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Report to the Ranking Minority Member, Committee on Governmental Affairs, U.S. Senate

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DEFENSE INVENTORY

Applying Commercial Purchasing Practices Should Help Reduce Supply Costs

GAO/NSIAD-93-112

GAO

United States
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National Security and
International Affairs Division

B-252436

August 6, 1993

The Honorable William V. Roth, Jr.
Ranking Minority Member
Committee on Governmental Affairs
United States Senate

Dear Senator Roth:

As you requested, we examined the cost considerations underlying the Department of Defense's inventory decisions for secondary items (i.e., operating supplies and spare parts). We reported to you in May 1992 how the Department developed and used cost data in making secondary item purchasing and stocking decisions. This report discusses the Department's inability to buy quantities of secondary items that result in the lowest total cost for ordering and holding inventory, which can unnecessarily increase supply costs. It also identifies commercial inventory practices that have substantially reduced supply costs at several private sector companies.

We are sending copies of this report to the Chairman, House Committee on Government Operations; the Chairmen, Senate and House Committees on Appropriations and on Armed Services; the Secretaries of Defense, the Air Force, the Navy, and the Army; and the Directors, Defense Logistics Agency and Office of Management and Budget. We will also make copies available to others on request.

Please contact me on (202) 512-8412 if you or your staff have any questions concerning this report. Major contributors to this report are listed in appendix V.

Sincerely yours,

Donna M. Heivilin, Director
Defense Management and NASA Issues

Executive Summary

Purpose

The Department of Defense's (DOD) material inventory is the largest in the world. It includes secondary items (spare parts and operating supplies) that maintain the readiness of the U.S. military's aircraft, ships, tanks, and other complex weapon systems and support the needs of military personnel. Concerned about the high cost of replenishing secondary items, the Ranking Minority Member, Senate Committee on Governmental Affairs, asked GAO to examine the cost considerations underlying DOD's inventory decisions for these items.

In response, GAO undertook a two-part effort. The first part resulted in a report that explained how DOD developed and used cost data in making secondary item inventory purchasing and stocking decisions.[1] The second part, which this report addresses, assesses the defense inventory control points' use of DOD's replenishment formula to compute optimum order quantities for secondary items and discusses the methods by which six private sector companies make their purchase decisions.

Background

Defense inventory control points are primarily responsible for managing secondary items to support the supply needs of customers (e.g., bases and ships). The inventory control points use DOD's replenishment formula in their purchase decisions to calculate order quantities for secondary items with frequent or high demand (demand-based items). Item demand within DOD is highly variable. For example, according to a 1988 Logistics Management Institute report, over 97 percent of the 789 individual line items that it analyzed had some change in demand (65-percent decreased and 32-percent increased in demand), and almost two-thirds of its sample items had demand changes greater than 20 percent. Even greater fluctuations in demand than the study showed occur during military hostilities, such as Desert Storm, and force structure changes, such as the current downsizing of the military.

DOD's replenishment formula determines the lowest (optimum) total variable costs for ordering and holding inventory. Ordering and holding cost values influence the quantity of a purchase. As order quantities decline, the number of purchases and, accordingly, ordering cost should increase. As order quantities increase, the number of purchases and the procurement work load should decrease. These savings are offset by a higher investment in inventory, which increases holding cost, and a reduction in the ability of the supply system to adjust to changes in future

[1]Defense Inventory: Cost Factors Used to Manage Secondary Items (GAO/NSIAD-92-112, May 14, 1992).

demand, which increases the likelihood of having inventory not supported by requirements.

Previous GAO reviews identified problems with DOD's replenishment formula. For example, as early as 1969, GAO reported that the military services did not have or were not using current and accurate costs in computing order quantities. DOD agreed with GAO's recommendation that cost data should be periodically updated. More recent GAO reviews have identified the advantages of using commercial inventory practices in DOD. For example, a 1991 GAO report on DOD's medical inventory identified opportunities to save millions of dollars by increased use of inventory management practices pioneered by leading civilian hospitals. DOD agreed with GAO's recommendation to conduct pilot programs to demonstrate the applicability of commercial practices to military medical facilities.

Results in Brief

Defense inventory control points do not always use DOD's replenishment formula to compute optimum order quantities for secondary items. When the formula is used, the lack of reliable cost data affects the results of the formula. In addition, policy restrictions and reduced budgets limit the use of the replenishment formula. As a result, DOD's supply costs may unnecessarily increase.

DOD's replenishment formula is a modification of the economic order quantity formula, which was published in 1915. According to academic logisticians, such formulas are not conducive to today's business operations because they are based on some assumptions that are rarely met, most importantly, constant demand. Since demand for DOD's secondary items varies over time, there is no simple, optimal procedure that can be implemented using the economic order quantity formula.

The six private sector companies that GAO visited consider the economic order quantity formula to be antiquated and undesirable not only because of its underlying assumptions but also because it forgoes efficiency gains identifiable through rigorous pursuit of lower inventory levels. These companies use alternative purchasing methods. Although most of the companies consider their purchasing methods to be proprietary, company officials did say that they use "quick response" purchasing methods that, while based on economic order quantity principles, have been tailored to their operations so items are delivered just before they are needed. Company officials said that the shift to alternative purchasing methods depended heavily on their being able to motivate suppliers and employees

to reduce inventories. Companies credit these efforts with substantially reducing their supply costs.

GAO conducted a search of literature on purchasing methods and found that a great deal of effort had been devoted to inventory problems over the years and that replenishment strategies had been developed that DOD could use to determine economic order quantities for demand that is not constant. Compared with the economic order quantity formula, these newer strategies, according to available literature, are better choices for establishing order quantities. Moreover, they could reduce DOD's supply costs.

Principal Findings

DOD's Replenishment Formula Is Often Not Used or Is Modified

The Air Force and the Defense Logistics Agency (DLA) do not always use DOD's replenishment formula to determine the optimum quantity of demand-based secondary items to order. Unlike the other services, the Air Force's inventory control points do not use the formula to determine the quantities of reparables it should purchase. Air Force reparable items are currently worth over $25 billion and comprise more than 80 percent of the Air Force's investment in demand-based items. According to an Air Force supply official, the Air Force does not use the formula because of its limitations: the high price of reparable items, coupled with their high reliability and maintainability, result in a recommended order quantity of between zero and one. Consequently, the Air Force bases its reparable order quantities on past and projected usage.

