percent for carried items. (Separate computations are made for reparable items, equipment-related consumables, and non-equipment-related consumables, with minimum protection levels of 60 percent for the first two categories.)[6] Since OST is not a factor in the computation of the FILL, it is not OST related.

Shore-Based Intermediate Maintenance Stock Lists

The SIMSL is a consolidated listing of materiel tailored to support the corrective and planned maintenance missions of a shore-based intermediate maintenance activity or a U.S. naval ship repair facility overseas. SPCC develops 10 to 11 SIMSLs.

[6] The separate computations are to prevent the computation from only giving protection to fast-moving inexpensive consumable items and crowding out spares for more critical slow-moving expensive reparable items.

In the SIMSL computation, OST is a parameter that specifies the endurance level. SPCC uses an 18-day OST for all items based on historical observation. (One exception is a SIMSL in support of minesweepers where SPCC is using a 30-day OST because of the distance involved.) To achieve its overall target of an 85 percent demand fill rate, the SIMSL employs safety levels. Safety levels for individual items can be positive or negative but have default fill rate constraints of 2 percent and 98 percent.

Selected Restricted Availability Stock Lists

The SRASL is an allowance list to provide planned maintenance material support to naval or commercial shipyards based on forecasted requirements of scheduled planned maintenance actions for selected ships undergoing a selected restricted availability. SRASLs are positioned at the nearest stock point to the industrial activity. Since SRASLs are project oriented versus supply oriented, OST is not applicable.

Tender Issue Load List

Intermediate maintenance is accomplished aboard a tender that carries a consumer level of inventory called the TILL. The TILL is a consolidated listing of equipment, components, repair parts, and consumable items required to support the mission of an individual tender.

SPCC currently prepares nonnuclear TILLs for five submarine tenders (AS ships), six destroyer tenders (AD ships), and the submarine bases at Pearl Harbor and New London. The TILL is generated with the same algorithm as the SIMSL except that, since the TILL is afloat, the endurance level is not considered an OST level. No OST level is authorized.

The TILL is designed to satisfy at least 85 percent of the requisitions submitted for carried items for a 90-day support period considering funding constraints.

Other Allowances

In addition to those previously mentioned, SPCC prepares other allowances (e.g., special projects, regional COSBALs). For ashore sites where multiple allowance quantities for an item may apply, SPCC optimizes the stock level across all applications to arrive at the operational support inventory (OSI)-approved level.

CONSUMABLE ITEMS

As noted previously, levels for consumable items can be computed using either demand-supported or non-demand-supported methods. The same non-demand-supported approaches used for reparable items also apply to consumable items essential to equipment operations. However, the computations are different and

the quantities from non-demand-based methods are minimum levels that have demand-based levels added to them.

Depending on its materiel management system, a retail activity uses either the variable operating and safety level (VOSL) program or the selected item management (SIM) program to determine demand-based levels. An item may not have a non-demand-based level but have a demand-based level.

The computational methods for computing non-demand-based and demand-based depth of stock for consumable items are as follows.

Aviation Consolidated Allowance List

The AVCAL quantities for consumable materiel are determined by decision logic that considers the item's ARR codes in the aviation equipment configuration list (AECL) and ships AVCAL asset tape (SAVAST), whether the item's ARR quantity is protected, and the size of the item's ARR and community SAVAST quantities.[7] Table C-5 shows the decision logic, which does not consider OST.

Table C-5. Retail Inventory Management—Air Decision Logic Used to Generate Consumable Allowance Quantities

If size of ARR quantity is	and If protection condition is	and If size of community SAVAST quantity is	and If relationship between AECL and SAVAST ARR codes is	Then resulting allowance quantity is
Greater than zero	Protected	Not determined	Not considered	ARR quantity
		Equal to zero	Equal	
	Not considered		Not equal	
		Greater than zero		
			Equal	Higher of ARR quality and community SAVAST quantity
	Unprotected	Not determined	Not considered	
		Equal to zero	Equal	
Equal to zero	Not considered	Greater than zero	Not equal	Zero
Not determined		Equal to zero	Not considered	
		Greater than zero	Identified to SAVAST ARR	
			Not identified to SAVAST ARR	Community SAVAST quantity

[7] The AECL lists avionics, instruments, armament, and fire control systems; the applicable aircraft on which these equipment are installed; the allowance requirements register in which they reside; and the quantities used per aircraft.

The ARR-based quantities are developed by either the Initial Outfitting List model or by manual ARR updates. The community SAVAST quantity is computed as the average monthly demand for three similarly configured ships times 3 months times a wartime factor of 2, or essentially one-quarter's demand at twice the peacetime rate.

UADPS Variable Operating and Safety Level

The VOSL program applies to Navy and Marine Corps activities using UADPS programs and procedures as well as Navy CBCs. It employs a demand-based (R,r) model, whose objective is to obtain a maximum requisition effectiveness within funding constraints. The r in the (R,r) model, is the stock level when the activity places an order, or the VOSL reorder point (ROP), while the R is the stock level the activity orders to, or the VOSL requisitioning objective (RO). The formulas for RO and ROP are as follows:

$$RO = ROP + OL$$

and

$$ROP = SL + OSTL,$$

where

OL = operating level (i.e., retail order quantity),

SL = safety level, and

$OSTL$ = order and shipping time level.

While the OL computation does not consider OST, both the SL and $OSTL$ computations have OST as a component. The formula for SL is

$$SL = 0.7216(MAD)\left(\sqrt{OST}\right)(SLF),$$

where

0.7216 = a computational constant,

MAD = mean absolute deviation of quarterly demand,

OST = order and shipping time, and

SL = safety level factor (based on the risk factor assigned to the item).

The formula for *OSTL* is

$$OSTL = \frac{AQD}{3}(OST),$$

where

AQD = average quarterly demand, and

OST = as defined above.

The *OST* used in both computations is updated quarterly with an average formula based on exponential smoothing and is expressed in months by item. The following filters apply to the OST update:

- For CONUS activities, only those observations greater than or equal to 10 days and less than or equal to 120 days are included in the update.
- For overseas activities, only those observations greater than or equal to 15 days and less than or equal to 180 days are included in the update.
- For items that are not centrally managed (i.e., acquisition advice codes I, J, K, or L), any observation below 10 days or greater than 365 days is bypassed.

Since the *OST* data element is in terms of months and has a field length of one digit before and one digit after the decimal, the largest possible OST of record is 9.9 months, or approximately 300 days. If no OST is recorded, 1 month for CONUS activities, 2 months for FISC Pearl Harbor, and 3 months for FISCs Yokosuka and Guam are the recommended values.

For purposes of the *SL* computation, *OST* is constrained with an upper limit of 2 months for CONUS activities and 4 months for overseas activities.

Selected Item Management

The SIM program applies to Navy ships using SNAP II programs and procedures and to ashore sites using UADPS-DOSS (e.g., NTC Great Lakes). It employs a demand-based (R,r) model. The r in the model is the stock level when the site places an order or SIM low limit, while the R is the stock level the site orders to or SIM high limit. The parameters for the low and high limits are set by either the Atlantic and Pacific type commanders or NAVSUP. The linkage between OST and assigned low limits is not direct.

PWC Demand-Based Item

The PWC demand-based item computation employs another form of the demand-based (R,r) model. The R in the (R,r) model is the 3-month stocking objective, while the r is the item OST, i.e., the item's lead-time. For example, if the OST for an item is 1 month, when the item's on-hand and due-in stock level declines to 1 month's worth of stock, the PWC orders a quantity that would bring the stock level to 100 percent or 3 months of stock. If the OST is over 3 months, then the PWC will have multiple orders outstanding to cover the extended OST. In all cases, any reduction in OST should not impact item on-hand stockage.

Dollar Value of OST in Requirements Levels

ASO ALLOWANCES

For selected high-volume retail activities, the Navy has transaction reporting for reparable and critical items. In summarizing retail requirements data, the Navy distinguishes between ashore activities that have transaction reporting and those that do not.

We collected the data in Table C-6 on priceout requirements (dated 14 August 1995) from ASO.

Table C-6. ASO Allowance Dollars

Category	Value ($ million)
Carriers	2,561
FISCs	127
L class ships	381
Initial shipboard allowance lists	215
LAMPS	660
Transaction reporting activities	2,538
Other activities	2,481
Yokosuka AVCAL	417
Total	9,380

These categories can be aggregated into three broader categories oriented to this OST analysis:

- RBS where OST is included as a parameter in computing carrier AVCAL requirements for first-indenture depot reparable items (75 percent of purpose code W requirements) and LAMPS requirements

- Demand-based sparing (DBS) with a nonzero OST parameter (a 30-day parameter is used for the Yokosuka AVCAL)
- DBS with zero as its OST parameter for all other computations.

Although the second category in the above list does have an OST parameter, the effect of setting the parameter to zero is to make the category's DBS computations impervious to changes in OST. Table C-7 restructures the data in Table C-6 into these three categories.

Table C-7. ASO Allowances Dollars by Method of Handling OST

Category	Value ($ million)	Percentage
ASO RBS OST	2,548	27.2
ASO DBS OST	417	4.4
ASO DBS non-OST	6,416	68.4
Total	9,380	100.0

Of course, not all of the requirements level in a category is related to OST. For reparable items, the majority is related to local repair cycle time rather than OST. ASO estimates that 1 day of OST is worth $3 to $4 million in its RBS requirements. If the relationship between RBS requirements and OST were linear, the total OST portion of the requirements would be between $75 and $100 million of the total $2,548 million.[8]

Although ASO has dropped OST from a large portion of its DBS computation, it does provide for an endurance period, which acts much like an OST. For deployed or overseas activities, an endurance period may be warranted to maintain support during periods of conflict when normal supply channels may be broken. For CONUS activities, an endurance period rather than an OST period is questionable. In the case of SIMSLs that are for CONUS activities, the Navy has elected to drop the endurance period and use an OST period.

FISC Yokosuka AVCAL Reduction

For FISC Yokosuka, ASO has not dropped OST from its demand-based allowance computation. Like all demand-based AVCAL computations, the Yokosuka AVCAL consists of a rotatable pool quantity and an attrition quantity that are enhanced with safety stock to achieve an expected demand fill rate of 85 percent.

[8] The actual relationship is not linear, and it is not a simple expression that can be easily evaluated. The only way to estimate the change in the dollar value of the RBS requirement is to actually run the algorithm with different values for the OST parameter.

The attrition quantity is the sum of an endurance period of 60 days and an OST of 30 days.

The analytical procedure used to estimate the impact of reducing OST in this situation is somewhat complex. The general procedure is defined in detail in Appendix F. The step-by-step results of the procedure are as follows:

- When we reversed the mathematics of the Yokosuka AVCAL computation to determine the demand breakpoints for different allowance quantities, the results were as shown in Table C-8. We stopped at 50 because that number covered almost 98 percent of the dollars. The key statistics in this step were the 60-day attrition, the 30-day OST, an average repair cycle time of 5.6 days, and a rate of 25 percent for beyond capability of maintenance, the latter two taken from a concurrent intermediate maintenance study being conducted by LMI.[9]

Table C-8. Demand Breakpoints for Yokosuka Allowance Quantities

Allowance quantity	Starting level of demand	Ending level of demand
0	0.00	0.01
1	0.01	0.02
2	0.02	0.05
3	0.05	0.07
4	0.07	0.10
5	0.10	0.13
6–10	0.13	0.27
11–20	0.27	0.58
21–50	0.58	1.55

- Then, with a reduced OST, we determined the new demand breakpoints as well as new interval lengths. We used this information to determine how the ranges in Table C-9 changed.

[9] Logistics Management Institute, *Intermediate-Level Repair Cycle Management: Supply and Maintenance Process Improvements*, Report LG406RD1, Larry Klapper, Robert Jordan, and William McGrath, June 1996.

Table C-9. Original and New Yokosuka Demand Ranges

Allowance quantity	Original range of demand	New range		
		1 day	2 days	10 days
1	0.02	0.02	0.02	0.02
2	0.02	0.02	0.02	0.02
3	0.03	0.02	0.02	0.02
4	0.03	0.03	0.03	0.02
5	0.03	0.03	0.03	0.02
6–10	0.15	0.14	0.14	0.13
11–20	0.31	0.31	0.30	0.28
21–50	0.97	0.97	0.96	0.92

- Next, applying the current distribution for the FISC Yokosuka allowance quantities, and assuming demand is uniformly distributed across the items in each of the demand intervals associated with particular allowance quantities, we estimated the percentage reduction in inventory dollar for each of the allowance quantities. The Yokosuka allowance distribution in Table C-10 was taken from Yokosuka master stock records where the cog was "7R" and the reason for stockage was "SN."

Table C-10. Distribution of Yokosuka Dollars

Allowance quantity	Dollar value of allowance	Percentage of total Yokosuka allowance dollars
1	84,221,546	21.6872
2	48,127,590	12.3929
3	34,393,815	8.8565
4	26,469,204	6.8159
5	16,827,445	4.3331
6–10	71,557,447	18.4261
11–20	54,988,266	14.1595
21–50	42,268,334	10.8841

- Finally, we summed the percentage reductions for each reduction and multiplied them by the $471 million value of the Yokosuka AVCAL (as provided by ASO) to arrive at a dollar reduction per day of OST. The results are listed in Table C-11.

Table C-11. Yokosuka AVCAL Reductions Associated with Reducing OSTs

Reduction in OST parameter	Percentage reduction	Reduction ($ million)
1 day	0.27	1.2668
2 days	0.54	2.5565
10 days	2.93	13.7810
Average per day	$1.3 million for small reductions	

SPCC ALLOWANCES

For a given activity, SPCC may produce several allowances. In such cases, SPCC optimizes across the allowances to produce overall lower allowance quantities. Such allowances are referred to as operational support inventory approved levels.

We collected the requirements data in Table C-12 from SPCC.

Table C-12. SPCC Allowance Dollars

Category	Value ($ million)
COSALs	5,500
COSBALs	50
Shore COSALs	200
AVCAL support	5
Other non-OSI allowances	194
Other OSI allowances (less SIMSLs)	122
SIMSLs	15
Total	6,086

These categories can be aggregated into two broader categories oriented to this OST analysis:

- DBS with a nonzero OST parameter (an 18-day parameter is used for SIMSLs)
- DBS with zero as the value of the OST parameter for all other computations.

Some COSALs contain inventory levels that are readiness based and use an OST parameter. However, since the Navy was not able to provide a breakout for these

levels, they are included in the COSALs number that we placed in the category of DBS with a zero parameter.

Table C-13 restructures the data in Table C-12 into the two broad categories.

Table C-13. SPCC Allowance Dollars by Method of Handling OST

Category	Value ($ million)	Percentage
SPCC DBS OST	15	0.25
SPCC DBS non-OST	6,071	99.75
Total	6,086	100.00

SIMSL Reduction

To estimate the SIMSL reduction if the 18-day OST parameter were reduced, we applied the same approach that we used for Yokosuka, except that the endurance period is zero and no repair cycle quantity exists because the items are consumable. (For a SIMSL quantity distribution, we assumed the same distribution as the Yokosuka quantity distribution.) Table C-14 presents the results of the SIMSL analysis.

Table C-14. SIMSL Reductions Associated with Reducing OSTs

Reduction in OST parameter	Percentage reduction	Reduction ($ million)
1	1.8	264,362
2	3.7	561,769
10	24.9	3,731,797
17	61.6	9,241,204
Average per day	$0.3 million for small changes	

The reduction is not linear, and almost 40 percent of the inventory is still needed to cover a 1-day OST. This amount of stock is needed to provide the 85 percent fill rate.

OTHER CONSUMABLE INVENTORIES

Table C-15 lists consumable requirements data not previously addressed.

Table C-15. Other Consumable Requirements Dollars

Category	Value ($ million)
VOSL activities	478
Training centers	19
Hospitals	12
Atlantic fleet demand-based items	72
Pacific fleet demand-based items	64
Public works centers	75
Total	720

The data was collected from

- SPCC covering ashore sites except PWCs (i.e., VOSL activities, training centers, and hospitals),
- NAVSUP covering the Atlantic and Pacific fleets, and
- NAVFAC covering PWCs.

Table C-16 aggregates the data in Table C-15 into three categories that reflect different ways of treating OST.

Table C-16. Other Consumable Requirements Dollars by Method of Handling OST

Category	Value ($ million)
VOSL activities	478
High/low limit activities	167
Public works centers	75
Total	720

For PWCs, we made no estimate for the impact of reducing OST because a change in OST would not change the stock balance for an item.[10] It would only

[10] An exception would be when the item's OST is greater than 3 months. Without looking at individual item records, we had no way of knowing how many times this case might exist. Given the small dollars that would probably be involved, we thought that it was not worth pursuing.

change the portion of assets on order versus on hand. Reducing OST would increase the average quantity on hand and lower the average quantity on order.

VOSL Activities and OST Reductions

For VOSL activities, OST is used to develop both the OST and safety levels. Using consumable item budget (BP28) data, we compiled the total dollar value of monthly demand across all VOSL activities. We then divided that total of $61,838,452 by 30 to arrive at $2,061,282 for the dollar value of 1 day of demand. We used that number as our estimate of the value of 1 day of OST level.

To estimate the safety level value of a 1-day reduction in OST, we used the factor that the square root of the OST is part of the safety level computation. Specifically, we reasoned that the ratio of the new safety level to the square root of the new OST (i.e., the old OST minus the reduction) is equal to the ratio of the old safety level to the square root of the old OST. The dollar value of the total old or original safety level was $81,611,244 with a computed OST of 53.71 days. Table C-17 provides the results of this analysis.

Table C-17. VOSL Levels and OST Reductions

Reduction (days)	New level	Savings	Percentage of original
1	$80,847,929	$763,315	0.9
2	$80,077,337	$1,533,907	1.9
10	$73,622,818	$7,988,426	9.8
13.43 (1/4)	$70,677,410	$10,933,833	13.4
26.85 (1/2)	$57,699,150	$23,912,094	29.3
40.28 (3/4)	$40,805,622	$40,805,622	50.0
47	$28,853,932	$52,757,312	64.6
51.71	$15,748,498	$65,862,747	80.7
52.71	$11,135,869	$70,475,375	86.4
Average per day	$0.8 million for small reductions		

High/Low Limit Activities and OST Reductions

For high/low limit activities, such as Navy hospitals and demand-supported shipboard stock, the low limit is a days-of-supply computation covering OST and safety levels. Generally, the number of days is set through OST and safety level parameters. A reduction of 1 day for either would reduce the overall limit by 1 day, which is equivalent to 1 day of demand.

For ashore high/low activities, i.e., training centers and hospitals, we used SPCC data on monthly demand and levels to calculate a monthly total of $10,098,206, or

$336,607 per day with an average requirements level of 2.888 months of demand. For afloat high/low activities, we only had data on requirements levels. Therefore, we used the ashore demand-to-levels ratio to estimate monthly demand for them. The result was $47,357,498, or $1,578,584 per day. Summing the two daily demand numbers, we arrived at an estimate of $1,915,190 for a day of OST.

FUTURE PLANS

The following Navy initiatives are related to OST:

- The Navy is moving toward standard retail systems for ashore and afloat activities. This modernization of systems will reduce OST by streamlining requisition processing within retail supply activities, i.e., it will reduce the time to prepare and transmit requisitions as well as the time to receive and stow materiel.

- The Navy is moving from demand-based algorithms to readiness-based algorithms for high-cost items related to the operational availability of aviation and non-aviation equipment. Although the current demand-based algorithms generally use a zero value for OST, they include an endurance level that acts much in the same way as an OST level. Readiness-based algorithms consider all factors affecting item availability, including OST, and do not rely on an endurance level to provide needed support.

- The Navy has an extensive program to manage and reduce average customer wait time. All activities involved in the OST pipeline are being challenged to make improvements that will reduce requisition OST.

Appendix D
Air Force Retail Inventory Management

INTRODUCTION

This appendix examines retail inventory management in the Air Force. First, it gives an overview of the Air Force supply system and discusses how items are cataloged in the Air Force and how that relates to the way in which an item is managed. Next, it describes the activities and systems involved in retail management. Then, it describes how order and shipping time (OST) is recorded, computed, updated, and used and how OST reductions will affect inventories at the retail level.

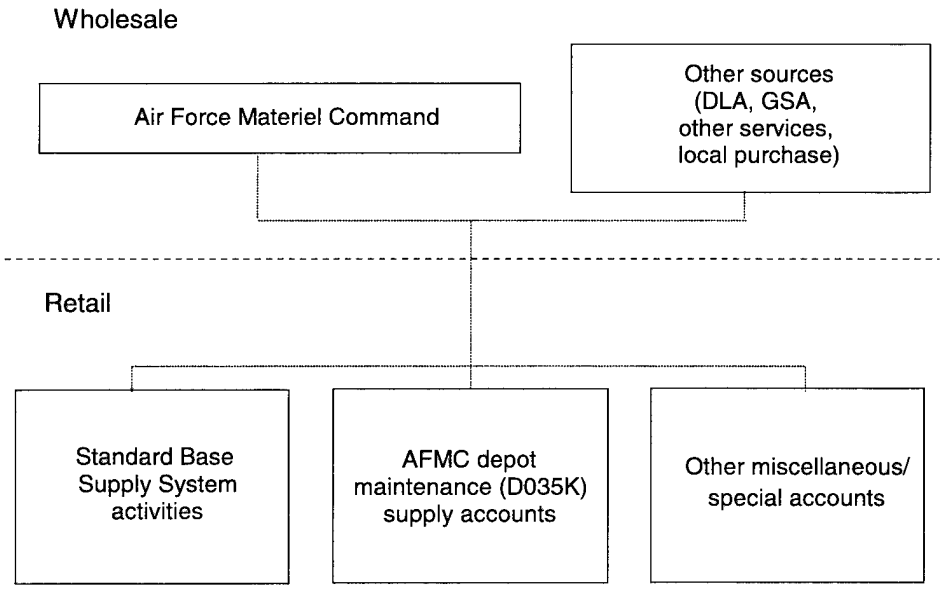
This appendix is based on interviews and research conducted at Headquarters, U.S. Air Force (HQ USAF), Washington, DC; Standard Systems Group and Air Force Logistics Management Agency (AFLMA), Maxwell Air Force Base (AFB) Gunter Annex, AL; Warner-Robins Air Logistics Center (ALC), Robins AFB, GA; 23rd Logistics Group, Pope AFB, NC; and 436th Logistics Group, Dover AFB, DE. Additional background was obtained through telephone interviews with personnel at Headquarters, Air Force Materiel Command (AFMC), Wright-Patterson AFB, OH, and Oklahoma City ALC, Tinker AFB, OK.

OVERVIEW OF THE AIR FORCE SUPPLY SYSTEM

As portrayed in Figure D-1, the Air Force operates a two-echelon supply system consisting of a wholesale level and a retail level. The retail or "base level" operates below the wholesale or national level and is the echelon where supplies are issued to the customers. The bases controlled by the major commands are the primary customers of the Air Force wholesale supply system, and each base or major grouping of organizations is assigned an account number. In support of the retail level, the wholesale supply system, managed by AFMC through its ALCs, processes requisitions for the items assigned to it. These stocks back up requirements for the items stocked and managed at the retail level.

Retail-level inventories are stored and managed primarily at the Air Force base using the Standard Base Supply System (SBSS). These inventories include all supplies required to operate the base and support the missions of assigned units and are available for immediate issue to the customer. Some retail levels of inventory exist outside the SBSS (such as the inventories that support the ALC depot maintenance shops).

Figure D-1. Air Force Inventory System



Note: DO35K = Depot Supply Stock Control and Distribution System; DLA = Defense Logistics Agency; GSA = General Services Administration.

Stock control procedures limit the number of items on hand at the base to those needed for immediate and projected requirements. Customer requests for issue are submitted to the supply supporting activity, which either issues the item to the requester or backorders the item. If not already due in on an appropriate priority, the supply activity originates a requisition for the requirement directly to the source of supply. Three basic categories of organizations are authorized to submit requisitions and can be assigned a stock record account number by AFMC. They are SBSS activities, AFMC Depot Supply Stock Control and Distribution System (D035K) accounts located at the ALCs, and other miscellaneous/special accounts.

Key Feature—Management by Item Category

In the Air Force, secondary items are generally categorized as equipment, reparables, or consumables. Management of these categories is assisted by the use of an expendability, recoverability, reparability category (ERRC) designator. As shown in Table D-1, the designator identifies whether an item is normally consumed in its use, its level of repair or condemnation, the unit cost or management category, and the management system used.

Generally, the Air Force considers items to be equipment if they keep their identity throughout their life cycle in the environment of their intended use. Equipment is considered to be non-expendable. Expendable items include reparables (spares) and consumables (repair parts) that either will be consumed in use or lose their identity by being installed on a higher assembly or end item. Although both

reparables and consumables are coded expendable (as indicated by the X in the first position of the ERRC designator), only reparables can be economically repaired. Consumable items cannot be repaired economically, are frequently referred to as economic order quantity (EOQ) items, and have an ERRC code of XB3.

Table D-1. Air Force Secondary Items

ERRC designator	Consumable/ reparable	Lowest condemnation level	Comments
XD1	Reparable	Depot	Serialized Control and Reporting System (SCARS)
XD2	Reparable	Depot	Air Force Recoverable Assembly Management System (AFRAMS)
XF3	Reparable	Base	—
XB3	Consumable	User	—

Depot-level reparable (DLR) items at the retail level are in two separate visibility categories. For assets being stored in anticipation of use, information is retained on supply point details. For assets progressing through the repair cycle, information is retained on due-in-from-maintenance details. At the base level, SBSS tracks each asset from the time of the reparable generation until it is repaired, condemned, or coded not reparable this station (NRTS). The reparable item is counted as an asset to SBSS until it is turned in as NRTS, condemned, or repaired. Only at this time will a stock replenishment action be taken if required. Demands are recorded on the turn-in of the item.

Field-level reparable (FLR) items are treated as expense items, and their wholesale levels are calculated using EOQ principles.

Figure D-2 shows that, considering inventory value, the majority of Air Force retail stocks in SBSS activities consists of DLRs. Based on summary information provided by the AFLMA as of the end of March 1995, DLRs and FLRs constitute over 80 percent of the retail on-hand inventory.

Reparable and consumable items are managed through stock fund procedures. As presented in Table D-2, the Air Force uses three stock fund divisions to manage these assets. The primary stock fund manager is the chief of supply, who is responsible for managing the divisions of the stock fund at the base level.

Item accountability is maintained at the retail level but is dropped when the item is sold from the stock fund to the user. Transfers of items from the wholesale to the retail level are treated as intra-stock fund transfers, and no funds are expended since no "buy-sell" action occurs. Similarly, transfers between bases are changes

in stock location, and no buy-sell action occurs as long as the stock remains with the stock fund. Therefore, issues of items to the customer—including those, such as depot maintenance repair shops, operated under reimbursement procedures of the Defense Business Operating Fund (DBOF)—are considered as sales and require reimbursement to the stock fund. Income obtained from sales is balanced against expenses incurred by acquisition of the materiel at the wholesale level, transportation costs, and losses to the stock fund.

Figure D-2. Air Force Retail On-Hand Inventory by Asset Category

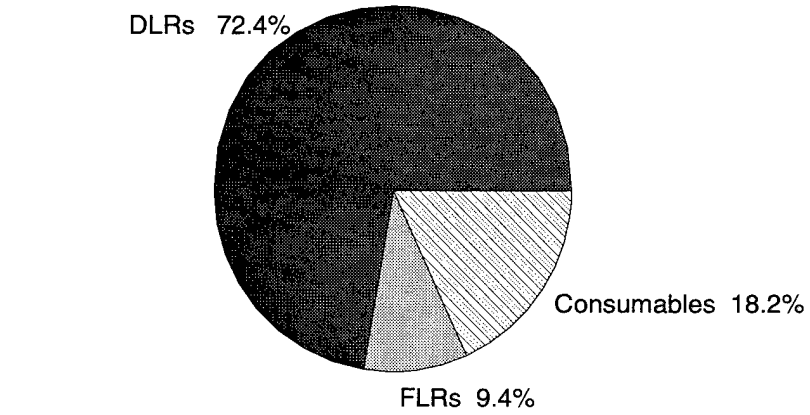


Table D-2. Air Force Stock Fund Divisions

Division	Type of stock fund	Type of item assets	Manager	Budget code
Reparable support division (RSD)	Vertical	DLRs	Air Force	1
Systems support division (SSD)	Vertical	Expense items other than DLRs	Air Force	8
General support division (GSD)	Reparable	Expense items	Other than Air Force	9

AIR FORCE RETAIL SUPPLY

Activities

POLICIES AND SYSTEM ORGANIZATIONS

Several Air Force organizations are major participants in developing retail and OST policies and systems. They include the following:

- The Supply and Fuels Policy Division (HQ USAF/LGSP) in the Office of the Deputy Chief of Staff, Logistics, at HQ USAF is responsible for Air

Staff supply policy and overall surveillance of the Air Force supply system.

- The major commands are the operating commands or users of supply items. They control the base-level organizations that provide retail-level supply support. Each base account provides supplies and equipment to all activities located on the base or in its proximity.

- AFMC is the central manager of Air Force materiel. HQ AFMC has assigned management responsibility for the federal supply classes among the inventory managers at the ALCs. Its ALCs provide life-cycle weapon system sustainment, maintenance, and repair. AFMC is also responsible for the operation and computer programming of the retail-level support functions at the ALCs.

- Standard Systems Group a component of AFMC, is also deserving of mention, since it is responsible, through its Directorate of Logistics Systems, for preparing and disseminating computer programs for use at all AFB supply activities. These standard programs implement Air Staff policy at Air Force supply activities operating under SBSS.

- AFLMA (formerly known as the Air Force Logistics Management Center, AFLMC) assists the Air Staff, AFMC, and the other commands by conducting logistics studies and analysis, including evaluations of OST standards, and recommending changes to Air Force policies.

BASE SUPPLY

At the base level, the consolidated base supply activity is responsible for the overall management, technical supervision, and maintenance of accountable records for most of the supplies consumed by the operating units. The base supply activity is the heart of the retail system and is the first echelon of the Air Force supply system where supplies are issued to the customers or consumed by the base itself. The base is the source of consumption data that serves to guide the worldwide replenishment, distribution, and procurement of Air Force stocks.

SUPPLY SUPPORT FOR DEPOT MAINTENANCE

A depot maintenance support center (DMSC) is established to support specific depot-level maintenance shops at an ALC. At Warner-Robins ALC, for example, there are 11 DMSCs. The DMSCs belong to "depot supply," which is the supply support activity for the depot maintenance complex.

The retail level supporting depot maintenance consists of 90 days of requirements. The DMSC is forward located and maintains 30 days of supply for items with frequent use; in addition, another 60 days of supply are maintained in the Defense

Logistics Agency (DLA) distribution depot (collocated with wholesale stocks). Each DMSC fills line issue requests from specific depot maintenance shops. A 6-month net issue history based on the specific line issues from a particular DMSC is used to compute the stock level of that DMSC.

Up to approximately 27,000 national stock numbers (NSNs) are loaded on a DMSC's account. Using the Warner-Robins ALC as a representative of D035K support for depot maintenance, Table D-3 identifies the line items stocked and the requisitions processed in FY94.

Table D-3. D035K Activity at Warner-Robins ALC

Division	Line items stocked		Requisitions processed	
	Number	Value ($ million)	Number	Value ($ million)
RSD	1,259	54.0	4,061	183.3
SSD	2,764	18.3	5,958	45.0
GSD	18,992	16.4	13,862	26.5
Total	23,015	88.7	23,881	254.8

Systems

STANDARD BASE SUPPLY SYSTEM

The base supply system is completely automated and standardized throughout the Air Force, using the same procedures, organizational structures, forms, and computer programs regardless of the base mission, size, or location. SBSS is that system and it operates on the Sperry U2200 computer. It is an automated inventory accounting and control system designed to provide total supply support to base-level activities. It is the main communicating vehicle between the base units supported and the supply processing and management systems of AFMC, DLA, General Services Administration (GSA), and the appropriate major commands. The system is completely compatible with all DoD standard military systems and uses their data element codes and standard forms where applicable.

SBSS is a "pull" system that provides for the requisitioning of all the requirements from the wholesale system operated by the ALCs and from other wholesale sources outside the Air Force using Military Standard Requisitioning and Issue Procedures. Each activity involved in the receipt, custody, or shipment of government property is identified by a code called a stock record account number (SRAN). The SRANs are six-position, alphanumeric designations. The first two positions are letters that identify the type of account (base supply, equipment, satellite, propulsion, etc.), and the remaining four positions are numerals that identify a specific activity within the account.

SBSS is an on-line processing system, which immediately updates both supply and financial records on the input of a single transaction. Financial programs are built into SBSS, and supply transaction accounting drives and updates financial records on a near-real-time basis, which provides updated status of funds to base supply managers and to user organizations. SBSS also captures maintenance data pertinent to component repair, including repair rates, repair times, due-in-from-maintenance, reasons for nonrepair, etc.

The standard system uses remote input-output devices that communicate directly and concurrently with the central processor without manual intervention or off-line conversion. Inputs, such as supply orders, are transmitted to the computer by way of remote devices located throughout the base. The computer notifies the warehouse of the item needed and informs the requester of the availability of the item. If it is not available, the computer automatically provides a list of substitute items and on-hand quantities that may be used to satisfy the requirement. If suitable stock is not available, it prepares a requisition for the source of supply, prints a due-in/due-out record, obligates the appropriate funds, notifies the requester of the status, and takes any necessary follow-up action.

The system uses a host-satellite concept of operation. Under this concept, the host base is designated as the computer support base and operates the main computer. Bases, Reserve units, and Air National Guard supply accounts that do not have sufficient logistics activity to use a computer share time on a nearby base U2200. Each satellite retail-level account is equipped with a remote input-output device. The smaller satellite accounts are identified by their own SRANs and are separate accounts, even though they are serviced by the main support base computer. As of 1 July 1995, SBSS was used by 103 computer support bases, each with its own computer, and 253 satellite accounts, which shared the computer at an active AFB.

AIR FORCE RECOVERABLE ASSEMBLY MANAGEMENT SYSTEM AND SERIALIZED CONTROL AND REPORTING SYSTEM

The Air Force Recoverable Assembly Management System (AFRAMS) manages DLRs. All DLRs at the base are visible to the item manager through AFRAMS reporting accomplished by SBSS. Each SBSS reports daily to the wholesale level the transactions affecting these assets (e.g., reparable generations, usage data, knowledge of materiel in transit, and gains or losses to the inventory).

The Serialized Control and Reporting System (SCARS), an intensified management system within the AFRAMS, assists in the intensive management of selected, very-high-cost items through manual serial number control to improve the utility of the limited number of these assets. No wholesale stock level is authorized for SCARS (XD1) items.

Depot Supply Stock Control and Distribution System

D035K is the largest and most extensive retail system outside of SBSS and, as previously noted, supports the large industrial-type maintenance activities at the ALCs. It is the only accountable record for all depot supply stocks.

Other Systems

Other supply support applications, separate from SBSS and D035K, exist in the Air Force below the wholesale level. The applications are related to special activities or unique situations that require a specialized type of supply support. They are the Air Mobility Command forward supply support system, AFMC laboratory support procedures, and miscellaneous accounts outside the scope of this study. These accounts include contractor-operated parts stores for vehicle maintenance activities and contractor-operated civil engineering supply stores for base engineering activities; both are external to SBSS. In addition, other specialized accounts using the same SRAN as the computer support base include munitions, fuel, and medical/dental.