DLA uses DOD's replenishment formula to establish order quantities that will allow it to stay within self-imposed funding limits. DLA often bought less than the formula would compute for its 700,000 demand-based consumable items. DLA officials said that they did this because they could not afford to buy the amounts recommended by the formula.

Lack of Reliable Data Affects the Formula's Results

Most ordering and holding costs used in the formula are not current or accurate, and the procedure for computing the obsolescence rate, one component of holding cost, is not valid. The ordering costs used in the formula by the Air Force are based on a study that was completed in 1984. Moreover, DOD procedures allow such studies to be updated by simply

applying annual cost-of-living wage increases, which assume that all real costs have remained substantially constant for the last 9 years. Since 1970, the services and DLA have used 10 percent as the rate for inventory investment cost, which is generally the largest component of the holding cost rate. In 1985, the Air Force changed the rate from 10 to 6 percent. GAO believes this rate should be based on the interest rate for marketable Treasury debt because it more accurately reflects the actual cost of investment, which has varied greatly since 1970.

DOD's procedure for determining the obsolescence cost is not valid. The obsolescence cost is based on past disposal of items. It does not consider changes in inventory retention and disposal policies. According to the Navy, this cost should be based on an item's remaining useful life. GAO agrees with the Navy that obsolescence cost should be based on an item's useful life.

Noncost Constraints Limit Use of Formula

Noncost constraints limit the use of DOD's replenishment formula. DOD's policy requires that both minimum and maximum limits be set on the size of an order, regardless of the quantity computed by the replenishment formula. According to a DOD supply official, minimum limits are to prevent overload of purchasing departments, and maximum limits are to avoid overstockage. An Army inventory control point has a local procedure of making the minimum contract award price approximate the ordering cost of its small purchases. Buying more than the recommended quantity should decrease ordering costs, but the increased holding costs of the large inventory should more than offset the decrease.

Maximum limits have been set as a result of budgetary limitations. For example, the Air Force's inventory control points are purchasing 50 percent of the recommended order quantity for some items in response to funding cuts. Likewise, DLA's inventory control points reduced the quantities they purchased. Buying less than the recommended quantity decreases the cost of holding inventory but increases ordering costs.

Private Sector Companies Use Alternative Purchasing Methods

GAO discussed the method by which six private sector companies—Federal Express Corporation; General Motors Corporation, Service Parts Operations; Johnson & Johnson Medical, Inc.; SERVISTAR Corporation; Wal-Mart Stores, Inc.; and W.W. Grainger, Inc.—purchase their materials. These companies are considered to be leaders in inventory management.

Four are wholesale distributors, one is a wholesale distributor that also manufactures some of its items, and one is a retailer.

These companies generally do not rely on the economic order quantity formula, which is the basis for DOD's replenishment formula, to make purchase decisions. They do not use the formula because of the assumption that the demand rate is constant. The companies operate in environments where demand for their items varies over time. In addition, they said that the formula assumes that replenishment is instantaneous. Companies told us that it is rare for a vendor to replenish an item the same day that it is requested.

Consequently, the companies use alternative purchasing methods that have been tailored to their operations so that the right quantity of inventory is purchased when needed. Three of the companies are implementing various phases of a new logistics system (Distribution Resource Planning logistics system). Company officials said that this system integrates the efforts of the supplier, distributor, and customer. In addition, one company is using the IBM Forecasting and Replenishment Modules III purchasing process. According to officials from this company, the process employs data from users to calculate lead time and future needs and uses other factors, such as the desired period of supply and vendor discounts and constraints, to calculate the optimal quantity to purchase.

Company officials said that the shift to alternative purchasing methods depended heavily on the cooperation of suppliers. Companies share inventory data with suppliers and actively orient them to company operations so they can better match production to company needs. The companies are not only developing their relations with suppliers, but also are retraining their own employees so that they no longer maintain excess inventory. Some companies offer rewards to change employee behavior.

Because most companies were unwilling to identify their specific replenishment strategies, GAO supplemented the information that they provided by conducting a literature search on purchasing methods. GAO identified two replenishment strategies that were based on economic order quantity principles but recognize fluctuations in demand: the Wagner-Whitin algorithm and the Silver-Meal heuristic. The Wagner-Whitin algorithm guarantees the determination of an optimal order quantity that minimizes the total costs of ordering and holding inventory. The Silver-Meal heuristic selects the order quantity that minimizes total

relevant costs for the time that the replenishment will last. Compared with the economic order quantity formula when demand is not constant, these replenishment strategies significantly reduced ordering and holding costs. According to available literature, the heuristic is considered to be the better strategy because it is a simple modification of the economic order quantity formula and is less complicated than the algorithm.

Recommendations

Due to the many and long-standing difficulties associated with DOD's replenishment formula and the success of some private sector companies in replacing this type of formula with newer replenishment strategies, GAO recommends that the Secretary of Defense consider (1) for common items such as medical supplies, which have an extensive commercial manufacturing base, using quick response commercial purchasing processes similar to those being used by private sector companies to maintain a constant flow of inventory without maintaining large inventories and (2) for other items such as military-unique items, using alternative economic order quantity-based replenishment strategies reflecting the variability of demand. GAO makes additional recommendations in chapter 3 for further improving DOD's inventory practices.

Agency Comments

DOD generally agreed with the findings in a draft of this report and concurred with the recommendations. DOD acknowledged that it needed to consider alternative economic order quantity-based replenishment strategies to reflect the variability of demand and needed to continue to encourage the use of innovative commercial inventory practices.

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Abbreviations

DLA	Defense Logistics Agency
DOD	Department of Defense
GAO	General Accounting Office

Introduction

The Department of Defense (DOD) classifies the items in its material inventory as principal (e.g., aircraft, ships, and tanks) and secondary (parts for aircraft, ships, and tanks; construction, medical, and dental supplies; and food, clothing, and fuel). At the end of fiscal year 1990, DOD's secondary item inventory was valued at over $100 billion. With a reduction in inventory of about $4 billion in fiscal year 1991 and with the revaluation of inventory of about $14 billion, DOD's secondary item inventory was $88 billion at the end of fiscal year 1991.

Management of Secondary Items

The Assistant Secretary of Defense for Production and Logistics is responsible for the secondary item inventory. The services' and the Defense Logistics Agency's (DLA) inventory control points have the primary responsibility for managing secondary items to support the supply needs of customers (e.g., bases and ships).