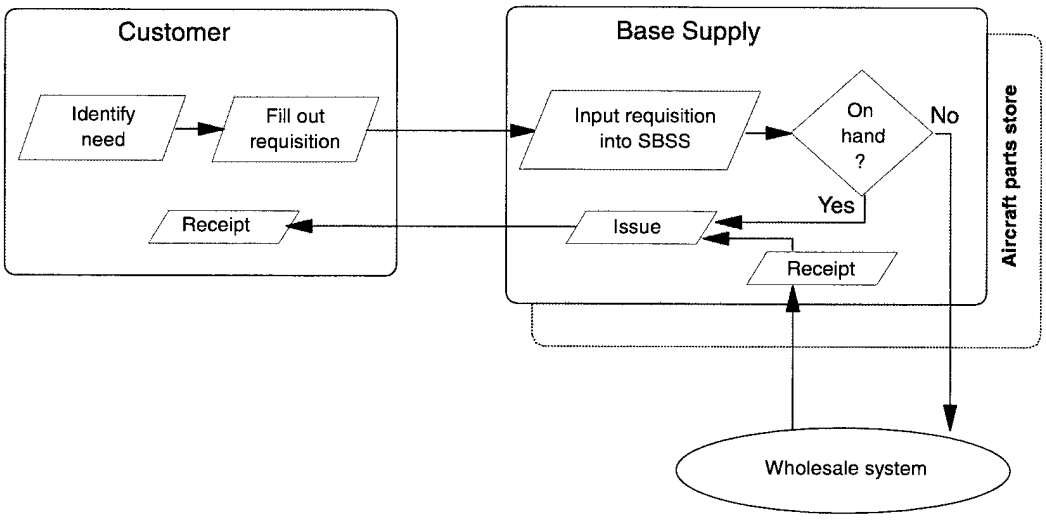
Requisitioning Channels

As illustrated in Figure D-3, requisitioning channels in AFBs are established based on the concept of direct requisitioning. A customer goes directly to base supply to fill materiel needs. If the materiel is not available at that level, requisitions are routed directly to the source of supply and transmitted by AUTODIN. An exception is when the needed materiel is causing an aircraft to be down, i.e., not mission capable (MICAP), then the base may chose to use the MICAP asset sourcing system to laterally fill the requisition from another base.

Besides end-use requisitions, bases also generate replenishment requisitions whenever the asset level for an item reaches the item's reorder point. For both end-use and replenishment requisitions, no retail intermediate levels exist to review or pass requisitions, and only a single level of wholesale inventory exists in the Air Force.

As shown in Figure D-3, some high-demand items at a base are positioned close to the customer (such as in an aircraft parts store) to expedite their delivery to the user when needed; these items are still part of the retail inventory even though they are not physically located in the central warehouse.

Figure D-3. Air Force SBSS Requisition Flow



At a DMSC, if the on-hand balance is at or below the reorder point (50 percent of the computed stock level), a stock replenishment transaction is output to move materiel to the DMSC. If no assets are available or the DMSC record contains a special level indicator, the D035K does not output an automatic replenishment transaction. Instead, a notice is transmitted to the DMSC so that replenishment action can be processed manually.

A similar process occurs when the D035K computes individual stock levels for each DMSC at the beginning of each month. After the level is computed, the system checks to see if assets on hand in the DMSC are equal to the computed level and outputs an automatic stock replenishment transaction to move the assets to the DMSC if the on-hand balance is less than the computed level and assets are available for replenishment.

RETAIL INVENTORY LEVELS AND OST

Stockage Policies and Practices

Replenishment actions at the retail level are based primarily on established demand levels. Separate computation methodologies for reparable (repair cycle XD/XF) and consumable (XB) items are used.

For the base stock of reparables, these computed levels include the following: base repair cycle quantities to replace removals made serviceable at the base level during the base repair cycle time; the OST quantity, consisting of quantities to replace removals condemned or returned to the depot for repair during the time required to receive serviceable replacements from the item manager; the base safety level, consisting of a quantity needed to permit continuous operations with a specified confidence if resupply is interrupted or demand varies; and negotiated

levels. However, the base-computed levels of reparables were previously overridden by levels centrally computed by AFMC in applying a "marginal analysis" approach to distributing reparables, and the Air Force is now in the process of returning to centrally computed levels.

Demand levels for consumable items are computed at the retail level by determining and adding the following quantities: EOQ, OST quantity, and safety level quantity. The determination of the EOQ takes into consideration the cost to order, the cost to hold, the unit price, and the daily demand rate.

Special levels are used to adjust base stock levels in consideration of factors or events where usage experience is not the best predictor of future needs. All special levels are identified separately from demand levels. Special levels consist of additive and adjusted levels. Additive levels are war reserve materiel requirements. Adjusted levels can generally be considered in two categories—predetermined and base initiated. Predetermined levels are those developed independently of the operating base (such as initial spares support lists). Base-initiated levels are developed in consideration of base-specific situations (flight safety, seasonal requirements, limited storage, etc.).

AIR FORCE ORDER AND SHIPPING TIME

Maximum standards are established for the total requisition OST. These time standards are established for the supply of materiel from the time that the requirement originated (date of the requisition) to the time that the physical receipt is posted to the requisitioner's inventory record.

OST Standards

As shown in Table D-4, time standards vary by priority and geographical location. (The priority designator is based on the force/activity designator, representing the relative mission essentiality, assigned to the requisitioning activity and the urgency of need designator, indicating the urgency of the end use of the item being requisitioned, and is used to identify the relative priority of competing requisitions and to allocate available stocks among them.) Overseas locations are divided into four geographical areas for establishing their standard delivery dates (SDDs).

Rules for Computing OST

Both retail and wholesale systems use the same general methods for computing OST—subtracting the date ordered from the date received. They both also have a series of decision rules with which they attempt to comply with DoD guidance that only data from stock replenishment shipments in stock at the source of supply be included in computing OST.

Table D-4. Air Force Standard Delivery Dates

Priority group	Priority designator	CONUS SDD	Overseas SDD (varies by location)
1	01–03	7	12–17
2	04–08	11	16–21
3	09–15	24	52–92

To comply with the in-stock item constraint, SBSS excludes from its OST computations any shipment that exceeds a fixed number of days based on the Uniform Materiel Movement and Issue Priority System (UMMIPS) standard for the region. Any shipment received before this truncation point is considered in stock, and any time exceeding the fixed percentage is not considered off the shelf and is thus excluded. For most items, SBSS uses 175 percent of the UMMIPS standard. If the receipt is equal to or less than 175 percent of the UMMIPS standard for that geographical location and for that priority group, the computer will update the OST days. (However, for some items, such as systems support division items with acquisition advice codes A–D, it uses 200 percent as the in-stock constraint.)[1]

On the other hand, for the wholesale system to count a shipment as in stock, the requisition cannot have a delay code (which could have been caused by a backorder with a vendor, a warehouse refusal, or an item manager review) in the Stock Control and Distribution System (D035A), and it must have reached the base within 90 days, regardless of destination. The Intransit Control System (D143K) combines two data sources to determine whether or not a shipment is off the shelf. It matches the materiel receipt acknowledgment document (D6S), which SBSS automatically produces at the receiving base, with the corresponding requisition history record in the D035A. Another constraint is that the D143K must have at least five "qualifying" receipts for a specific subgroup master NSN over an eight-quarter period before it will compute an OST value for that item.

SBSS Procedures

SBSS procedures for OST require bases to record an average OST for each routing identifier code or source of supply. The routing identifier is used to provide management data, by priority group, on requisitions submitted, status received, cancellations, etc. It is used to compute new average OST days by priority group and to provide an option to update the OST standard with the new average OST days for each priority group.

[1] Indicating that the item is service regulated, service managed, inventory control point regulated, or DLA managed, thus excluding items that are managed by GSA or the other services, are local purchase, or have restricted requisitions, etc. Acquisition advice codes are used to determine the correct routing identifier for loading to an item record.

The UMMIPS standard OST is stored on the routing identifier record by the load program as the base OST standard. In the OST update procedures, the program logic computes new average OST days by priority group and updates the routing identifier record if the update option is being processed. Each priority group's average OST days for all routing identifiers are stored on the system designator record when the update option is processed.

Bases run the routing identifier listing quarterly and annually. For each priority group and source of supply, the program updates the OST standard with the new average OST days. However, the program does not make an update if there are fewer than 100 receipts (or if the bypass update flag is on for the priority group and source of supply). The annual update is run at the end of September (after the quarterly update option for September is completed). When the annual option is processed, only current data (up to 1 year) stored on the routing identifier record are retained; data older than 1 year are deleted. The current data are then used to compute OST standards and for other management analysis.

The relevant data fields of the routing identifier listing during the OST update are described in Table D-5.

Table D-5. Selected Data Fields of the Routing Identifier Listing

Data field	Description
Priority group OST standard	Used to compute demand levels. Initially loaded at the time a routing identifier record is established and then updated quarterly by program Q05/GV871 with the actual averages computed.
OST days	Computed using receipts that fall within 175 percent of the UMMIPS standard and used as the new priority group OST standard when processing criteria are met.
Variance of OST	Computed for all routing identifiers and placed on the routing identifier record for use in computing the safety level.
New average OST days	Computed by dividing the receipts (within the UMMIPS constraint) in the OST days for the applicable priority group. The new average OST days are loaded as the new OST standard when program Q05/GV871 is run with the quarterly update option and 30 or more receipts have been processed for the applicable priority group.

Exception OST

An exception OST can be loaded to a routing identifier record and priority group OST standard. When assigned to the routing identifier record, the exception OST is automatically applied to each item record assigned that routing identifier, and the computer does not make a quarterly update of the OST standard using base data. Bases do not normally use the exception OST override on an item record,

but an exception time can be assigned to control an individual line item when the source of supply advises that an extended OST is required to procure the item or the source of supply does not normally stock the item. The override option is not used to compensate for times when items are temporarily out of stock.

Computation of Requirements Levels and OST

Stock control personnel are responsible for maintaining the items to support base missions. They manage, monitor, and process base assets. Each item has a demand level, a stock level for it based on past user demands. Demand levels are reviewed during file status. File status, the review of the entire item record file, is conducted once each quarter and updates the item record demand levels, identifies excesses, and deletes inactive item records.

Demand levels are a factor of the daily demand rate (DDR), the date of last demand, the current on-hand asset position, and the mission impact code. Past demand data and consumption levels, accumulated and stored in the demand data fields of an item record, are used to calculate current demand levels. Demand data consist of the following: date of first demand, date of last demand, number of demands, cumulative recurring demands, and date of last releveling.

OST is one of the factors used to compute requirements (demand) levels for both the retail and wholesale supply systems. For the computational formula, the OST quantity (OSTQ) is the quantity required to be on hand to meet demands during the period represented by the OST.

SBSS Procedures

SBSS computes demand levels for consumable items by determining and adding the following quantities: EOQ, OSTQ, and safety level quantity (SLQ). The Air Force stockage policy does not permit the use of an EOQ greater than 1 year of demand or less than 30 days of demand.

Repair cycle levels are designed for individual base repair capabilities, and the criteria are based on the unit price and percentage of base repair (PBR). For reparables, the demand level is the sum of the repair cycle quantity (RCQ), OSTQ, SLQ, and NRTS/condemned quantity, and a half adjust factor. If the item unit price (IUP) is $750 or less, the half adjust factor is 0.9; if the IUP is over $750, the factor is 0.5 In addition, for XF3 items with an IUP equal to or less than $750 and a base repair of 50 percent or less, an EOQ is calculated and included with the other elements as part of the repair cycle demand level.

Safety levels help prevent the supply activity from running out of stocked items. The SLQ is the quantity required to be on hand to permit continuous operation in the event of a minor interruption of normal replenishment or unpredictable increases in demands. A minimum of 15 days is computed.

The basic safety level computation is *C* multiplied by the estimated standard deviation of the distribution of demands during lead-time, where *C* equals the number of standard deviations permitted for the safety level. Table D-6 show what percentage of the demand distribution is covered by different *C* factors. This coverage relates directly to the expected stock depletions during an inventory cycle.

Table D-6. Safety Level Factors and Demand Coverage

C factor (standard deviation)	Percentage of inventory cycles
1	84
2	97
3	99

As the number of standard deviations increase, the total support costs increase; therefore, the number of standard deviations (*C* factor) is usually limited to 1. For example, at both Dover and Pope AFBs, no item had a *C* factor greater than 1. Exceptions can be provided by the Air Force Stockage Policy Work Group. In addition, European and Pacific bases are authorized to assign a *C* factor of 2 to certain categories of items, for example, EOQ items having a stockage priority code (SPC) of 1 or 2.

The OSTQ is a factor in determining demand levels and the reorder point for repair cycle items and consumables. SBSS uses OST to compute the OSTQ and the SLQ components of demand level. Equations D-1, D-2, and D-3 are the OSTQ formula, the SLQ formula, and the demand-level formula, respectively. The first set is the formulas for recoverable assets, and the second set is for consumable assets. The results of both demand-level formulas are truncated to provide a whole number value.

For recoverable assets,

$$OSTQ = DDR \times (1 - PBR) \times OST, \qquad \text{[Eq. D-1]}$$

$$SLQ = C\sqrt{3(RCQ + OSTQ + NCQ)}\text{, and} \qquad \text{[Eq. D-2]}$$

$$repair\ cycle\ demand\ level = RCQ + OSTQ + NCQ + SLQ + adjust\ factor; \qquad \text{[Eq. D-3]}$$

for consumable assets,

$$OSTQ = DDR \times OST, \qquad \text{[Eq. D-1]}$$

$$SLQ = C\sqrt{OST(VOD) + DDR^2(VOO)}\text{, and} \qquad \text{[Eq. D-2]}$$

$$EOQ\ demand\ level = EOQ + OSTQ + SLQ + 0.999, \qquad \text{[Eq. D-3]}$$

where

DDR = daily demand rate,

PBR = percentage of base repair,

OST = order and shipping time,

C = C factor,

RCQ = repair cycle quantity,

$OSTQ$ = OST quantity,

NCQ = NRTS/condemned quantity,

SLQ = safety level quantity,

VOD = variance of demand, and

VOO = variance of OST.

The variance of demand (VOD) is

$$VOD = \frac{\sum demand^2 - \frac{\left(\sum demand\right)^2}{n}}{n},$$

where

$\sum demand^2$ = total from the SBSS data element 101-CUMLTV-DMD-QTY-SQ,

$\sum Demand$ = total from the SBSS data element 101-CUMLTV-DMD-QTY, and

n = the number of days since the date of first demand.

The variance of OST (VOO) is

$$VOO = \frac{\sum (FI \times MI)^2 - \frac{\left(\sum FI \times MI\right)^2}{N}}{N},$$

where

FI = the number of receipts reflected in each segment of the routing identifier record's frequency distribution table,

MI = the midpoint of each segment (in days) of the routing identifier record's frequency distribution table, and

N = number of receipts.

The adjust factor is 0.5 if the IUP is over $750 or 0.9 if the IUP is $750 or less. For XF3 (FLR) items, the repair cycle demand level will include an EOQ segment when the IUP is $750 or less and the PBR is less than 50 percent.

Exceptions to Demand-Level Computations

The following are exceptions to demand-level computations:

- *Airlift Investment Items.* Airlift investment items represent a special case in the way SBSS computes its demand level. Instead of using an OST value computed by SBSS based on the base's receipts from a given depot, airlift investment items use an OST value computed by the D143K using only airlift investment shipments from the depot to the base. (Note: As this appendix was being prepared, AFMC was taking steps to eliminate the airlift investment category.)

- *Centrally Computed Levels.* Another special case for computing demand levels has been the use of a marginal analysis distribution technique that positions assets at the bases to produce the greatest reduction in the expected worldwide backorder rate. Base stockage requirements for selected recoverable items have previously been determined and automatically fulfilled by AFMC based on a marginal analysis technique using the Air Force Recoverable Central Leveling System (D028). In this situation, a base's demand level was pushed from AFMC and overrode any SBSS-computed demand level.

  The D028 process began with a worldwide requirement calculated by the Recoverable Consumption Item Requirements System (D041). The D028, in turn, distributed this worldwide requirement to the bases that were users of the specific item according to a backorder minimization algorithm that used OST values from the D143K for each routing identifier base combination. However, the D028 process was suspended during Operation Desert Shield/Storm.

  The Air Force is evaluating several options, including readiness-based levels, to return to a marginal analysis approach to distributing reparables. In the interim, base stockage requirements are being set by SBSS, although these requirements are divorced from the D041 computational process. The Air Force is now moving to reestablish centralized distribution using a readiness-based algorithm.

When recoverable items have had either a centrally computed level (that overrode the base-computed demand level) or have been coded airlift investment (and therefore used an OST value pushed from AFMC), the retail value for OST has been used primarily to compute demand levels for consumable (XB) items.

EOQ Range Determination

In addition, OST is a factor in EOQ range determination. SBSS computes the demand level for an EOQ (consumable) item based on a comparison of the cost to stock and the cost to not stock. The average OST for the source of supply (stock-level computation symbol "L") and the average OST for the base (stock-level computation symbol "Lt") are factors used in both the customer model and unit model to determine the cost to retain stock (and thus to stock) and the cost to not stock.

The cost to stock is the cost incurred when a level is computed and carried against an item. Determining this cost requires computing the cost to retain the stock. The cost to stock is based on the cost to maintain (a value established at $15.98 by policy), the holding cost rate (a value established at 15 percent by policy), the IUP, the reorder point, the number of demands, the EOQ, the cost to order (a value established at $19.94 for local purchase items and $5.20 for all others by policy), the line item availability factor, shortage costs (a constant for each SPC), the backorder cost (a value established at $3.60 by policy), "L," and "Lt."

The cost to not stock is the cost incurred when an item is not stocked and a level is not computed or carried against the item. The cost to not stock is based on shortage costs (a constant for each stockage priority code), the end of use order cost (a value established at $8.38 by policy), "L," "Lt," and the number of demands.

If the cost to not stock is less than the cost to stock, no demand level is computed. If the cost to not stock is greater than or equal to the cost to stock, a level is computed and stored on the item record. As "L" increases, both the cost to stock and the cost to not stock increase. As "Lt" increases, both the cost to stock and the cost to not stock decrease.