The Assistant Secretary of Defense for Production and Logistics has established regulations for the inventory control points to follow when making secondary item purchase decisions. Specifically, the inventory control points use an automated inventory management system that periodically compares inventory requirements with assets and then forecasts demand for items.

DOD's demand for secondary items is highly variable. For example, a Logistics Management Institute report[1] showed that over 97 percent of the 789 individual line items analyzed had some change in demand (65 percent, or 512, decreased in demand and 32 percent, or 255, increased in demand). For the 512 items with declining demand, almost two-fifths had demand declines greater than 40 percent. For the 255 items with increasing demand, almost one-third had demand increases greater than 40 percent. The report also showed that almost two-thirds of the sample items had demand changes greater than 20 percent. Even greater fluctuations in demand than the study showed occur during military hostilities, such as Desert Storm, and force structure changes, such as the current downsizing of the military due to the end of the cold war.

Items with infrequent or low demand (nondemand-based items) are ordered as needed or, if considered sufficiently critical, can be held in minimum quantities. Order quantities of items with frequent or high demand (demand-based items) are determined by using DOD's

[1]Dynamic Order Quantity - An Alternative to Economic Order Quantity (Logistics Management Institute Report AL614R2, Aug. 1988).

replenishment formula. Over 90 percent of DOD's investment in secondary items is for demand-based items, as shown in table 1.1.

Table 1.1: DOD's Demand- and Nondemand-Based Secondary Items

Dollars in millions

	Demand		Nondemand	
DOD component	**Value**	**Percent**	**Value**	**Percent**
Air Force	$31,201	86.9	$4,695	13.1
Navy	20,921	96.6	730	3.4
Army	12,436	99.8	25	0.2
DLA	8,691	82.4	1,859	17.6
Total[a]	**$73,249**	**90.9**	**$7,309**	**9.1**

[a]According to DOD, the difference of $7,542 million between the sum of the demand- and nondemand-based secondary items shown in this table and its reported total secondary item inventory ($88.1 billion) is due to unstratified assets, some customer assets, and the Marine Corps' inventory.

Source: Office of the Assistant Secretary of Defense for Production and Logistics.

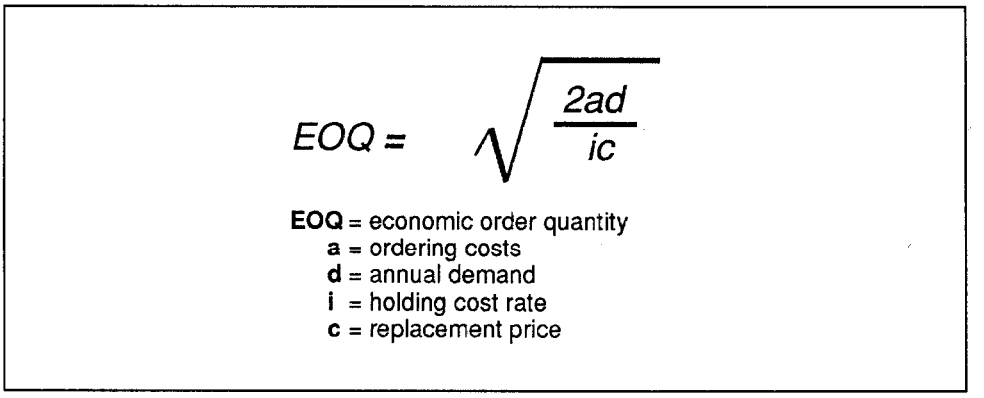
Replenishment Formula

DOD's replenishment formula is a modification of the economic order quantity formula, which was published in 1915.[2] By making certain assumptions, such as demand is constant, the economic order quantity formula determines the optimum quantity to be purchased by computing the amount that meets replenishment needs at the lowest total variable costs for ordering and holding inventory. Because DOD's replenishment formula is based on the economic order quantity formula, the formula supposedly enables inventory control points to balance the cost of placing the orders (ordering cost) for secondary items whose demand is constant against the cost of holding stock. According to the economic order quantity principle, whenever an amount other than the optimum order quantity is purchased, the economic order principle is not adhered to, so ordering and holding costs are not minimized and costs will increase.[3] Figure 1.1 shows the economic order quantity formula.

[2]Ford, Harris. Operations and Costs, Factory Management Series. Chicago, IL: A.W. Shaw Co., 1915, pp. 48-52.

[3]An exception to this rule is when a DOD component obtains a price discount on large-quantity purchases.

Figure 1.1: Economic Order Quantity Formula



Components of the Formula

Ordering cost includes the costs of determining replenishment needs, processing purchases, and receiving orders. Holding cost consists of investment cost (those funds tied up in inventory), which represents the value of money over time; storage cost, which includes the amortized cost of warehouses; obsolescence cost, which represents the effect of all factors that render an item superfluous to need; and inventory losses, which include pilferage, theft, and inventory adjustments.

The services' and DLA's ordering costs range from $116 to $4,803. Their holding costs (expressed as a percentage of the value of average on-hand inventory) range from 11 to 23 percent. Table 1.2 shows the cost data values used by DOD components, and appendixes I and II show ordering costs and holding cost rates, respectively, by DOD components' inventory control points.

Table 1.2: Values for Ordering and Holding Costs Used by DOD Components During Fiscal Year 1992

	Cost factor	
DOD component	Ordering	Holding (percent)
Air Force	$ 566 - 1,443	11 –17
Navy	286 - 1,919	21 and 23
Army	1,503 - 4,803	15 - 18
DLA	116 - 2,981	12 - 19

Under the formula, ordering and holding costs influence the quantity of a purchase. When these values change, the order quantity changes. As order quantities decline, the number of purchases and, accordingly, ordering cost should increase. As order quantities increase, the number of purchases and the procurement work load should decrease. These savings

are offset by a higher investment in inventory, which increases holding cost, and a reduction in the ability of the supply system to adjust to changes in future demand, which increases the likelihood of having inventory not supported by requirements.

Tables 1.3 and 1.4 illustrate the impact of changes in ordering and holding costs, respectively. Both tables assume the following actual values for the purchase of an Army cable assembly in fiscal year 1991: ordering cost, $1,966; annual demand, 24 items; holding cost rate, 16 percent; replacement price per unit, $710 (for an optimum order quantity of 29).

Table 1.3: Effect of Changes in Ordering Costs on the Optimum Order Quantity

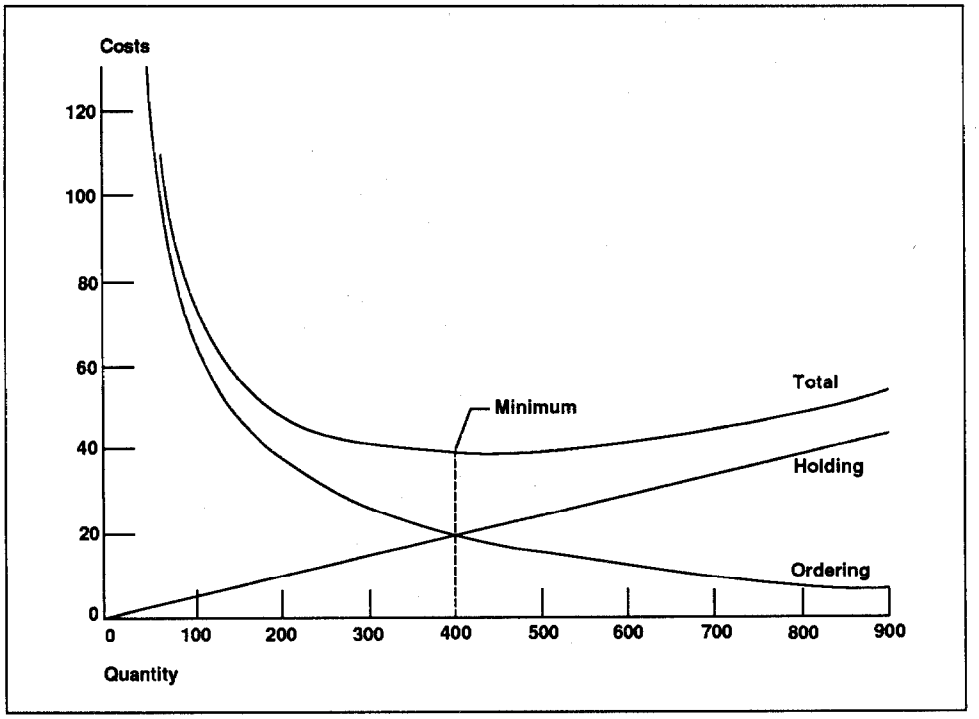
	Quantity of order	
Ordering cost	Amount	Percent change
$45	4	-86
1,006	21	-28
1,966	**29**	**0**
2,923	35	21
3,880	40	38

Table 1.4: Effect of Changes in Holding Cost Rates on the Optimum Order Quantity

	Quantity of order	
Holding cost (percent)	Amount	Percent change
10	36	24
13	32	10
16	**29**	**0**
20	26	-10
23	24	-17

As shown in table 1.3, an increase in the ordering cost from $1,966 to $2,923 (about 50 percent) would increase the order quantity by 21 percent, whereas a similar decrease in the ordering cost from $1,966 to $1,006 (about 50 percent) would decrease the quantity by 28 percent. Conversely, an increase in the holding cost rate, as shown in table 1.4, would decrease the order quantity, whereas a decrease in the rate would increase the quantity. Figure 1.2 illustrates how ordering and holding costs are affected by order quantities.

Figure 1.2: Costs as Functions of the Order Quantity



Source: Peterson, R., and E.A. Silver. Decision Systems for Inventory Management and Production Planning. New York: John Wiley and Sons, 1979.

As shown in figure 1.2, ordering cost decreases as the order quantity increases, resulting in fewer replenishments, whereas the holding cost increases with the quantity, resulting in a larger average inventory. Ordering and holding costs are minimized at the economic order quantity. The total cost curve is shallow near this quantity; thus, deviations in the order quantity tend to have little effect on total costs.

In determining total replenishment needs, DOD also considers safety level and lead time requirements.[4] Safety level and lead time requirements are established by the inventory control points as the reorder point. If on-hand and on-order stocks fall below the reorder point when the optimum order quantity is determined, then the quantity to be ordered is increased to cover that deficiency.

[4]Safety level is the amount of stock needed to meet fluctuations in demand and lead time. Lead time level is the amount needed to meet demand during the time required to order and receive stock.

Reported Problems With the Formula

Previous reviews have identified several problems associated with the use of DOD's replenishment formula. In 1969 and 1974, we reported that the services did not have or were not using current and accurate cost data in computing optimum order quantities.[5] The 1974 report also noted that DOD was not fully or properly applying the economic order quantity principle. In both reports, DOD agreed that ordering and holding costs should be periodically updated.

In our 1988 report, we recommended that the Navy should minimize its ordering and holding costs by rescinding its routine purchase of at least a 12-month supply instead of the optimum order quantity.[6] However, DOD did not agree with our recommendation. In 1987, DOD's Inspector General found that (1) the use of minimum 12-month procurement cycles was not the most cost-effective method to procure secondary items and (2) ordering and holding costs were inaccurate or outdated.[7] DOD has taken some action in response to these reports, but it still overrides computations. (Under current DOD policy, minimum purchases are limited to the lesser of either the administrative lead time demand or 6-months' demand.)

In a recent series of reports, we identified the advantages of using commercial inventory practices in DOD. For example, our 1991 report on DOD's medical inventory identified opportunities to save millions of dollars by increased use of inventory management practices pioneered by leading civilian hospitals.[8] DOD agreed with our recommendation to conduct pilot programs to demonstrate the applicability of commercial practices to military medical facilities.

During this review, we found that DOD is unable to buy quantities of secondary items that result in the lowest total cost for ordering and holding inventory, which can unnecessarily increase supply costs. We also identified some commercial inventory practices that have substantially reduced supply costs at several private sector companies.

[5]Savings Attainable Through Improved Application of the Economic Order Principle in the Procurement of Military Supplies (B-133396, June 20, 1969) and Proper Use of the Economic Order Quantity Principle Can Lead to More Savings (B-133396, June 27, 1974).

[6]Navy Supply: Economic Order Quantity and Item Essentiality Need More Consideration (GAO/NSIAD-88-64, Jan. 6, 1988).

[7]Minimum Economic Order Quantities (DOD/IG-88-020, Oct. 8, 1987).