D035K PROCEDURES

As previously explained, the D035K provides the accountability records for all depot supply stocks and computes the requirements to support the DMSCs. (In D035K documentation provided to LMI, the term "pipeline time" (PLT) was used instead of OST and is used in the following discussion.) PLT similarly is the amount of time between the date of the requisition and the date the item is received.

Procedures similar to those used by SBSS are used to record and update PLT records by NSN. The D035K algorithm uses the average PLT in its computations unless it is over 90 days old. If it is over 90 days old, a new average is computed. If the computed PLT average is greater than 30 for airlift items, then 30 is used. For non-airlift items, if the computed average is greater than 90, then 90 is used. If

the computed average equals 0 (meaning that no pipeline time has been established), then 11 is used for airlift items and 30 for all others.

In calculating the levels of EOQ items, the PLT is a factor in calculating the safety level, since

$$safety\ level = \sqrt{\frac{demands}{days\ experience} \times DDR \times PLT \times \left(\frac{SCF}{demands}\right)^2},$$

where *days experience* is the difference between the stock level begin date and the current processing date. *Stock control factor* (*SCF*) is the number of items requested since the stock level begin date. The *demands* quantity is the number of times an item was requested. *DDR* is the daily demand rate and is

$$DDR = \frac{total\ SCF}{oldest\ days\ experience}.$$

In calculating the levels of repair cycle items (ERRCs of XD1, XD2, and XF3), the *PLT* is a factor in calculating the safety level and reorder level, since

$$OSTQ = DDR \times PLT \times \left(1 - \frac{RTSF}{SCF}\right), \text{ and}$$

$$safety\ level = \sqrt{3\left[\left(DDR \times \frac{RTSF}{SCF} \times 10\right) + OSTQ\right]},$$

where

RTSF = repair this station factor, and

reorder level = safety level + *OSTQ*.

In addition, the stock level is based on an additive to the reorder level and is thus influenced by changes in the PLT.

WHOLESALE SYSTEM APPLICATIONS

Wholesale system applications concerned with secondary items include the D041 and the EOQ Buy Budget Computation System (D062). The D041 determines the worldwide (wholesale and retail) requirements for reparable items. The D062 computes the wholesale requirements for EOQ items.

For reparable items, the D041 computes worldwide requirements for each subgroup master NSN using the OST value from the D143K for that specific subgroup master NSN. If the D143K does not pass an OST for a given item (which would occur if the item had not had at least five qualifying shipments over the

previous eight-quarter period), the D041 has to rely on a default, or "standard," OST value determined by HQ AFMC. An AFLMA study in 1991 (conducted when the wholesale system considered only priorities 9–15 as stock replenishment and thus applicable for computing OST values) found that 62 percent of the active items in the D041 database failed to meet the minimum-shipment criteria, and the D041 used the standard value for OST.

The D062 does not use base OST data in its demand-level computations. Its levels are based instead on demand history from the bases and the administrative and procurement lead-times involved with filling depot stocks.

Dollar Value of OST in Requirements Levels

Using currently reported OST data provided by the Air Force, this final section projects an approximate value of secondary items in the Air Force OST pipeline. In closing, it presents some broad analysis as to the impacts of reducing OST on Air Force retail inventories.

OST Value for DLRs

We estimate the daily value of the Air Force OST pipeline to be $28.6 million, based on the following analysis. The majority (87 percent) of the pipeline consists of DLRs with a value of $24.9 million; the remainder of the pipeline consists of $0.4 million of FLRs and $3.3 million of consumable items.

The *Air Force Central Secondary Item Stratification (CSIS) Report*, as of 31 March 1995, reports a base OST pipeline of $409.7 million for DLR assets (at a forecasted acquisition cost in the CSIS opening position), which is the soundest aggregated value for the Air Force DLR pipeline obtained during this study. We have used the stratification's standard base OST of 17 days (which is also the default value for D041 computations) to provide a macro-level estimate of the pipeline's value per day. Dividing the OST into the total pipeline value results in an amount of $24.1 million for the daily DLR value of the pipeline.

The Air Force uses a the readiness-based sparing model called the Aircraft Availability Model (AAM) to calculate the worldwide requirements levels for its DLRs. The AAM uses item OSTs (either actual or the standard default value of 17 days) to compute DLR levels. In the model, an item's OST affects both its wholesale and retail stock levels and how those stock levels stratify to wholesale safety level, retail safety level, and OST level. In 1994, the Air Force tasked LMI to use the AAM to look at the impact of reducing OSTs on DLR worldwide requirements. That analysis showed that reducing OST to 15 days reduced worldwide requirements levels by $49.7 million. Reducing OST to 9 days reduced requirements levels by $254.2 million. If we assume a baseline of 17 days, then the $49.7 million represents a 2-day reduction, for an average value of $24.9 million per day. The $254.2 million represents an 8-day reduction, for an average value of $31.8 per

day. Since the 2-day reduction or 15 OST is the Office of the Secretary of Defense goal for OST, we will use the value of $24.9 million as the value of 1 day of OST in DLR levels.

If we subtract the $24.1 million from the CSIS for the value of 1 day of DLR OST levels from the $24.9 million from the AAM analysis for the value of 1 day of OST in total DLR levels, we are left with $0.8 million for the value of 1 day of OST in safety level stocks.

OST Value for FLRs and Consumable Items

To develop an estimate for the FLR and consumable assets in the OST pipeline, we relied on a portion of OST analysis conducted by the AFLMA in 1994 (described in more detail on pages D-22 through D-25). For SBSS-computed demand levels, we extrapolated from the AFLMA study that a daily change in OST represented 1.11 percent of the demand level for a base within CONUS and 0.58 percent of the demand level for a base OCONUS.

The demand level for SBSS activities, as of March 1995, for FLRs was $37.9 million, consisting of approximately $32.8 million at CONUS bases and $5.1 million at OCONUS bases. The demand level for SBSS activities, as of March 1995, for consumable assets was $322.6 million, consisting of approximately $276.6 million at CONUS bases and $46.0 million at OCONUS bases. Applying the respective percentages to the CONUS and OCONUS levels results in a composite estimate of $3.3 million of consumables and $0.4 million of FLRs in the OST pipeline per day.

Data for D035K activities was not made available to us. Therefore, we did not develop an estimate for 1 day of OST in D035K requirements levels.

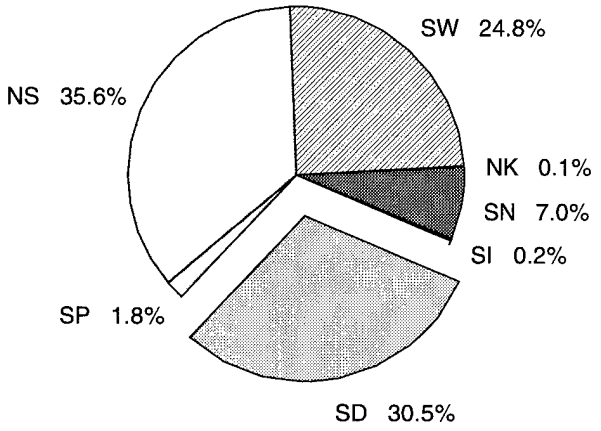
Relating the Effects of Reducing OST to the Total Air Force Retail Inventory

Requirements computation is the process of comparing total available assets to the total requirement. The requisitioning objective (RO) is the quantity of an item that must be on hand or on order to maintain current base operations. ROs are computed for repair cycle and consumable items.

In AFB-level supply management reports, total requirements (the requisitioning objective) are composed of several components based on the reason for stockage. The one that is OST related is stocked demand (SD), since as previously shown the demand level is based in part on the OSTQ. The remaining components are not OST related and include stocked insurance (SI), stocked provisioning (SP), stocked numeric (SN) (also referred to as stocked limited demand, SL), stocked war reserve (SW), not stocked (NS), and other (NK).

From summary information on SBSS activities provided by AFLMA (as outlined in Figure D-4), approximately 30 percent of the on-hand base-level inventory is for the stocked demand component; thus, less than one-third of the total on-hand quantities are related to OST.

Figure D-4. Base-Level On-Hand Inventories by Stockage Reason



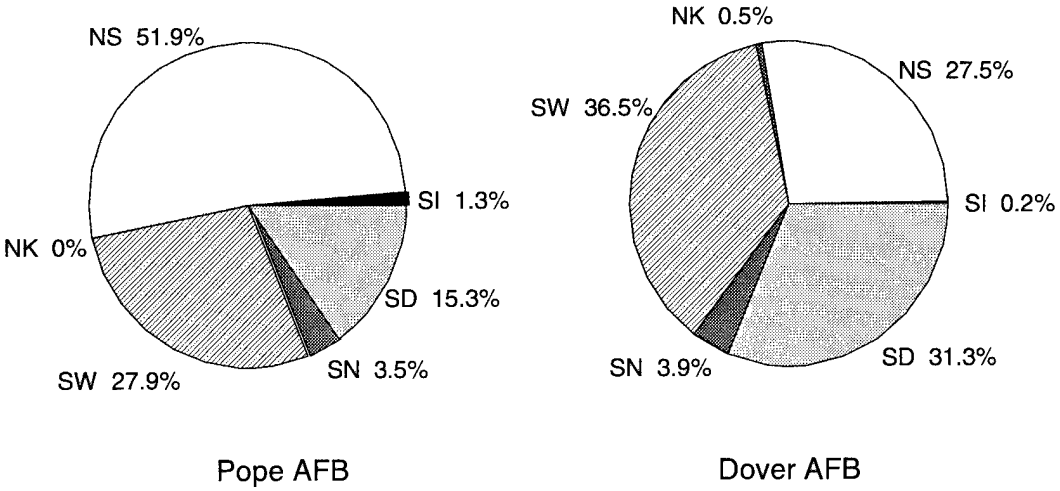
As of March 1995

This representation was generally replicated at the two sample AFBs used for this study, as Figure D-5 shows. The OST-influenced portions of the on-hand inventory at both Pope AFB and Dover AFB were less than one-third of the total inventory, although the quantity related to the stocked demand component at Pope AFB was particularly smaller than that at Dover AFB and for the overall Air Force.

Unlike the experiences of other military services, which use fixed OST values for some selected secondary items (as reported in other appendixes to this report), the Air Force does compute actual OST values for application to its retail inventories. However, as Figures D-4 and D-5 on the composition of on-hand inventories show, the inventory levels of the majority of Air Force retail stocks would not be impacted by adjustments in demand levels resulting from OST changes.

The impacts of OST changes on DLR inventories would be further constrained by any application of a marginal analysis distribution technique to centrally compute levels and position assets at the bases to produce the lowest probable worldwide backorder rate. The specific impacts of OST changes on the demand levels for consumable items, as examined in an AFLMA study, is presented in the following section. In addition, as other OST research discussed below shows, only a small percentage of the procurement and repair requirements for reparable items is affected by changes in OST.

Figure D-5. Selected Bases: On-Hand Inventories by Stockage Reason



As of July 31, 1995 (Pope AFB, NC) and June 30, 1995 (Dover AFB, DE)

AIR FORCE ANALYSES OF OST

Several recent studies have been conducted to evaluate the impacts of attaining the OST goals proposed by the 1995 *Department of Defense Logistics Strategic Plan*.[2] The plan proposed an OST goal of 3 days for all the services by September 1998. It also proposed interim OST goals of 15 days by September 1995 and 5 days by September 1996. The AFLMA has examined the relationship of changes in OST to the retail demand levels of consumable items as well as to DLR procurement requirements. LMI has also examined OST impacts on DLR buy and repair requirements.

Consumable Demand Levels

In an unpublished analysis conducted in 1994, the AFLMA evaluated the impact on the retail demand levels of consumable items from changes in OST. A baseline was developed by using the existing demand levels on the item records at 12 sample bases (8 CONUS and 4 OCONUS). The projected changes from the baseline for the selected CONUS bases if OST were reduced are outlined in Table D-7.

[2] Office of the Deputy Under Secretary of Defense (Logistics), *Department of Defense Logistics Strategic Plan*, 1995 Ed., 17 July 1995.

Table D-7. Changes in CONUS Consumable Item Demand Levels

OST days	Average of selected CONUS bases ($ million)	Percentage change from baseline
Baseline (approximately 40)	6.016	–
21	4.714	21.6
15	4.313	28.3
9	3.881	35.5
3	3.244	46.1

The AFLMA expanded this analysis to determine when the break-even point would be exceeded in comparing the costs of expedited transportation required to support the lower OST days with the projected reductions in retail consumable demand levels. For example, using the 15-day OST, the projected demand-level reduction in consumables was approximately $1.7 million. However, AFLMA determined that an additional $220,000 would be required annually in priority shipments, resulting in a savings duration of less than 8 years.

In a similar manner, the AFLMA also analyzed the impact on demand levels of OST reductions for the OCONUS bases. Because the OCONUS OST pipeline is much longer than that of CONUS (compare Tables D-7 and D-8), an OST reduction for the OCONUS bases to achieve delivery times comparable to those listed in Table D-7 results in significantly greater demand-level reductions. For example, AFLMA estimated that a reduction in the OCONUS OST to 21 days would result in a decrease in the demand levels of 52.3 percent, a reduction not achieved for the CONUS bases even if the 3-day OST goal were met (Table D-7). The projected changes from the baseline for the selected OCONUS bases if OST were reduced are outlined in Table D-8.

Table D-8. Changes in OCONUS Consumable Item Demand Levels

OST days	Average of selected OCONUS bases ($ million)	Percentage change from baseline
Baseline (approximately 72)	8.361	–
27	4.283	48.8
21	3.993	52.3
15	3.640	56.5
9	3.300	60.5
3	2.902	65.3

In reviewing the AFLMA analysis of base OST changes, we noted that as the OST was decreased to 15 days for CONUS bases, it resulted in approximately a 1.11 percent reduction per day in the demand level from the next higher OST threshold (21 days) evaluated, indicating that in this range, each day of OST

represents approximately 1.11 percent of the demand level. Similarly, each day of OST reduction for the OCONUS bases resulted in an approximate decrease of 0.58 percent in demand levels as the OST was reduced to 21 days. These measurements were used earlier in this appendix (see page D-20) to develop an estimate of the Air Force OST pipeline's value per day.

Inventory Procurement Dollars

In a 1992 study of "express cargo" alternatives, the AFLMA concluded that to achieve savings in inventory procurement dollars from OST reductions in peacetime, the Air Force would have to concentrate on high-value, high-demand, recoverable (DLR) supply items that were in a buy position.[3] The study noted that one-time savings for items currently in a buy position could be achieved, while actions to expedite shipments would incur continuing transportation costs.

Aircraft Reparable Buy and Depot Repair Requirements

In a similar analysis for the Air Force in 1994, LMI evaluated the impacts of the proposed OST goals on the buy and depot repair requirements of aircraft reparable items by conducting a sensitivity analysis using the D041 database (as of March 1994).[4] Of the 108,648 aircraft reparable items in the database, the buy or repair requirements for only 14,547 (or 13.4 percent) were affected by these OST reductions. However, of these 14,547 items, 6,904 (47 percent) did not have any buy or repair requirement in the current fiscal year (FY94); thus, any reduction in the gross requirements for these items could have possibly resulted in an excess position. The remaining 7,643 items did have a buy or repair requirement for the current fiscal year, but as many as 323 of them could also be placed in an excess position from a reduced requirement resulting from the OST reductions.

Most of the 7,643 items, however, would still remain in a buy or repair position, although their worldwide requirements would be reduced as Table D-9 indicates. The "Value" column provides the value of the reduction in the desired inventory position (the "worldwide target") for these items at their future acquisition costs for the OST days indicated. (However, Figure D-6 presents a more composite view of the impact of OST changes and shows the net savings after considering both buy and depot repair requirements.)

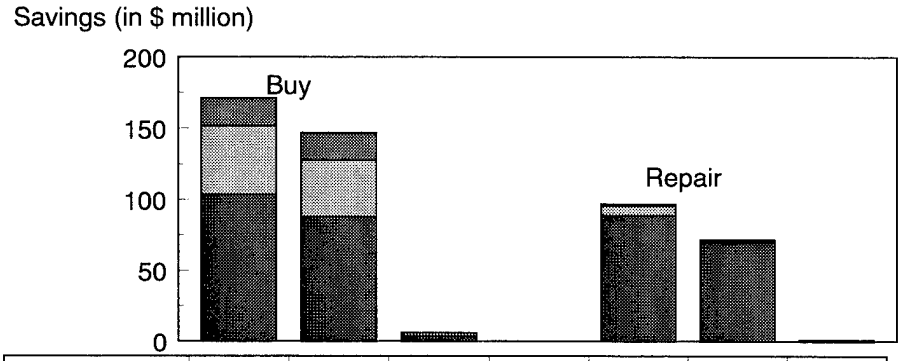
[3] E.J. Scarpa et al., *Peacetime Express Cargo Movement*, Air Force Logistics Management Center, AFLMC Final Report LT912111, Gunter AFB, AL, March 1992.

[4] LMI Memorandums for HQ USAF/LGSW, from Virginia (Ginny) A. Mattern, *Savings from Decreases in Order and Ship Time*, 19 September 1994; 6 October 1994, *Expedited Transportation Costs*; and 10 October 1994, *Reduction in OST Causing Long Supply*.

Table D-9. Aircraft Reparable Items Affected by Changes in OST

OST days	Items affected	Value ($ million)	Percentage of FY94 target world-wide level for items affected
15	414	45.9	8
9	1,519	230.9	10
7	1,864	316.0	12
5	2,184	427.5	15
3	2,390	534.2	16

Figure D-6. Impacts of OST Changes



OST	3 days	5 days	15 days		3 days	5 days	15 days
First year	104	88	4		89	70	1
Second year	48	40	2		7	1	0
Third year	19	19	0		1	1	0

Source: March 1994 D041 database.

Since many items were in long supply, the projected savings were relatively constrained, particularly for an OST reduction to 15 days, although potential long-term savings would be greater if the items eventually moved out of a long-supply condition. Figure D-6 shows the impact on buy and depot repair requirements of changes in OST for 3 consecutive years using the D041 database from March 1994. The savings would be relatively small if OST were reduced to 15 days. Greater savings would be achieved for significantly greater reductions in OST as shown in Table D-9, again, these savings would have to be considered with other corresponding logistics costs. In conducting a tradeoff analysis comparing logistics costs required to reduce OST, it is important to remember (as the AFLMA study also observed) that the spares investment is a "one-time" buy, but the expedited transportation expenses to provide faster delivery would be recurring costs.

The difference between Table D-9 and Figure D-6 is that Table D-9 shows the buy value at the future acquisition cost of the items (in a buy or repair position) with lower worldwide requirements because of OST changes (but the value does not

equate to savings in inventory requirements since most of the requirements are satisfied by the depot repair cycle rather than by new procurement). Actual savings would come from both buy and repair reductions. Therefore, Figure D-6 more realistically shows the savings potential of OST reductions since it also considers the contribution of the depot repair cycle to inventory requirements.

Appendix E
Marine Corps Retail Inventory Management

INTRODUCTION

This appendix addresses the retail supply activities that are part of the Marine Corps supply system and how order and shipping time (OST) affects the retail intermediate and consumer levels of inventory maintained by those activities.

This appendix is based on interviews and research conducted at Headquarters, U.S. Marine Corps, Arlington, VA; Camp Lejeune, NC; Marine Corps Air Station, (MCAS) New River, NC; and Marine Corps Logistics Base (MCLB), Albany, GA.

OVERVIEW OF THE MARINE CORPS SUPPLY SYSTEM

Figure E-1 illustrates the supply system involved in supporting Marine Corps fighting forces and installations. As shown, three levels of inventory exist in the Marine Corps (for non-aviation material): wholesale, retail intermediate, and retail consumer.[1] Wholesale-level stock is defined as that stock over which an inventory manager at the national level has asset knowledge and exercises unrestricted asset control to meet worldwide inventory management responsibilities. The retail intermediate level of stock bridges the gap between wholesale and consumer stock and is tailored to support either a specific geographical area, such as a Marine Corps installation, or a specific organization, such as a Fleet Marine Force (FMF). Consumer stock is usually restricted in range and depth and is held only by the final element in the Marine Corps supply system for the sole purpose of internal consumption. An example of a consumer level of stock is the stock held by a unit in an FMF.

MARINE CORPS RETAIL SUPPLY

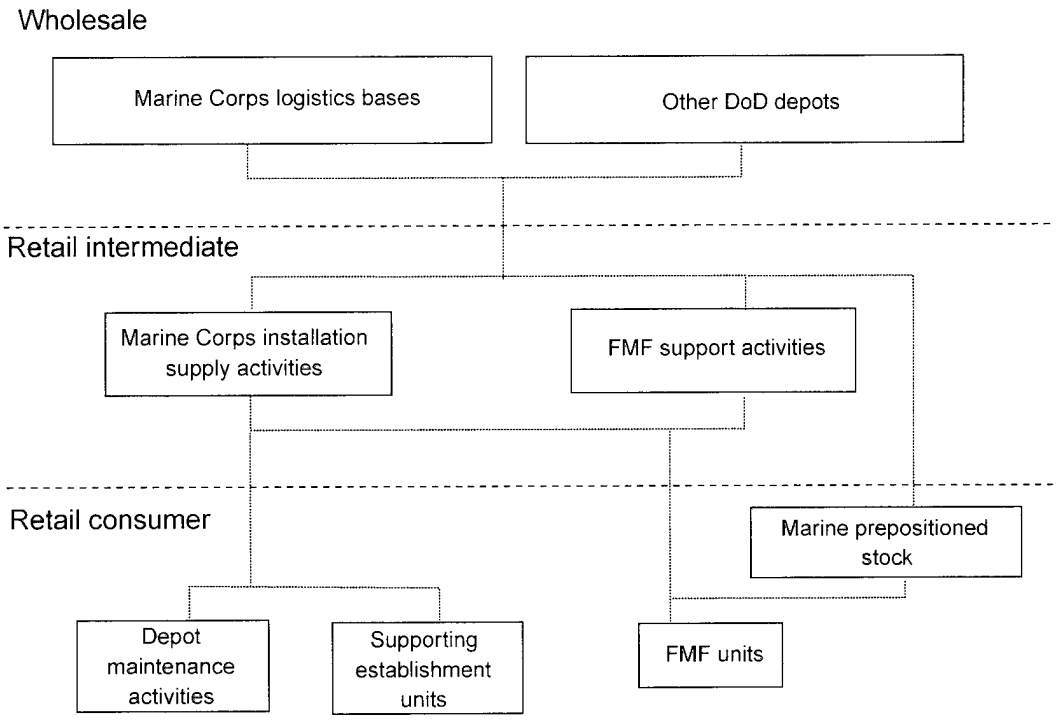
Activities

As shown in Figure E-1, several types of Marine Corps activities manage retail-level inventories. Marine Corps retail supply activities are the installation supply activities (ISAs), FMF units, FMF support activities, depot maintenance activities

[1] As discussed later in this appendix, inventories at MCASs (identified as aviation materiel in this appendix), which are managed by Marine aviation logistics squadrons (MALSs), are under the guidance of the Navy's supply system, which is described in Appendix C.

(DMAs), Marine pre-positioned stock; and Marine Corps retail aviation activities under the Navy.

Figure E-1. Overview of the Marine Corps Supply System



These inventories consist of the following three general types of material:

- Assets managed by the direct support stock control (DSSC) activities that include subsidiary inventories in self-service, shop stores, or similar intermediate-level stock points
- Material in the general accounts of the FMF combat service support units to satisfy consumer requirements
- Material in a Marine air-ground task force to satisfy consumer requirements.

INSTALLATION SUPPLY ACTIVITIES

The Marine Corps has intermediate ISAs at the following nine locations:

- Camp Lejeune, NC;
- 29 Palms, CA;

- Albany, GA;
- Camp Pendleton, CA;
- San Diego, CA;
- Barstow, CA;
- Parris Island, SC;
- Quantico, VA; and
- Okinawa, Japan.

The inventories at these supply activities are stock funded. Each supply activity manages a number of issue points, including shop stores (base maintenance and motor pool units), self-service stores, retail clothing outlets, and subsistence (commissary and mess hall).

These activities stock general housekeeping and administrative supplies for base and tenant units, and maintenance material and repair parts for the direct support of base units. They are further authorized to stock repair parts, subsistence items, and petroleum. Finally, they are authorized to stock and sell individual equipment and Marine Corps uniform items.

FMF Units

Unit inventories consist of allowance items, demand-supported consumable items, and selected reparable items in support of critical, low-density equipment. The reparable items are maintained in consumer reparable issue points (RIPs).

FMF Support Activities

The Marine Corps has four intermediate FMF support activities at the following locations:

- Okinawa, Japan,
- Camp Lejeune, NC;
- Camp Pendleton, CA; and
- Camp Smith, HI.

These supply activities are financed through the Operation and Maintenance, Marine Corps (O&MMC), funds. Each of these retail intermediate activities manages consumable items through a general account and reparable items—both

depot-level reparables (DLRs) and field-level reparables (FLRs)—through RIPs. They are deployable and totally manned by marines.

DEPOT MAINTENANCE ACTIVITIES

The Marine Corps has supply activities within its DMAs at Albany, GA, and Barstow, CA. These activities depend on commercial contractors and their installation supply activities to acquire repair parts needed to support depot maintenance schedules. Material planned for a maintenance action, but not used, is retained for future maintenance actions or transported between depots to support maintenance requirements.

MARINE PREPOSITIONED STOCK

To support its expeditionary force mission, the Marine Corps has prepositioned principal and secondary item stocks at four locations, three afloat and one in Norway. These stocks are funded through the O&MMC and procurement accounts. The accounting for these stocks is managed out of Blunt Island, FL.

The inventory levels for secondary items within these prepositioned packages constitute 30 days of supply (DOS). These levels are built by running a generator within the FMF support activities system. The generator produces a list of items and levels for a package. This list is reviewed and refined to support the specific missions assigned to the Marine expeditionary brigade (MEB) that will use the package if deployed. Prepositioned packages are updated every 2 years.

MARINE CORPS RETAIL ACTIVITIES UNDER NAVY SYSTEMS

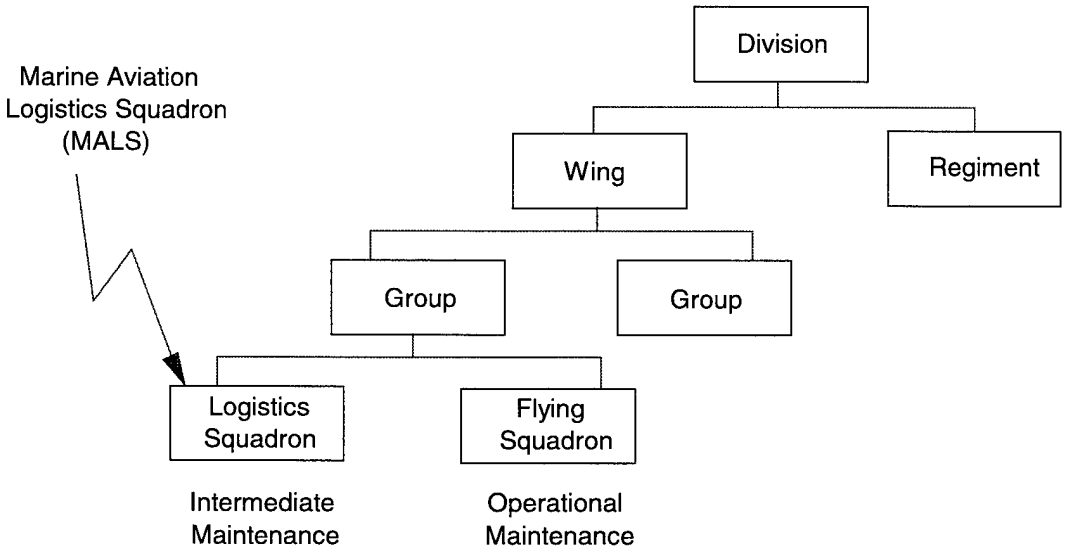
Inventories at MCASs are managed by MALSs. Consumable item inventories are stock funded while reparable item inventories are O&MMC financed. Although the MALS' immediate guidance is from Marine Corps commanders, MALS inventories are under the Navy's supply system. Figure E-2 pictorially reflects the MALS position within the Marine Corps organizational hierarchy. There are currently 15 MALSs (11 active and 4 reserve). The active MALSs are located at the following 10 MCASs:[2]

- Cherry Point, NC;
- New River, NC;
- Beaufort, SC;
- Yuma, AZ;

[2] MCASs El Toro and Camp Pendleton are in the process of moving to Naval Air Station Miramar and MCAS Santa Ana respectively.

- El Toro, CA;
- Kaneohe Bay, HI;
- Iwakuni, Japan;
- Santa Ana, CA;
- Camp Pendleton, CA; and
- Futenma, Okinawa.

Figure E-2. MALS Organizational Hierarchy



Systems

The current Marine Corps inventory management systems for non-aviation material are DSSC, the Supported Activities Supply System (SASSY), and the Marine Corps Unified Material Management System (MUMMS). MUMMS is the Marine Corps wholesale inventory system, while DSSC and SASSY refer to the inventory systems that manage ISAs and FMF support activities, respectively. All of these systems are under the Systems Branch of Headquarters, Marine Corps, while MCLB Albany is the central system design and maintenance activity. The Marine Corps has designed and is implementing a more advanced material management system called the Asset Tracking Logistics and Supply System (ATLASS) to replace SASSY.

For aviation material, the Marine Corps uses the Navy's Uniform Automated Data Processing System–Stock Point (UADPS-SP) for nondeployed forces and the Navy's Shipboard Uniformed Automated Data Processing System–Real Time

(SUADPS-RT) for deployed forces. The types of retail inventory and their associated management information systems are depicted in Table E-1.

Table E-1. Retail Management Information Systems

Function	FMF support	DSSC	MALS
Inventory	SASSY	MUMMS subsystem 07	SUADPS-RT
Maintenance[a]	MIMMS	Not applicable	NALCOMIS
Financial	SASSY	PRIME for stock fund SABRES for O&MMC	SUADPS-RT

[a] Both SASSY and MIMMS will be replaced by ATLASS.

Note: MIMMS = Marine Corps Integrated Maintenance Management System; NALCOMIS = Naval Aviation Logistics Command Management Information System; PRIME = Primary Management Effort; SABRES = Standard Accounting Budget Reporting System.

Requisitioning Channels

The requisitioning process for ground and aviation units starts similarly. However, the requisitioning channels differ since different inventory management units and systems are used.

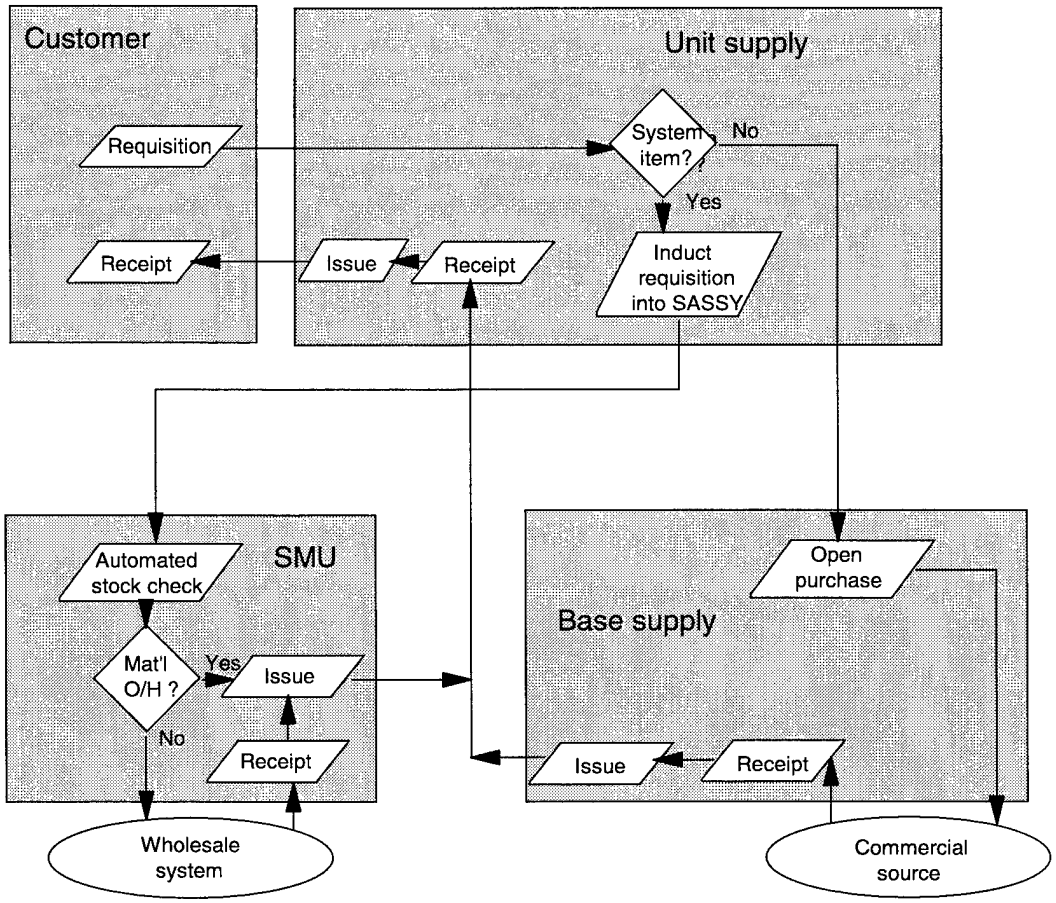
MARINE CORPS—GROUND

The requisitioning process starts when a customer (or consumer) of the retail system identifies a requirement for material. As illustrated in Figure E-3, the customer submits a requisition to the unit supply. Unit supply determines whether the item is a system item and assigns a stock number. This action starts the OST clock. Unit supply typically processes requisitions as a batch once per day, although high-priority requisitions may be passed immediately to the SASSY management unit (SMU) as required.

If the item is a system item, the unit supply inducts the requisition into SASSY or ATLASS (the system being developed to replace SASSY) and forwards it to the SMU via a disk before 1600 for processing the next day. An automated stock check is performed at the SMU to determine if the asset is on hand. If it is available, a DD Form 1348-1 (issue release/receipt document) is generated during the next SASSY (batch process) cycle. A material release order (MRO) is generated, and the item is picked, packed, and issued by the SMU to unit supply. The organizational level's OST clock is then turned off. If the item is not in stock, the requisition is passed to the wholesale system to be filled. Upon receipt of the material from the wholesale level, the SMU will pass it to the requisitioning activity's unit supply for receipt. Upon receipt, the unit supply processes a material receipt document (document identifier D6T), and the OST clock is turned off.

If the item is not a system item, the unit supply will obtain it from a commercial source through base supply. OST is not collected for nonsystem items.