[8]DOD Medical Inventory: Reductions Can Be Made Through the Use of Commercial Practices (GAO/NSIAD-92-58, Dec. 5, 1991).

Objectives, Scope, and Methodology

The Ranking Minority Member of the Senate Committee on Governmental Affairs asked us to examine the cost considerations underlying DOD's inventory decisions for secondary items. In May 1992, we reported how DOD developed and used cost data in making purchasing and stocking decisions for secondary items.[9] This report assesses the use of DOD's replenishment formula to compute order quantities for secondary items and discusses the methods by which six private sector companies make their purchase decisions.

We performed our work at the Office of the Assistant Secretary of Defense for Production and Logistics, Washington, D.C.; Air Force, Navy, Army, and DLA headquarters, Washington, D.C.; Joint Logistics Systems Center and Air Force Materiel Command, Wright Patterson Air Force Base, Ohio; Naval Supply Systems Command, Washington, D.C.; and Army Materiel Command, Alexandria, Virginia. We also performed work at four inventory control points—the San Antonio Air Logistics Center, San Antonio, Texas (Air Force); Aviation Supply Office, Philadelphia, Pennsylvania (Navy); Missile Command, Redstone Arsenal, Alabama (Army); and Defense General Supply Center, Richmond, Virginia (DLA). We excluded the Marine Corps from our review because of the small number of items affected by DOD's purchase policy.

At each of the locations, we analyzed inventory ordering and holding cost data in decisions to purchase secondary items and evaluated the data's accuracy. We used the same computer reports, records, and statistics that DOD uses to manage inventories, especially those used in making purchase decisions, but we did not independently determine their reliability.

To obtain information on the private sector's cost considerations in purchase decisions, purchasing methods, and efforts to improve inventory practices, we reviewed relevant literature and spoke with academic logisticians and with industry logistics advisors from Cass Logistics Inc., St. Louis, Missouri; Center for Inventory Management, Stone Mountain, Georgia; and Cleveland Consulting Associates, Mayfield Heights, Ohio. In addition, to learn how private sector companies make purchase decisions and what they have done to improve inventory practices, we visited Federal Express Corporation, Memphis, Tennessee; General Motors Corporation, Service Parts Operations, Flint, Michigan; Johnson & Johnson Medical, Inc., Tampa, Florida; SERVISTAR Corporation, Butler,

[9]Defense Inventory: Cost Factors Used to Manage Secondary Items (GAO/NSIAD-92-112, May 14, 1992).

Pennsylvania; Wal-Mart Stores, Inc., Bentonville, Arkansas; and W.W. Grainger, Inc., Lincolnshire, Illinois.

We chose these companies because the academic logisticians and industry logistics advisors that we spoke with consider these companies to be leaders in inventory management. Four are wholesale distributors (two have multi-echelon, multi-item inventories), one is a wholesale distributor that also manufactures some of its items, and one is a retailer. These companies have similar environments to DOD's because their items are independent and demand varies over time.

We performed our work from March to October 1992 in accordance with generally accepted government auditing standards. DOD provided written comments on a draft of this report, which are summarized in chapter 3 and appear in appendix IV.

DOD Is Often Unable to Minimize Supply Costs

DOD's replenishment formula is supposed to minimize ordering and holding costs if the assumptions underlying the formula hold true (e.g., demand is constant). We found that the demand for secondary items does not match the assumptions of the formula. Moreover, defense inventory control points often do not minimize supply costs because they do not always use the formula to compute optimum order quantities or they lack reliable cost data. In addition, noncost constraints, such as policy restrictions and reduced budgets, limit the use of the replenishment formula. DOD's inability to replenish demand-based secondary items in optimum order quantities can result in unnecessary supply costs.

Formula Is Often Not Used or Is Modified

The Air Force does not use DOD's replenishment formula to determine order quantities for its reparable secondary items because of the formula's limitations. These items are valued at over $25 billion, which is more than 80 percent of the Air Force's investment in demand-based items. Although DLA uses the replenishment formula to compute order quantities to replenish its 700,000 demand-based consumable items, it does so only to stay within funding limits, not to compute optimum order quantities.

Air Force Does Not Use the Formula for Reparables

DOD Instruction 4140.39 (dated July 17, 1970) states that order quantities for reparable items, to the extent feasible, should be determined by DOD's replenishment formula. The Navy and the Army use the formula to establish reparable order quantities, but the Air Force does not.[1]

According to an Air Force supply official, replenishment of reparable items should occur only when a condemned item needs to be replaced. The official said that the Air Force's condemned reparable items represented less than 10 percent of its total reparable inventory; therefore, the formula is not the best method for determining order quantities for those items. The Air Force bases order quantities on past and projected usage, using readiness-based sparing models to determine these quantities.[2] The model does not incorporate economic order principles because the high price of these items, coupled with their high reliability and maintainability, result in recommended order quantities between zero and one. Similarly, the Navy's order quantities for its reparables, using

[1]DLA does not stock reparable items.

[2]For its reparables, an Air Force official said that the Air Force is using readiness-based sparing models that are capable of computing the optimal range and depth of spare and repair parts to achieve a weapon system readiness goal for the least cost or maximize readiness for a fixed cost.

DOD's replenishment formula, are one.[3] The Army's reparable order quantities, according to an Army supply official, are generally larger than those of the Air Force and the Navy.

DLA Has Modified Its Use of the Formula for Consumables

DLA uses DOD's replenishment formula to establish order quantities that will allow it to stay within self-imposed funding limits. Also, unlike the services, which can incorporate multiple costs into their automated purchasing processes, DLA is limited to one cost factor, which represents a ratio of the holding cost rate to the ordering cost. In the 1970s, this cost factor was initially established at a value of 74, which, through manipulation of the economic order quantity formula, equates to a holding cost rate of 18 percent and an ordering cost of $123. In 1981, to stay within the limits of its available stock funds, the DLA inventory control point we visited set the value of this factor at 100, which equates to a holding cost rate of 17 percent and an ordering cost of $213. The inventory control point continues to use this factor, even though a 1989 DLA-contracted study showed that its ordering costs actually ranged from $45 to $853 for various types of small purchases ($25,000 or less) and was $1,174 for large purchases (more than $25,000).[4]

According to officials at the inventory control point, this factor DLA uses does not reflect its actual cost to effect a procurement but is an artificial ceiling it has imposed on its stock operations to stay within funding limits. According to DLA, the current budgetary limitations, which have been placed on its inventory control points, make it necessary to modify economic order quantity formula computations. The effect of applying budgetary limits to the economic order quantity computations is a reduction in the order quantity. A higher factor results in a larger order quantity, but orders must then be placed less frequently, which reduces ordering costs. A smaller factor has the opposite effect.