Figure E-3. Retail Requisitioning Flow (Non-Aviation)

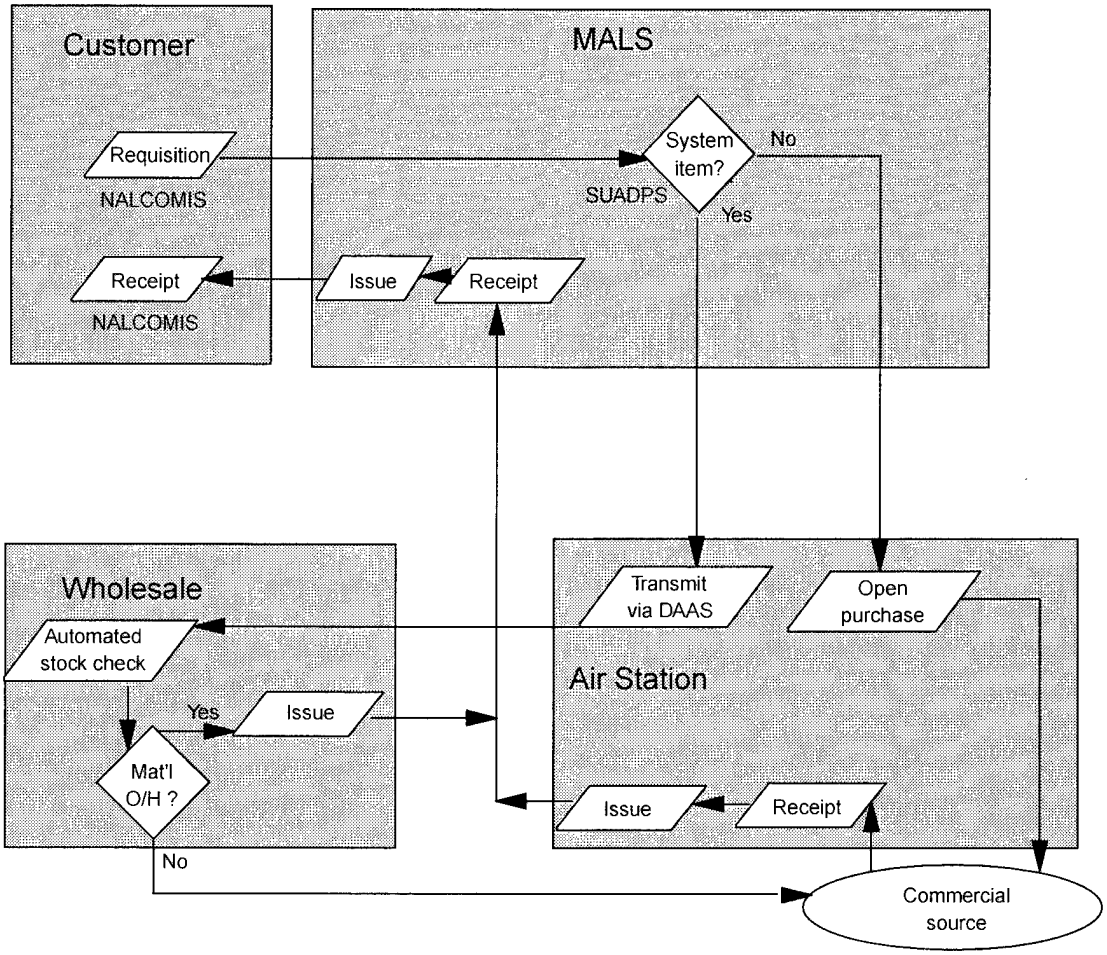


MARINE CORPS—AVIATION

The aviation requisitioning process starts similarly to the ground side process. The customer (normally a flying squadron) of the retail system identifies a requirement for material. As illustrated in Figure E-4, the customer processes a requisition via the Naval Aviation Logistics Command Management Information System (NALCOMIS) to the supporting MALS. If the asset is carried and is on hand, it is immediately issued from the MALS stock. Inventory and financial transactions are posted in SUADPS. If it is not carried or not in stock, the requisition will be bundled with others and sent to station supply. This action starts the OST clock. MALS processes requisitions as a batch once per day, although high-priority requisitions are phoned to the responsible inventory control point immediately.

The air station transmits requisitions from its supported MALSs via the Defense Automated Addressing System (DAAS) to the appropriate inventory control point for issue. The asset is normally sent directly to the supporting MALS, which will make the appropriate financial annotations in SUADPS and issue to the customer. Upon receipt, the MALS processes a material receipt document, and the OST clock is turned off. In cases where the requirement is not a system asset, the station supply may make a local purchase.

Figure E-4. Retail Requisitioning Flow (Aviation)



RETAIL INVENTORY LEVELS AND OST

Stockage Policies and Practices

Although the Marine Corps supply system has up to three echelons, most items are not stocked below the DSSC or SMU level. SMUs are measured by their percentage of demand for stocked items that is immediately filled (i.e., supply availability for stocked items).

DSSCs do not backorder. They collect statistics on the percentage of stocked items with demand and the percentage of items with demand that are stocked. However, the success of the DSSC is judged on how close the stock turn ratio is to 1.[3]

Authorized stock levels consist of both demand- and non-demand-based items. Demand-based levels generally consist of an operating level, safety level, repair cycle level (for reparables), and an OST/procurement lead-time level.[4] Non-demand-based items are generally limited to a specifically defined requirement. In either case, all items on the balance file of an intermediate-level activity will be assigned a reason-for-stockage category (RSC). The RSC codes are defined as follows:

- *Stocked demand (SD).* The decision to stock is based upon previously recorded actual demands. For a stock-funded activity, 10 recurring demands registered in 12 months qualify an item for stock. For an O&MMC-funded activity, three recurring demands in 12 months are required to stock an item if it is deemed combat essential. If the item is not combat essential, six recurring demands in 12 months are required to stock the item.

- *Stocked insurance (SI).* This is a non-demand-supported item for which replacement is not anticipated as a result of normal usage and for which an unacceptable lead-time (procurement or OST) has been established.

- *Stocked numeric (SN).* This is a non-demand-supported item for which there is usage data that does not meet established stockage criteria.

- *Stocked provisioning (SP).* This is a non-demand-supported item specifically stocked to support a newly introduced end item for that period of time until requirements are forecast entirely based upon actual demands.

- *Stocked prepositioned War Reserve Material (SW).* This is an item that is designated to satisfy war reserve material requirements.

The inventory objective of the intermediate level of supply is to provide the optimum stockage for each material category by striking a balance between performance and economy. Stockage computations employ actual demand and should minimize total variable costs for any given supply performance or investment objective.

OST Policy

The Marine Corps policy for determining the OST for calculating the requisitioning objective (RO) is to use an arithmetic mean, or average value, computed on an

[3] Dollars on hand divided by dollars of sales.

[4] As prescribed in Headquarters, U.S. Marine Corps, *Intermediate-Level Supply Management Policy Manual* (Marine Corps Order P4400.151), 9 July 1992.

item-by-item basis. The OST must be recalculated at least quarterly. Excluded from the OST calculation are abnormal conditions such as

- nonroutine requisitions,
- items of supply delivered under "other-than-usual" transportation modes, and
- items that are "stock out" at the supply source.

OST Determination

For consumables, an SMU simply multiplies the average monthly demand by two to determine the reorder point (ROP) and by four to determine the RO. The OST used for reparables is an actual OST measurement. On newly provisioned items, the OST is estimated.

DSSCs compute OSTs as an average of actual observations over a 12-month period. They are collected on a module of MUMMS called subsystem 07.

MALS consumable items have a fixed OST of 3 months. The Aviation Supply Office calculates MALS ROs for reparable items based upon fully justified usage information during a formal process known as "Re-AVCAL" (for recomputing the aviation consolidated allowance list). A prescribed constant of 17 days is used for the OST segment. The MALS, however, also computes proposed new ROs when they feel demand variations or other factors warrant changes prior to the next scheduled Re-AVCAL. A locally run subroutine, called the SUADPS DI 101, computes a proposed RO based upon the new information and is submitted to the Aviation Supply Office as an allowance change request. The local computation does not include OST, only the average monthly demand and the beyond-the-capability-of-maintenance rate.

OST is not a variable in range determination for either consumable or reparable items, but it is a factor in depth determination, as the following two sections describe.

Computation of Requirements Levels

Consumable Depth Determination

The Marine Corps stockage quantity for a demand-based consumable item managed by an SMU is a DOS calculation consisting of the following levels:

- *Requisitioning objective.* The RO is the sum of an operating level (OL), a safety level (SL), and an OST level.

- *Operating level.* The OL is that quantity of material required to sustain operations during the interval between the initiation of replenishment action and the arrival of successive replenishment shipments into the supply system.

- *Safety level.* The SL is that quantity needed to protect against fluctuations in demand or replenishment time.

- *Order and shipping time/procurement lead-time level.* This level covers demand during the time, in days, between the initiation of stock replenishment action and the receipt of the material resulting from that action.

REPARABLE DEPTH DETERMINATION

The Marine Corps retail reparable depth rule at the RIPs is a repair cycle demand-level computation, performed annually, which consists of the following levels:

- *Requisitioning objective.* The RO is the sum of an OL time (OLT) requirement, a repair cycle requirement (RCR), an OST requirement, and an SL. Instead of the demand-supported RO, RIPs may have a fixed RO for an item to support an insurance requirement. Special allowances may also exist that are additive to the RO. Special allowances would normally be authorized by the major subordinate commander for a specified purpose, which may include the commander's specific authorization of insurance items that otherwise do not meet usage, stockage, or directed allowance criteria for combat readiness. All special allowances are revalidated annually, and the RIPs maintain supporting documentation for their duration.

- *Operating level time.* The Marine Corps uses a fixed 60 days in setting operating levels for CONUS SMUs and 90 days for OCONUS SMUs.

- *Repair cycle requirement.* The RCR is the number of items repaired in a month multiplied by the average time (in months) required for repair of one item divided by the actual number of maintenance work days in the month.

- *Order and shipping requirement (OSR).* The OSR is the difference between the number of requests for exchange and the number repaired (per month) times the average time (in months) to order and receive this difference.

- *Safety level.* The SL is the sum of the RCR and OSR.

The ROP is the sum of the RCR, the OST requirement, and the SL.

FREQUENCY OF COMPUTATIONS

Level computations are performed monthly. (The current DOS OL computations will be replaced with an economic order quantity computation as part of the planned SASSY update.)

Current Marine Corps retail consumable depth rules at the intermediate level are given in Table E-2.

Table E-2. Intermediate-Level Depth Determination Rules

Factor	SMU CONUS	SMU OCONUS	DSSC CONUS	DSSC OCONUS	MALS
OL	60/30	90	30 or 60	90	300/90
SL	30	45	30	45	60/Poisson distribution
OST	Parameter	Parameter	Actual	Actual	90/17
RCL	Actual	Actual	Not applicable	Not applicable	Actual (20 maximum) Poisson distribution with 85% protection level
RL	Based on combat essentiality[a]	36 months		36 months	

Note: Levels are in days (consumable/reparable). RCL = repair cycle level; RL = retention level.

[a]For combat-essential items, RL = RO plus the planned requirement and 24 months of stock at anticipated issue or washout rates. For non-combat-essential items, the RL is 18 months of stock at anticipated issue or washout rates.

Current Marine Corps consumable item depth formulas for intermediate-level stockage are the DOS computations given in Table E-3.

Table E-3. Intermediate-Level Depth Determination Formulas (Non-Aviation)

Factor	Formula	Comment
Repair cycle requirement (RCR)	(RR × RCT)/22, capped at 90, includes awaiting parts	Workdays in month
Resupply rate (RSR)	MFR – RR	—
Operating level (OL)	(RSR × OLT)/30	—
Order and shipping requirement (OSR)	(RSR × OST)/30	—
Safety level (SL)	RCR + OSR and table	Poisson distribution—90% confidence level
Requisition objective (RO)	RCR + OSR + SL + OL	—
Mount out storage level (MOSL)	RO + MOAL	—
Total allowance	Larger of MOSL and CLD/PAL + SPL	—

Note: CLD = critical low density; MFR = maintenance failure rate; MOAL = mount out allowance list; PAL = provisioning allowance list; RCT = repair cycle time; RR = repair rate; SPL = special allowance.

Current Marine Corps retail consumable depth rules at the consumer level are the DOS computations given in Table E-4.

Table E-4. Consumer-Level Depth Determination Rules

Factor	Consumer-level user
OL	30 (60 for MIPs)
SL	Not authorized
OST	Actual by national stock number
Retention level	None authorized

Note: MIP = materiel issue point.

Current Marine Corps retail consumable depth formulas at the consumer level are based on Table E-5.

Table E-5. Consumer-Level Depth Determination Formulas

Factor	Formula	Comment
RO	OL + OSTL	—
ROP	RO – OL	—
OL	(RSR × OLT)/30	(RSR × OLT)/60 for MIPs
OSR	(RSR × OST)/30	—
Insurance	Variable	Determined by commander

Note: OSTL = OST level.

Dollar Value of OST in Requirements Level

The final section of this appendix provides aggregated inventory data to identify the dollar value of retail assets, retail requirements, and the OST pipeline.

Dollar Value of Assets

On-hand inventory values for Marine Corps retail supply activities, as provided by Headquarters, U.S. Marine Corps, from stratification data in April 1995, are shown in Table E-6.

Table E-6. Dollar Value of Retail Assets ($ million)

Activity	Consumables	Reparables
SMUs	92.6	135.6
DSSCs	35.8	Not applicable
DMAs	Not available	Not applicable
Total	128.4	135.6

DOLLAR VALUE OF RETAIL REQUIREMENTS

The requisitioning objective values for Marine Corps retail supply activities as provided by Headquarters, U.S. Marine Corps, from stratification data and SMU balance analysis reports in April 1995, are shown in Table E-7.

Table E-7. Dollar Value of Retail Requisitioning Objective ($ million)

Activity	Consumables	Reparables
SMUs	92.8	197.2
DSSCs	28.6	Not applicable
DMAs	Not available	Not applicable
Total	121.4	197.2

OST-RELATED STOCKS

The total estimated value of the Marine Corps OST pipeline is $4.4 million per day, as developed by the following analysis. Of that amount, $1.8 million is financed with operations and maintenance, Navy, dollars.

SMU Consumable Stocks and OST

An SMU manages both non-demand-based and demand-based items. The stockage quantity for non-demand-based items has no OST component. The stockage quantity for a demand-based consumable item managed by an SMU is the sum of an OL, SL, and OST level (OSTL).

To estimate the value of 1 day of OST, we started with the demand-based requirements for SMU consumable items. We divided those requirements by their respective days of OL, SL, and OSTL to arrive at the dollar value of 1 day of demand. Since the value of 1 day of demand is the same as the value of 1 day of OST, we have a value of $0.5 million.

SMU Reparable Stocks and OST

The SMU's RIP also manages both non-demand-based and demand-based items. Much the same as for consumables, the stockage quantity for non-demand-based items has no OST component. The stockage quantity for a demand-based reparable item managed by a RIP is the sum of the repair cycle requirement (RCR), OSR, SL, and OL.

To estimate the value of 1 day of OST, we applied the Marine Corps reparable item RO calculation formula to RIP item data collected from Camp Lejeune's SMU. Next, we computed baseline requirements levels from which we could measure the influence upon each stockage level of changes in OST, and thus apply

dollar metrics to those changes. Unlike consumables, which have a fixed SL, OST factors for reparables affect both the OSR and SL requirement. Therefore, any evaluation of OST dollar value must include both components.

Using this data, we computed the percentage changes in OSR and SL requirement if file OSTs were reduced by 1, 2, and 10 days. The results of those reductions are portrayed in Table E-8.

Table E-8. Percentage Reduction of SL and OSR

Days of reduction	SL requirement (per day)	OSR (per day)
1	0.9%	0.8%
2	1.3%	1.3%
10	2.7%	6.3%
Total weighted reduction per day	0.4%	0.6%

Since the percentage reduction by day is nonlinear, we determined weighted averages for each level influenced by OST. They were 0.6 percent and 0.4 percent, respectively. We applied those percentages to the demand-based piece of all SMU ROs to arrive at a reduction of $1.2 million in OSTLs and a reduction of $0.7 million in SLs.

DSSC Stocks and OST

A DSSC manages demand-based consumable items. Therefore, to estimate the value of 1 day of OST at the DSSCs, we used the same technique as we applied for the SMU consumable items. The result is $0.2 million per day.

SUMMARY

Table E-9 summarizes the relationships between OST and Marine Corps retail requirements levels impacted by OST.

Table E-9. Estimated Value of OST Pipeline

Requirements level	OST	Value of 1 day of OST ($ million)	Funding
MALS AVCALs (reparables)	Parameter (17 days)	1.8	O&M
SMU reparable OST level	Actual	1.2	O&M
SMU reparable safety level	Actual	0.7	O&M
SMU consumable OST level	Parameter	0.5	O&M
DSSC consumable OST level	Actual	0.2	DBOF
Total		4.4	—

Appendix F
Analytical Procedure Used to Estimate Allowance Reductions for Navy and Marine Corps

The role played by order and shipping time (OST) in the computation of the Navy's Yokosuka aviation consolidated allowance list (AVCAL) and its shore-based intermediate maintenance stock lists (SIMSLs) and of the Marine Corps' Marine aviation logistics squadron (MALS) AVCALs is not linear. Therefore, to develop estimates in these cases for the levels reductions caused by reduced OSTs, we developed the analytical procedure described in this appendix.

Basic Construction of Allowance Quantity

To compute the allowance quantity (q) for a Naval aviation item, the Aviation Supply Office (ASO) employs the Poisson distribution to describe demand over the supply pipeline and then sets the allowance quantity at a level that provides for a given level of protection against backorders (i.e., an 85 percent fill rate). Specifically, q is the smallest stock level such that

$$\sum_{i=0}^{s} \frac{e^{-\lambda} \lambda^{i}}{i!} \geq 0.85,$$

where λ = the supply pipeline.

Mathematically, λ is given as

$$\lambda = d \times RCT \times (d \times NRTS) \times (END + OST),$$

where

d = daily demand for item based on number of failures,

RCT = item repair cycle time in days,

$NRTS$ = percentage of failures that are not repairable this station,

END = endurance level in days, and

OST = order and shipping time.

If RCT, $NRTS$, END, and OST are known, then s has a number i as a solution for a given range of demand (i.e., $di - 1$ to di where $d - 1 = 0$).