Lack of Reliable Data Affects the Formula's Results

Ordering and holding costs are major factors in DOD's replenishment formula; accordingly, they affect the results of the formula. Most of DOD's ordering and holding costs are not current or accurate, and the procedure for computing the obsolescence rate, one component of holding cost, is not valid.

[3]According to Navy officials, the Navy also considers past and projected usage data from its program data to determine order quantities. The officials said that usage data are applied as an input to the economic order quantity formula.

[4]Final Report: Multiple Cost EOQ Study. Washington, D.C.: Synergy, Inc., 1989.

Most Costs Are Not Current or Accurate

To maximize the savings inherent in the economic order quantity concept, ordering and holding costs must be up-to-date and accurate. Most of the inventory control points' cost data, however, are not.

The Navy reevaluates its ordering costs annually, but only the Army has reviewed in great detail and updated its ordering costs to ensure that the cost data reflect the major changes in contracting that have occurred since ordering costs were first established in 1970. The Army periodically conducts thorough studies to identify all costs associated with ordering items. In contrast, the Air Force and DLA still use old and questionable baseline data. The Air Force bases its ordering costs on a 1984 draft study and has updated them only by applying the subsequent cost-of-living increases to civilian wages. Although this method is allowed by DOD, it assumes that for the last 9 years the Air Force's combination of pay grades and the number of large versus small contracts administered remained constant, which is unlikely. DLA determined its actual cost data in 1989; however, it has not used these data to establish order quantities.

Similarly, holding cost components have not been updated for many years. In 1970, DOD fixed 10 percent as the annual charge for funds invested in inventory (generally the largest component of the holding cost rate), and 1 percent of the annual value of inventory as the rate to represent the cost of fixed storage points. The investment cost rate was based on the Office of Management and Budget Circular A-94 (Mar. 1972), which prescribed the use of a standard 10-percent discount rate. The storage cost rate was derived by dividing DOD's estimated total annual storage operating cost by its average inventory value. DOD has not adjusted those rates since 1970. However, on the basis of the results of a contracted study, the Air Force lowered its investment cost rate to 6 percent in 1985. This new figure increased order quantities by 10 to 15 percent.

Furthermore, DOD's methods for setting the investment cost and storage cost rates are questionable and probably increase inaccuracies in computing order quantities. According to our policy on discount rates used in cost-benefit studies,[5] the investment cost rate should be based on the interest rate for marketable Treasury debt with maturity comparable to the program being evaluated. This method more accurately reflects the actual cost of investment. From 1970 to 1991, the annualized Treasury bill rate varied from 5 to 13 percent. However, the computation of the services and DLA did not reflect these fluctuations. Also, the storage cost rate should theoretically be allocated in proportion to the warehouse space

[5]Discount Rate Policy (GAO/OCE-17.1.1, May 1991).

occupied (i.e., storage cost should be related to an item's physical characteristics), yet DOD relates this rate to the value of an item.

In addition, some inventory control points do not properly calculate another component of the holding cost rate—the loss rate for other inventory losses. They should include such losses as a fraction of total assets (i.e., net losses in inventory divided by total assets). Even though DOD requires the services and DLA to include an inventory loss rate as a separate component in their holding cost, only the Army fully complies with this requirement. The Navy and DLA do not include an inventory loss rate in computing their holding costs, even though such losses occur, because they consider the rate to be relatively insignificant. The Navy's loss rate could not be determined. In fiscal year 1990, DLA's net losses were $1.3 million, resulting in a loss rate of 0.012 percent. The Navy and DLA have set the rate at zero. The Air Force includes inventory losses in its computation of the obsolescence rate rather than identifying such losses as a separate loss rate.

Some Cost Bases Are Not Valid

The procedure used to compute the obsolescence cost rate, one component of holding cost, is not valid. As required by DOD, the Air Force, the Army, and DLA base their obsolescence rates on historical disposal data. This procedure is questionable because it does not consider changes in inventory retention and disposal policies or an item's remaining useful life.

DOD defines obsolescence cost as inventory losses due to all causes that render on-hand inventory superfluous to need (e.g., technological obsolescence or deterioration beyond the point of use). However, only the Navy's calculation considers an item's remaining useful life. The other services and DLA follow DOD instructions to calculate the obsolescence rate by dividing the total value of items transferred to disposal during a fiscal year by the average annual value of on-hand inventory plus items on-order. This method, for instance, leaves out obsolete items still in stock but not yet transferred to disposal.[6] Consequently, obsolescence rates could be sharply understated. For example, in 1990 we reported that the Air Force had over 41,000 duct segments worth $4.7 million for the F-100 engine that

[6]The Air Force's calculation of the obsolescence rate does include those stocks declared as potential excess stocks—one of the categories of unrequired stocks.

were being replaced by new and improved items.[7] This stock was not figured into the obsolescence rate because it was still in inventory.

Furthermore, the method of basing obsolescence rates on disposal data does not recognize a change in disposal policy, which can introduce substantial inefficiencies in inventory management. For example, from 1985 to 1990, DOD imposed a moratorium on all disposals of inventory that pertained to active weapon systems. Because DOD bases the obsolescence rate on historical data, this action lowered the inventory obsolescence rate and, consequently, increased order quantities. DOD's current disposal policy, revised to expedite disposal of unrequired inventory, should have the opposite effect on obsolescence rates until disposals return to a normal level. From fiscal years 1988 to 1991, the amount of total disposals grew from nearly $7 billion to over $12 billion.[8]

The Navy's policy to base the obsolescence rate on an item's remaining useful life has some flaws. For example, at least 15 years ago, the Navy specified that consumable and reparable items had an average life of 8 and 10 years, respectively, but the Navy could provide no support for these figures. Also, the Navy's obsolescence rates have not been changed over this period, even though a 1992 Navy study stated that the rate should progress from 5 to 20 percent over the life of an item.[9]

DOD authorizes different obsolescence costs for various types of items when warranted, particularly those items subject to rapid technological change or deterioration. However, we identified only one instance in which one service (the Army) broke down obsolescence costs in this manner. Because the types of items managed by the services' and DLA's inventory control points are largely different, using the same obsolescence costs for all items is unreasonable. Shelf-life items, for example, should have a much higher obsolescence cost than other items because they deteriorate faster and generally require special storage facilities.[10]

[7]Defense Inventory: Growth in Air Force and Navy Unrequired Aircraft Parts (GAO/NSIAD-90-100, Mar. 6, 1990).