DESCRIPTION OF PROCEDURE

Step 1

The first step in the procedure is to develop a set of demand ranges for the a set of allowance quantities as shown in Table F-1:

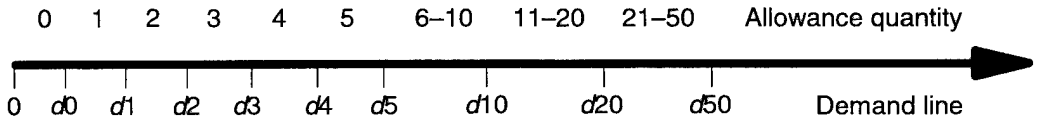
Table F-1. Allowance Quantities and Demand Ranges

Allowance quantity	Starting level of demand	Ending level of demand
0	0	*d*0
1	*d*0	*d*1
2	*d*1	*d*2
3	*d*2	*d*3
4	*d*3	*d*4
5	*d*4	*d*5
6–10	*d*5	*d*10
11–20	*d*10	*d*20
21–50	*d*20	*d*50

This table is built by first reversing the Poisson distribution to find the range of λs that would give the target allowance. For the target ranges of 6–10, 11–20, and 21–50, the target allowance was the average quantity in that range for the specific activity (i.e., Yokosuka, SIMSLs, or MALS). Then, the λ ranges are converted to demand ranges by substituting in the above formula average values for *RCT*, *NRTS*, and, in the case of the MALS, *OST*, and parameter values for *END* and *OST* in the case of Yokosuka and the SIMSLs. In building our tables, we stopped at a quantity of 50 because quantities of 1 to 50 usually covered 98 percent of the dollars in an allowance list.

Figure F-1 illustrates the concept of demand ranges and allowance quantities.

Figure F-1. Allowance Quantities and Demand Ranges

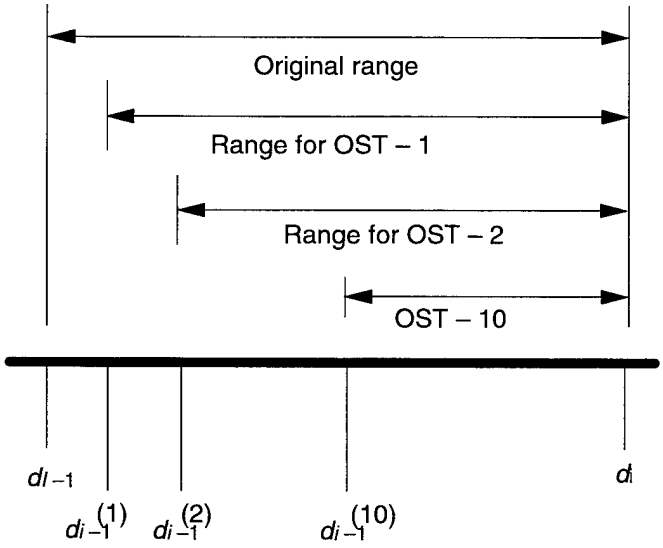


Step 2

Step 2 repeats step 1 except with a reduced OST. We worked with reductions of 1 day, 2 days, and 10 days. We then computed the original range of demand for each

allowance quantity as the difference between the starting and ending points. We repeated the range computations for the new starting points of OST minus 1 day, 2 days, and 10 days. Figure F-2 illustrates step 2 for the demand interval for allowance quantity *i*.

Figure F-2. Demand Ranges for Different OSTs



Step 3

Step 3 computes, for each allowance category, the dollar value of the allowance quantity reduction for items that have their quantities changed due to a reduction in OST. The computation is based on the assertion that the percentage change in the range of demand is the percentage change in the number of items with reduced allowance quantity. (This assertion is true if the items are uniformly spread over the demand range.) Mathematically, the dollar change is given by

$$DC_i = DV_i \left(\frac{R_k}{R_0}\right)\left(\frac{1}{AQ_i}\right),$$

where

DC_i = dollar change for the category with allowance quantity equal to λ,

DV_i = total dollars invested in allowance category i,

R_k = demand range for an OST reduction of k days,

R_0 = original demand range (no OST reduction), and

AQ_i = allowance quantity for category i.

(For categories where i = 1, 2, 3, 4, and 5, quantity equals i; for other categories, quantity equals average quantity.)

This formula can be interpreted as saying that the dollar value of the reduced requirements level is equal to the original dollars invested in the level, times the fraction of change, times the fractional reduction in the quantity. The fraction of change is the ratio of the new and original demand range. The fractional reduction in the quantity is one divided by the category quantity (e.g., if the category quantity is four, then the reduction in levels would be one in four, or 1/4).

Step 4

Step 4 prepares the total estimated dollar reduction in requirements levels for an activity by computing the percentage change in dollars for each category, adding up the percentages, and multiplying them times the dollar attributed to the inventory.

We used this approach instead of simply adding up the dollar changes because in cases when data from the subject activity were not available for one of the previous steps, we performed the step using data from another activity. In such cases, although the calculated dollar changes would not be correct, we could still use the percentage changes against the subject activity's baseline dollars to estimate the dollar reduction.

Appendix G
Analysis of Order and Shipping Time and Costs of Maintaining Inventory

At the beginning of Chapter 4, we listed the costs of maintaining an inventory as a prelude to presenting analyses on how individual costs were impacted by a reduction in order and shipping time (OST) and the associated reduction in requirements levels. However, we only discussed in Chapter 4 those costs where the effects of reducing OST were significant. In this appendix, we address the other costs. Those costs are

- the cost of acquisition,
- the administrative cost of repair,
- the cost of storage,
- the cost of capital,
- the cost of a backorder, and
- the cost of management.

COST OF ACQUISITION

Acquisition cost is the cost of ordering and receiving materiel from a source of supply into the supply activity. If the supply activity is a DoD wholesale activity, acquisition cost is the cost of a procurement action. If it is a DoD retail activity, acquisition cost is the cost of a requisition.

As presented in Chapter 4, an OST reduction will cause levels to decrease and will create a one-time asset surplus at the retail level that demand would consume over time. If the temporary surplus is redistributed to another retail site or the wholesale system, it will have no impact on the replenishment program at that retail activity. If it is not redistributed, it should delay the next replenishment requisition placed by the retail activity. However, since the period between such requisitions is from 1 month to 1 year (i.e., the constraints on the minimum and maximum replenishment order quantities), an OST reduction of a few days should not significantly reduce the annual number of requisitions placed for the item. For example, if an item is requisitioned six times a year and would normally be requisitioned next week, but now the requisition is delayed 2 weeks, it should still have six requisitions this year. In any case, a delay does not change the number of

requisitions over the life of the item since that number depends on demand and the order quantity.

The temporary surpluses at retail activities will, in turn, cause a one-time decrease in wholesale demand. The result would be a one-time asset surplus at the wholesale activity that demand would consume over time. The temporary surplus should delay the next procurement for the item. However, the long period between procurements (i.e., 6 months to 2 years) would not be significantly affected by a few days' delay. Moreover, the costs associated with making and receiving a procurement are "people" costs. However, the people and their costs should not change if the change is only a one-time decline in a workload that is otherwise constant. Again, a delay does not change the number of procurements over the life of the item.

In summary, since an OST reduction will only delay replenishment actions and not change the number of actions (except for the small possibility of changing the number of actions in a given year) or the number-of-people working actions, it should not affect the acquisition costs at either the retail or wholesale levels.

ADMINISTRATIVE COSTS OF REPAIR

As noted in Chapter 4, a reduction in OSTs does not affect the costs of field-level repair but does affect the costs of depot-level repair. The cost of repair refers to two costs—the administrative cost of directing the repair of unserviceable assets of an item and the maintenance costs of repairing an unserviceable asset. The maintenance costs of repair were discussed in Chapter 4.

The administrative costs of repair are like the cost of acquisition in that they are both based on the number of actions. And, like the cost of acquisition, a reduction in OST should cause a one-time delay in the number of depot repair orders if the orders are based on asset position. However, depot repair orders are often scheduled periodically; thus, the impact would be much smaller because it would be focused on the quantity to be repaired versus the number of orders. In any case, the one-time delay should not affect the number of people working on the orders. Consequently, an OST reduction should not affect these costs.

COST OF STORAGE

The cost of storage refers to the costs of warehousing or storing materiel, caring for the materiel in storage, and inventorying. Within DoD, the estimated cost of storage is 1 percent of the value of the average on-hand inventory. In this case, we are only interested in the on-hand inventory for demand-based items or items with demand-supported levels that involve OST (e.g., some Navy allowance quantities).

Theoretically, the expected average on-hand inventory for demand-based items is one-half of the operating level plus the safety level.[1] Since OST is not part of the operating-level computation, a reduction in OST only affects on-hand inventory if OST is included in the computation of the safety level. If an OST reduction causes a safety level reduction, then the one-time savings in storage costs should be equal to 1 percent of the dollar value of the reduction.

Demand-supported levels that involve OST but are not for demand-based stockage include Navy reparable allowance quantities and Air Force depot-level reparables (DLRs) levels. An expression for the average on-hand inventory is difficult in these cases, where order quantities are one and the OST pipeline is only based on demands not satisfied by local repair. It would be one-half unit less than the total requirements level minus the OST level (assuming stock in local repair is still subject to local stockage costs). If an OST reduction causes a reduction in the difference between the total requirements level and the OST level, then the one-time savings in storage costs should be equal to 1 percent of the dollar value of that reduction.

Based on Chapter 3, the potential cost reductions are shown in Table G-1. To develop Table G-1, we multiplied either the safety level reduction or the non-OST-level portion of a reduction in a reparable demand-supported stockage quantity by 1 percent.

Because key statistics for developing Table G-1 were not available in some cases, we had to substitute statistics from other similar cases in other services. Specifically, we did the following:

- To develop the savings for Navy readiness-based sparing (RBS) aviation consolidated allowance lists (AVCALs), we used the Air Force RBS statistic of 3.2 percent for that portion of the reduction that is not an OST level reduction.[2]

- For Navy Yokosuka and shore-based intermediate maintenance stock lists (SIMSLs) savings, we used the Marine Corps SASSY management unit (SMU) reparable item statistic of 36.8 percent for that portion of the overall reduction that is not an OST-level reduction.[3]

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[1] In reality, the average on-hand inventory is greater than expected. This phenomenon occurs because of forecasting errors. If a retail activity underforecasts the demand for an item, then it simply requisitions earlier to correct the error. However, if a retail activity overforecasts demand for an item, then the stock level for that item will be higher than expected. The overall effect is higher levels. (The Army was the first service to quantify this phenomenon at the wholesale level and developed asset adjustment factors to account for the effect in their order quantities.) However, reducing OST will not reduce forecasting errors and will not change the effect of higher levels.

[2] Taken from Chapter 3, *Air Force DLR Worldwide Requirements Computation and OST.*

[3] From Table 3-4, $0.7 million of the total $1.9 million reduction in SMU reparable stocks, or 36.8 percent, was in safety levels.

- For Air Force consumable and field-level reparable (FLR) demand levels, we used the Navy's variable operating and safety level (VOSL) statistic of 27.6 percent to quantify that portion of the reduction related to safety level.[4]

Table G-1. Stockage Cost Reductions

Service	Type of computation	Level associated with cost reduction	Cost reduction
Army	Demand-based	DBOF ASL safety levels for AMC activities	$401
	Demand-based	DBOF ASL consumable item safety level for non-AMC activities	$1,316
Navy	Demand-based	VOSL activities safety level	$7,633
	Demand-supported	RBS AVCALs	$1,285
	Demand-supported	Yokosuka	$4,789
	Demand-supported	SIMSL	$1,105
Air Force	Demand-based	Consumable and FLR demand levels	$10,207
	Demand-supported	DLR worldwide requirements	$8,000
Marine Corps	Demand-based	SMU reparable safety level	$7,000
	Demand-supported	MALS AVCALs	$6,631
Total			$48,367

Note: AMC = Army Materiel Command; ASL = authorized stockage list; DBOF = Defense Business Operating Fund; MALS = Marine aviation logistics squadron.

As Table G-1 clearly shows, the savings are extremely small. Even if the actual storage cost rate were twice the DoD standard, the savings would be less than $100,000 per year. In conclusion, a reduction in OST would affect the cost of storage, but the savings would be negligible.[5]

COST OF CAPITAL

Inventory is an investment made to effectively provide supplies to customers when they need them. A smaller inventory means a smaller investment, usually at the expense of lower effectiveness. When making inventory decisions or other investment decisions, Government and private-sector activities consider the cost of capital. For example, DoD supply activities use an investment rate when for-

[4] From Table 3-2, $0.8 million of the total $2.9 million reduction in VOSL consumable levels, or 27.6 percent, was in safety levels.

[5] Moreover, the question exists if any small reduction in safety level due to an OST reduction would actually affect the retail storage space or associated costs for maintaining that space. At the retail level, either onboard a ship even at base supply on a large base, storage space is limited and a large portion of the volume of occupied space is unaffected by OST. Reducing the quantity of stock that goes into that space may not change the amount of space set aside for retail stockage or the resources assigned for caring for stored materiel.

mulating economic order quantities. Traditionally, the DoD supply activities use a 10 percent rate for the cost of capital, with the exception of Air Force wholesale activities, which use a 6 percent rate.

The reduction in requirements levels resulting from reduced OSTs is a reduction in the total DoD inventory investment. Therefore, if we apply the standard 10 percent rate to the $48.8 to $84.2 million estimates for 1 day of OST requirements levels, we have an annual reduction in the cost of capital of between $4.88 and $8.42 million.

However, the cost of capital is an opportunity cost—that is, it is not reflected in budget requirement. It is merely a mechanism for making sound investment decisions.

COST OF BACKORDERS

If stock is not available locally to fill a customer demand, that demand must be backordered. Depending on what the demand is for, a cost exists to not filling it. Unfortunately, that cost is not quantifiable.[6] But, before we dismiss this cost, we need to review how OST reduction might impact backorders.

Two possibilities exist, and both pose contradicting effects. The first possibility is that smaller OST means fewer backorders because the materiel management systems should be able to forecast demand better over shorter periods of time. Better forecasts would in turn mean fewer backorders. The second possibility is that smaller OST means less stock in the system to react to unforecasted demand. The result would be more backorders.

In either case, OST reductions will affect backorders, but the effects and associated costs are unknown without a detailed inventory and cost analysis.

COST OF MANAGEMENT

Throughout this report, we have focused on how an OST reduction would affect the depth of stock and not the range of items stocked. If an OST reduction only affects depth of stock, then the cost of managing an item would not change. Managing an item with a level of 10 units costs the same as managing the same item with a level of 8 units.

[6] Some DoD requirements determination processes employ the cost of a backorder, but that cost is an implied cost. It is the cost in inventory to avoid a backorder.

However, if an OST reduction decreased the number of items being stocked, then item management costs would be impacted. The following three conditions would have to exist before such a reduction would happen:

- The range rule at the retail level would have to consider OST. We found that many retail activities still use hit rules (i.e., so many demands in a period of time).
- The OST reduction itself would have to be significant enough to affect the outcome of the range rule. Rules that currently consider OST use it to quantify the demand variance that needs to be covered by stockage. Any small reduction will not greatly affect the variance projections.
- Finally, the retail manager would have to trust the reduced OST and the system's ability to routinely meet the new OST and not replace demand-based stockage with non-demand-based stockage.

Appendix H
Model for Determining When to Expedite Replenishment Shipments

This appendix develops a methodology for examining the conditions under which expedited shipments are cost-effective for replenishing retail levels of supply.

PROBLEM DEFINITION

An expedited shipment of materiel occurs when the transportation office at a wholesale storage depot elects to move materiel by a rapid mode of transportation. Since rapid modes of transportation cost more than routine modes, expedited shipments are typically limited to high-priority, urgent requests for the materiel.

The question that has arisen is whether it is worthwhile expediting shipments for routine requests. In such cases, expedited shipments would result in

- an annual increase in the cost of shipments, and
- reduced shipping times that produce a cost reduction consisting of a one-time shrinkage in a pipeline and reduced annual holding costs.

The contention in this appendix is that when the present value of the cost savings exceed the present value of the increased transportation costs, then shipments should be expedited.

PRESENTATION OF SOLUTION ALGORITHM

The solution algorithm represents a present value analysis of the costs and benefits of expediting shipments for an item. By present value, we mean that future-year costs are converted to this-year costs through a discount factor, so all costs and savings can be evaluated on an equal basis.

We will develop the solution algorithm in several steps. In the first step, we will not limit the life of the item so that costs will occur over an infinite horizon. We will also ignore the asset position of the item in formulating when costs and savings start. In later steps, we will back off of these initial assumptions and then formulate the solution algorithm in terms of reduced order and shipping time (OST) and items in weight classes.

Solution Environment

Before we formulate an analytical solution to the problem of when to expedite, we need to review the target environment for the solution. The following apply:

- We are not concerned with urgency of need, that is, we will assume that urgent requests are being satisfied with expedited shipments, and we are only dealing with routine replenishment requisitions from retail supply activities.
- We are operating in an environment where individual items are not assigned their own response time goals (an emerging DoD program, referred to as "multi-link," calls for response time goals by item).
- Our solution is at an item level and, as such, specifies the item data required to make an economic decision (our solution could also be applied to a group of items using group averages for data).
- The solution assumes that, for a given item, the shipments that replenish retail inventories are in the same weight class.
- For purposes of simplicity, we formulated a solution that applies to consumable items. (Although the solution for reparable items would be more complex to account for savings and costs in both procurement and repair, the overall approach to developing it would be the same as the solution for consumable items. At points in the development of the solution for consumable items, we will suggest how the development for reparable items might vary.)

Basic Formulation

Define the following variables:

s = annual number of item shipments,

$Del_{EXP}(w)$ = increased cost of an expedited shipment for a given weight class (w). For surface transportation, the cost is also a function of distance. For air transportation, distance is less of a factor,

Del_{INV} = dollar value of the reduced retail inventory that could be saved from expediting shipments,

H = rate for annual cost of holding inventory (based on storage and obsolescence costs),

r = discount rate, and

i = index for year.

Given the above, the annual increase in the cost of shipments (Del_{SHIP}) is a function of the weight of the shipment and the annual number of shipments. Mathematically, it is given as

$$Del_{SHIP}(w) = Del_{EXP}(w) \times s. \qquad \text{[Eq. H-1]}$$

The annual reduction in holding costs (Del_{HOLD}) would be

$$Del_{HOLD} = H \times Del_{INV}. \qquad \text{[Eq. H-2]}$$

If we let Del_{COST} be the present value of the cost savings minus the present value of the increased cost of shipment, then we should expedite when Del_{COST} is positive and not expedite when Del_{COST} is negative. Del_{COST} is given by the following formula:

$$Del_{COST} = Del_{INV} + \sum_{i=1}^{8} \frac{(Del_{HOLD} - Del_{SHIP})}{(1+r)^i}. \qquad \text{[Eq. H-3]}$$

Since $r > 0$ and (where $x = 1/(1 + r)$ and $x < 1$), Equation H-3 reduces to the following:

$$\begin{aligned} del_{COST} &= Del_{INV} + \frac{(Del_{HOLD} - Del_{SHIP})}{r} \\ &= Del_{INV}\left(1 + \frac{H}{r}\right) - \frac{Del_{SHIP}}{r}. \end{aligned} \qquad \text{[Eq. H-4]}$$

EXAMPLE

Using Equation H-4, we can develop a rule of thumb on when to expedite shipments. For example, if the discount rate r is 10 percent (the standard rate used by the U.S. Government) and the holding rate H is 10 percent, then Equation H-4 becomes

$$Del_{COST} = 2 \times Del_{INV} - 10 \times Del_{SHIP}. \qquad \text{[Eq. H-5]}$$

Equation H-5 says that Del_{COST} is greater than zero (i.e., expediting is cost-effective) if the annual increase in shipping cost is less than 20 percent of the reduced inventory. Again, this rule of thumb is based on an infinite period for discounting costs.

Finite Cost Horizon

A more general form of Equation H-3 in terms of the number of years (N) for discounting costs is given below:

$$Del_{COST} = Del_{INV} + \sum_{i=1}^{N} \frac{(Del_{HOLD} - Del_{SHIP})}{(1+r)^i},$$

or, since

$$\sum_{i=1}^{N} \left(\frac{1}{1+r}\right)^i = \frac{1-\left(\frac{1}{1+r}\right)^N}{r},$$

$$Del_{COST} = Del_{INV} + (Del_{HOLD}\ \ Del_{SHIP}) \times \left[\frac{1-\left(\frac{1}{1+r}\right)^N}{r}\right],$$

or

$$Del_{COST} = Del_{INV} \times [1 + H \times F(r, N)]\ Del_{SHIP} \times F(r, N), \qquad \text{[Eq. H-6]}$$

where

$$F(r, N) = \left[\frac{1-\left(\frac{1}{1+r}\right)^N}{r}\right].$$

EXAMPLE

The number of years N is equal to the remaining life of the item. Again, we can develop a rule of thumb for expediting shipments. If the holding rate H is 10 percent and the discount rate r is 10 percent, and if we assume that the remaining life of the item or discount period N is 10 years, then Equation H-6 becomes

$$Del_{COST} = 1.6145 \times Del_{INV} - 6.145 \times Del_{SHIP}. \qquad \text{[Eq. H-7]}$$

Del_{COST} is positive when the annual increase in transportation costs is less than $100 \times 1.6145/6.145$, or 26.3 percent of the inventory savings.

We can draw additional conclusions from Equation H-7. If all other things are equal, we would be willing to incur a larger cost for premium transportation as we

- shorten the period for discounting cost N,
- increase the discount rate r, or
- increase the holding rate H.

Consideration of Asset Position

As discussed in Chapter 4, a high asset position will delay savings from reduced OST. We will now add this consideration to our solution.

We will define n as the number of years that savings are delayed due to a high asset position. Our new variable has the following characteristics:

- n would be zero for a new item.
- For any established item, n would be zero if the item is not in long supply, that is, the asset position is less than or equal to its approved acquisitioning objective.
- For any established item that is in long supply, n is the number of years that the item is expected to be in long supply (any fraction of a year is considered zero).

If n is greater than or equal to N, then the item should never have any of its shipments expedited since no savings will occur before the end of the item's life. For the same reason, if n is positive, then expediting should be delayed. Only if n is zero should expediting be considered, and then Equation H-6 applies.

Formulation in Terms of Reduced OST and Dollar Value of Demand

We now will develop the logic for rewriting Equation H-6 in terms of these variables:

Del_{OST} = the reduced OST in days,

$DVAD$ = the total dollar value of annual demand for the item, and

P = the unit price for item.

First, we'll introduce the following additional variables:

ARS = average requisition size (would be one for reparable items),

d = the daily demand for the item, and

W = the washout or condemnation rate for the item (should be 1 for consumable items).

Then, we have the following basic relationships between variables:

$$s = \frac{365 \times d}{ARS} \qquad \text{[Eq. H-8]}$$

and

$$DVAD = 365 \times d \times P. \qquad \text{[Eq. H-9]}$$

If we limit the inventory reduction from a reduced OST to the decrease in the item's OST level (i.e., we ignore any safety level decreases that might also exist), then the reduction in requirements levels (Del_{REQ}) is equal to the value of the OST level decrease. And, the OST level decrease is the product of the reduction in OST times the item's daily demand rate. Thus, we have

$$Del_{REQ} = d \times Del_{OST} \times P = \frac{DVAD \times Del_{OST}}{365}. \qquad \text{[Eq. H-10]}$$

The second equality in Equation H-10 falls out of Equation H-9.

For a consumable item, the reduction in requirements Del_{REQ} translates directly into a reduction in inventory Del_{INV}. Thus, we have

$$Del_{INV} = \frac{DVAD \times Del_{OST}}{365}. \qquad \text{[Eq. H-11]}$$

We can use Equation H-9 in combination with Equation H-8 to rewrite Equation H-1 as follows:

$$Del_{SHIP} = \frac{Del_{EXP}\ (w) \times DVAD}{ARS \times P}. \qquad \text{[Eq. H-12]}$$

Theoretically, the one-time reduction in retail requirements levels will cause a one-time decline in wholesale demand for serviceable assets. This decline will, in turn, cause a one-time delay in procurement requirements (and, for reparable

items, a one-time delay in repair requirements). Substituting Equations H-11 and H-12 into Equation H-6 yields

$$Del_{COST} = DVAD \times \left\{ \left[1 + H \times F(r,N) \right] \frac{Del_{OST}}{365} - F(r,N) \times \frac{Del_{EXP}(w)}{ARS \times P} \right\} \quad \text{[Eq. H-13]}$$

When Del_{COST} in Equation H-13 is positive, then the use of expedited transportation is cost-effective. This condition occurs when the expression in the parentheses in Equation H-13 is positive. This expression is independent of the dollar value of annual demand (*DVAD*); however, we know from Equation H-13 that the total savings is directly proportional to the *DVAD*.

The product of *ARS* and *P* is the dollar value of the requisition. Therefore, we can express our solution in terms of the dollar value of the shipment, the expected reduction in OST, and the dollar increase in transportation cost.

EXAMPLE

Again, we can develop a rule of thumb by substituting values for variables in Equation H-13. If the holding cost factor is 10 percent, the discount rate is 10 percent, and the discount period is 10 years, then Equation H-13 becomes

$$Del_{COST} = DVAD \times 1.6145 \times \left(\frac{Del_{OST}}{365} - 6.145 \times \frac{Del_{EXP}(w)}{ARS \times P} \right). \quad \text{[Eq. H-14]}$$

If the reduction in order and shipping time is 10 days (e.g., a reduction from 25 days to 15 days), then Equation H-14 tells us that expediting is cost-effective when

$$1.6145 \times \frac{10}{365} - 6.145 \times \frac{Del_{EXP}(w)}{ARS \times P} > 0$$

or when

$$ARS \times P > 138.9 \times Del_{EXP}(w).$$

For a given set of parameter values, we used this approach to develop Table H-1 that defines the required requisition value for each dollar of increased transportation cost.

Table H-1. Required Requisition Value for Each Dollar Increase in Transportation Cost

Holding rate	Expected reduction in shipping time (in days)						
	1	2	3	4	5	6	7
0.04	$1,801	$901	$601	$451	$361	$301	$258
0.05	$1,716	$858	$572	$429	$344	$286	$246
0.07	$1,569	$785	$523	$393	$314	$262	$225
0.10	$1,390	$695	$464	$348	$278	$232	$199
0.12	$1,291	$646	$431	$323	$259	$216	$185

Table H-1 would be applied as follows:

- If you were considering a routine replenishment shipment of a Defense Logistics Agency consumable item, you would use the row with a holding rate of 0.07 based on Table 4-3.
- If the expedited mode of transportation would reduce shipping time by 5 days, you would use the column for a 5-day reduction, which has a value of $314.
- If the cost increase for expediting the shipment is $20, then you would expedite if the value of the shipment is 20 times $314 or $6,280.

Of course, actual implementation would require that the table be adjusted to account for commodity surcharges so that the value of the shipment would translate to acquisition price versus standard price.[1]

[1] Inventory savings are valued at acquisition price because they are the product of a one-time reduction in the cost of acquiring stock.

Appendix I
Abbreviations

AAM	Aircraft Availability Model
ABF	asset balance file
AECL	aviation equipment configuration list
AFB	Air Force base
AFLMA	Air Force Logistics Management Agency
AFLMC	Air Force Logistics Management Center
AFMC	Air Force Materiel Command
AFRAMS	Air Force Recoverable Assembly Management System
ALC	air logistics center
ALOC	air lines of communications
AMC	Army Materiel Command
ARR	allowance requirement register
ARROW	Aviation Retail Requirements Oriented to Weapon Replaceable Assemblies
ASL	authorized stockage list
ASO	Aviation Supply Office
ATLASS	Asset Tracking Logistics and Supply System
AUTODIN	automatic digital network
AVCAL	aviation consolidated allowance list
AVIM	aviation intermediate maintenance
AVUM	aviation unit maintenance
BCM	beyond the capability of maintenance
BN	Battalion
BRF	best replacement factor
CAM	central asset management
CBC	construction battalion centers
CLD	critical low density
CMMC	corps materiel management center

COBOL	Common Business Oriented Language
Cog	cognizance
CONUS	continental United States
COSAL	coordinated shipboard allowance list
COSBAL	coordinated shore based allowance list
COSCOM	corps support command
CSIS	Central Secondary Item Stratification
CSP	Contingency Support Package
D028	Air Force Recoverable Central Leveling System
D035K	Depot Supply Stock Control and Distribution System
D041	Recoverable Consumption Item Requirements System
D062	EOQ Buy Budget Computation System
D143K	Intransit Control System
D6S	materiel receipt acknowledgment document
D6T	materiel receipt document
DAAS	Defense Automated Addressing System
DASC	Demand Analysis System Control
DBI	demand-based item
DBOF	Defense Business Operating Fund
DBS	demand-based sparing
DDN	Defense Data Network
DDR	daily demand rate
DLA	Defense Logistics Agency
DLR	depot-level reparable
DMA	depot maintenance activity
DMF	demand master file
DMMC	division materiel management center
DMRD	Defense Management Review Decision
DMSC	depot maintenance support center
DMSO	division medical supply office
DO35A	Stock Control and Distribution System
DoD	Department of Defense

DOL	Directorate of Logistics
DORO	DLA Operations Research Office
DOS	days of supply
DRMO	Defense Reutilization and Marketing Office
DS	direct support
DS4	Direct Support Unit Standard Supply System
DSSC	direct support stock control
DSU	direct support unit
DVAD	dollar value of annual demand
EAC	echelons above corps
EOQ	economic order quantity
ERM	economic retention model
ERRC	expendability, recoverability, reparability category
FILL	fleet issue load list
FISC	fleet and industrial supply center
FISP	Fly In Support Package
FLR	field-level reparable
FLSIP	Fleet Logistics Support Improvement Program
FMF	Fleet Marine Force
FOSP	Follow On Support Package
FSB	forward support battalion
GS	general support
GSA	General Services Administration
GSD	general support division
GSU	geographically separated unit
HQ	Headquarters
ICP	inventory control point
IMSA	installation medical supply account
ISA	installation supply activity
ISSD	Installation Supply and Services Division
IUP	item unit price
LAMPS	Light Airborne Multipurpose System

LMI	Logistics Management Institute
LRT	logistics response time
MAG	Marine Air Groups
MALS	Marine Aviation Logistics Squadrons
MCAS	Marine Corps Air Station
MCLB	Marine Corps Logistics Base
MCO	Marine Corps Order
MEB	Marine Expeditionary Brigade
MEDLOG	Medical Logistics
MEF	Marine Expeditionary Force
MFR	Maintenance Failure Rate
MICAP	mission capable
MIMMS	Marine Corps Integrated Maintenance Management System
MIP	materiel issue point
MLB	Medical Logistics Battalion
MMC	materiel management center
MOAL	mount out allowance list
MOD-FLISP	Modified FLSIP
MOSL	mount out storage level
MRO	material release order
MSB	main support battalion
MUMMS	Marine Corps Unified Materiel Management System
NAB	Naval Air Base
NADEP	Naval Aircraft Depot
NALCOMIS	Naval Aviation Logistics Command Management Information System
NAS	Naval air station
NAVFAC	Naval Facilities Engineering Command
NAVHOSP	Navy hospital
NAVICP	Naval Inventory Control Point
NAVMEDCEN	Naval medical center
NAVSTA	Naval station

NAVSUP	Naval Supply Systems Command
NICP	national inventory control point
NK	other
NNMC	National Naval Medical Center
NRFI	Not Ready For Issue
NRTS	not reparable this station
NS	not stocked
NSC	Naval Supply Center
NSN	national stock number
NSY	Naval Shipyard
NTC	Naval Training Center
O&M	operations and maintenance
O&MA	Operations and Maintenance, Army
O&MMC	Operation and Maintenance, Marine Corps
OCONUS	outside of CONUS
OL	operating level
OLT	OL time
OSC	Objective Supply Capability
OSD	Office of the Secretary of Defense
OSI	operational support inventory
OSR	order and shipping requirement
OST	order and shipping time
OSTL	order and shipping time level
OSTQ	order and shipping time quantity
OSTSF	order and shipping time smoothing factor
OSTVSF	order and shipping time variance smoothing factor
PAL	provisioning allowance list
PBR	percent of base repair
PC	personal computer
PLL	prescribed load list
PLT	pipeline time
POD	Port of Debarkation

POE	Port of Embarkation
PRIME	Primary Management Effort
PWC	public work center
QOS/GVB71	routing identifier listing
RBS	readiness-based sparing
RCL	repair cycle level
RCQ	repair cycle quantity
RCR	repair cycle requirement
RCT	repair cycle time
RFI	ready for issue
RIM-AIR	Retail Inventory Model for Aviation
RIP	reparable issue point
RL	retention level
RO	requisitioning objective
ROP	reorder point
RR	Repair Rate
RSC	reason-for-stockage category
RSD	reparable support division
RSR	resupply rate
SABRES	Standard Accounting Budget Reporting System
SAILS	Standard Army Intermediate Level Supply System
SAMS	Standard Army Maintenance System
SARSS	Standard Army Retail Supply System
SARSS-O	Standard Army Retail Supply System–Objective
SASSY	Supported Activities Supply System
SAVAST	Ships AVCAL Asset Tape
SBSS	Standard Base Supply System
SCARS	Serialized Control and Reporting System
SCF	Stock Control Factor
SD	stocked demand
SDD	standard delivery date
SERVMART	retail self-service merchandising stores

SESAME	Selected Essential Stockage for Availability Method
SHORCAL	shore-based consolidated allowance list
SI	stocked insurance
SIM	selected item management
SIMA	ship intermediate maintenance activity
SIMLM	Single Integrated Medical Logistics Manager
SIMSL	shore-based intermediate maintenance stock lists
SL	safety level
SL	stocked limited demand
SLQ	safety level quantity
SMIS	Supply Management Information System
SMU	SASSY management unit
SN	stocked numeric
SNAP I	Shipboard Nontactical ADP Program
SOS	source of supply
SP	stocked provisioning
SPBS-R	Standard Property Book System-Revised
SPC	stockage priority code
SPCC	Ships Parts Control Center
SPL	special allowance
SRAN	stock record account number
SRASL	selected restricted availability stock lists
SRF	ship rework facility
SSAs	supply support activity
SSD	systems support division
SSIR	supply system inventory report
SUADPS	Shipboard Uniform Automated Data Processing System
SUADPS-RT	Shipboard Uniformed Automated Data Processing System-Real Time
SW	stocked war reserve
TAACOM	theater Army area command
TAMMC	theater Army materiel management center

TAMMIS	Theater Army Medical Management Information System
TAMMIS-MEDLOG	Theater Army Medical Management Information System-Medical Logistics
TILL	tender issue load list
TO&E	Table of Organization and Equipment
TRADOC	Training and Doctrine Command
TRF	TRIDENT refit facility
TSA	Training Squadron Allowance
TV	transaction variance
U2	UADPS version 2
UADPS	Uniform Automated Data Processing System
UADPS-DOSS	UADPS-Disk Oriented Supply System
UADPS-SP	UADPS-Stock Point
UICP	Uniform Inventory Control Point
ULLS	Unit Level Logistics System
UMMIPS	Uniform Materiel Movement and Issue Priority System
USAF	U.S. Air Force
USAMMA	U.S. Army Medical Materiel Agency
VCNO	Vice Chief of Naval Operations
VOD	variance of demand
VOO	variance of OST
VOSL	variable operating and safety level
VSL	variable safety level
WRM	war reserve materiel

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This report documents the findings of an analysis of the savings from reducing order and shipping time (OST) within DoD and also an analysis of how those savings could be traded off against the costs to implement OST reduction initiatives. The savings analysis determined what DoD retail inventory levels would be affected by a reduction in OST, then how much an OST reduction would reduce those levels, and finally how much savings would be generated by a reduction in retail levels. Working with the costs from distribution-oriented initiatives developed by the DLA Operations Research Office, the tradeoff analysis generated a method for determining when routine requisitions for replenishing retail stock should be expedited.

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