[8]The amounts of disposed property include material other than secondary items. DOD does not maintain separate records of secondary items that are submitted for disposal.

[9]Navy Fleet Material Support Office Study, Determination of Obsolescence Rates (Mar. 1992). The progression stated in this report is questionable, however, since an earlier Army study (U.S. Army Materiel Systems Analysis Activity Study, Obsolescence Rates of Secondary Items, Sept. 1990) described obsolescence rate as a bathtub curve over the life of an item, with a high probability of the item becoming obsolete during early field years, a low probability during the next 6 to 10 years, and a relatively higher chance during the item's last years.

[10]Shelf-life is the length of time an item can be stored before it can no longer be used.

Nevertheless, only the Army uses a different obsolescence rate for shelf-life items. DLA does use shelf-life as a constraint in setting order quantities.

Noncost Constraints Limit Use of Formula

Policy restraints and reduced budgets limit the use of DOD's replenishment formula. If the formula predicts accurately, supply costs should increase whenever an amount other than the recommended quantity is purchased. Buying less than the recommended quantity should decrease the cost of holding inventory, but the increased ordering costs should more than offset the decrease. Buying more than the recommended quantity should decrease ordering costs, but the increased holding costs of the large inventory should more than offset the decrease.

Policy Restrictions

In some cases, policy restrictions have prevented the services and DLA from purchasing order quantities recommended by DOD's replenishment formula. Inventory control points adjust the recommended order quantity if it falls outside DOD's designated minimum or maximum. Before February 1992, DOD limited purchased quantities to a minimum equal to either the greater of demand during the administrative lead time or 3 months of demand and to a maximum of 36 months of supply. Since then, DOD has changed the minimum to the lesser of either the demand during the administrative lead time or 6 months of demand. DOD also decreased the maximum to 24 months of supply, as required by Congress.[11] According to a DOD supply official, the minimum is to prevent overload of the purchasing departments and the maximum is to avoid overstockage. The effects of such restrictions, however, increase ordering or holding costs when buying less or more, respectively, than the recommended quantity.

Army and Navy procedures also have precluded buying the recommended amounts and have resulted in excess inventory. For example, at the Army inventory control point we visited, local procedures encouraged making the minimum contract award price approximate the ordering cost of its small purchases ($1,389). Supply officials believe that it does not make sense to purchase low-cost items for less than what it costs to order them. Although this practice sounds reasonable, it lacks validity. For 7 of the 21 transactions (33 percent) we reviewed, this practice increased the purchased quantity by a significant amount. On the basis of the average

[11]The Defense Authorization Act for fiscal years 1992 and 1993 limits DOD to 2 years of inventory for an item, unless the head of the procuring organization certifies that a larger order is necessary to achieve greater economy or is otherwise necessary for national security.

monthly demand during fiscal year 1992, contracting for at least $1,389 caused the purchased quantity for these transactions to exceed DOD's 24-month ceiling by an average of 531 months, or more than 44 years. This practice violates Congress' intent to limit DOD to 2 years of stock and is prohibited by DOD policy.

Similarly, one of the three weapons management divisions at the Navy inventory control point we visited discourages contracts for less than $2,000. This practice could also result in excessive inventory and violate the intentions of Congress and DOD.

Budget Reductions

Limits have been put on purchases of secondary items as a result of budget reductions. For example, in some cases, limited funds caused Air Force inventory control points to purchase 50 percent of the recommended amounts. Supply officials said that they were ordering smaller quantities more frequently, which was driving up the ordering cost. This practice reduced holding cost but was offset by the increase in ordering cost. In addition, the officials said that they had not been able to take advantage of many quantity discounts from suppliers.

To cope with limited funds, Army inventory control points have cut their ceiling on purchased quantities for low-cost items from 24 months of supply to 18 months,[12] and DLA inventory control points have cut their ceiling for all items from 24 to 6 months.[13] According to DLA supply officials, when their 1992 funds were cut to 50 percent of projected sales,[14] the inventory control points began adjusting the quantity to be purchased. An official said that the reduced funding had caused a drop in customer service because backorders were increasing and requisition fill rates were decreasing.

[12]The Army's ceiling is also intended to spur identification and recovery of items from Operation Desert Storm.

[13]Subsequent to our field work, DLA inventory control points changed their maximum and minimum constraints. DLA now limits order quantities to a maximum of 12 months and has no minimum.

[14]Direct vendor deliveries and foreign military sales are budgeted at 100 percent of projected sales.

Commercial Inventory Practices Have Reduced Companies' Supply Costs

During the last decade, private sector companies have significantly changed their view of inventory management. They now believe that inventory should be maintained at the lowest level consistent with the operation it supports. To do so, the companies we visited have essentially abandoned their use of the economic order quantity formula, which is the basis for DOD's replenishment formula. They rely instead on new purchasing methods that are based on economic order quantity principles but have been tailored to their operations so that the right quantity of inventory is purchased when needed. The change in purchasing methods has depended heavily on motivating suppliers and company employees to work closely with each other. This shift to alternative purchasing methods has reinforced the companies' competitiveness and substantially reduced their costs, even when they have expanded operations. DOD has been addressing its inventory problems and has implemented some commercial practices, which have resulted in savings.

Economic Order Quantity Formula Has Some Shortcomings

Because the economic order quantity formula is based on some assumptions that are rarely met, its usefulness is questionable. According to academic logisticians, the formula is a simple model not widely used. Private sector companies consider the formula to be antiquated and undesirable because of the assumptions made. For example, the formula assumes a knowledge of actual ordering and holding costs that companies find difficult to calculate. In general, companies do not calculate inventory ordering costs, and they use industry standards for their overall holding cost rate (25 to 30 percent) because the cost to derive these data outweigh the benefits of having the data.[1] Moreover, the formula is not consistent with actual business operations. It assumes that the demand rate is known and constant. In reality, inventory demand varies over time; therefore, the formula cannot ensure a minimum cost solution. Similarly, the formula assumes that replenishment is instantaneous. Companies told us that it is rare for a vendor to replenish an item the same day that it is requested.

Companies also dislike the formula because it forgoes efficiency gains identifiable through rigorous pursuit of lower inventory levels.

[1]The private companies do not use ordering and holding costs to determine replenishments but rather to help determine the cost of operations (for accounting purposes) and the profitability of an item.

Private Sector Companies Use Alternative Purchasing Methods

Many private sector companies believe that inventory should not exceed the minimum amount needed because excess inventory masks operational inefficiencies, hinders good capital investment policy, and reduces profit. To minimize their on-hand stock, the six companies we visited—Federal Express Corporation; General Motors Corporation, Service Parts Operations; Johnson & Johnson Medical, Inc.; SERVISTAR Corporation; Wal-Mart Stores, Inc.; and W.W. Grainger,Inc.—had either eliminated the use of the economic order quantity formula or severely limited its use. Companies now rely on alternative purchasing methods that have been tailored to their operations, which emphasize having the right quantity of materials at the right place when users need them.

This shift to alternative purchasing methods has been successful. Companies credit these efforts with substantially reducing their supply costs. One company said that it had reduced the amount of inventory held from $70 million to $20 million (over 70 percent) while increasing its customer requisition fill rate to 99.9 percent. Another company said that it was able to reduce inventory from $40 million to $23 million (over 40 percent) and increase its service level from 50 to 98.7 percent while expanding its operations and doubling the number of items in its inventory.

Most of the companies we visited would not identify the specific purchase methods that they used because they considered them to be proprietary. From a search of available literature, we found that a great deal of effort has been devoted to inventory problems over the years. As a part of that effort, replenishment strategies have been developed that are based on economic order quantity principles and can be used for varying demand patterns, such as those experienced by DOD and the six companies. The strategies include the following, which are discussed in detail in appendix III:

- A fixed economic order quantity based on the average demand rate from the present to some future point. This approach makes sense when the demand rate is approximately constant; that is, the constant demand rate assumption of the economic order quantity formula is not significantly violated.
- The exact best solution to a particular mathematical model of the situation. This strategy, known as the Wagner-Whitin algorithm, guarantees that the total cost of ordering and holding inventory is minimized.

- An approximate model. This strategy selects the order quantity so that the total relevant costs are minimized for the time that the replenishment quantity will last. One well-accepted example of this approach is the Silver-Meal heuristic.

The Wagner-Whitin algorithm and the Silver-Meal heuristic[2] have been tested against the economic order quantity formula on a wide range of examples. Anytime the algorithm significantly outperformed the economic order quantity formula, so did the heuristic. According to available literature, the heuristic is considered to be better than the algorithm because it is a modification of the economic order quantity formula and is less complicated than the algorithm. Furthermore, this heuristic has performed extremely well compared to other heuristics.[3]

The companies did say that they had implemented automated multiple forecasting models and replenishment strategies that primarily considered past and projected demand to compute the number of items to purchase. Other factors considered included the criticality of the item, future trends, vendor lead time, desired safety level, and target levels of inventory to be maintained. The companies tailored their purchase methods to their particular operations to avoid unnecessary investment in inventory.

One company uses the IBM Forecasting and Replenishment Modules III system. According to company officials, this system, which can be specifically tailored for wholesale and retail operations, manipulates information from users to calculate lead time and future needs and uses other factors (e.g., the desired period of supply, vendor discount provisions, and vendor constraints) to calculate optimal order quantities. Company officials said they can calculate the optimum order quantity according to different parameters set by the user. In addition, three companies are implementing various phases of the Distribution Resource Planning logistics system. According to officials from these companies, this system, which is also applicable to both wholesale and retail operations, provides the planning and scheduling tool that allows the entire supply distribution network—manufacturer, distributor, and customer—to make sure that stock is available when the customer needs it. Company officials said that the effectiveness of this system hinges on its

[2]Silver, Edward A., and H.C. Meal. A Heuristic for Selecting Lot Size Quantities for the Case of a Deterministic Time-Varying Demand Rate and Discrete Opportunities for Replenishment. Washington, D.C.: American Production and Inventory Control Society, 1973.

[3]The Silver-Meal heuristic was not available when DOD adopted the economic order quantity principle in 1958.

ability to predict future inventory requirements and possible outcomes, critique ongoing activities, and recommend the appropriate action.[4]

The companies also are closely monitoring operations to avoid excessive inventory buildup. For example, some use the inventory turnover rate[5] to identify excess stock. Any decrease in the rate from the norm is a sign that excess inventory could be building. Generally, the higher the turnover rate, the lower the amount of inventory being held. One company visited has increased the number of times its inventory turns over from 10 to 100 times a year for some items while maintaining an availability rate of 98 percent.

Another company has established specific targets for the levels of inventory to be maintained, and it monitors those levels for compliance and correction. This company periodically samples a segment of its inventory to determine how much excess is on hand for that particular sample and then uses the rate to project the amount of overall excess inventory. When the projection is too high, it takes immediate action to drive down the excess.

Success of Alternative Methods Depends on Suppliers and Employees

According to company officials, the change in purchasing methods depended heavily on the companies' relationships with their suppliers and employees. For example, through training, performance evaluation, and electronic communication, companies have persuaded suppliers to provide items as needed rather than in bulk.

The companies are training suppliers to operate with the philosophy that excess inventory is an unnecessary expense. They are conducting training sessions to teach the suppliers how company inventory systems operate and what kind of services the company needs from them to operate efficiently and economically. They are also helping suppliers improve their overall performance to shorten procurement lead time. For example, one company created a supplier evaluation program and used a report card to rate supplier performance in lead time, estimated arrival time, quality, and service. Within 2 years, all of the company's suppliers shortened their lead time, which improved their performance.

[4]Martin, Andre J. DRP: Distribution Resource Planning. Essex Junction, VT: Oliver Wright Limited Publications, Inc., 1990.

[5]The inventory turnover rate is the ratio of sales (quantity) for a period of time to the average inventory level.

Some of the companies had connected certain suppliers to their inventory computer systems. Therefore, when the quantity of an item in the companies' inventories reaches a predetermined level, the suppliers initiate orders automatically. This arrangement reduces ordering costs, increases fill rates, and minimizes inventories. Moreover, it shortens order and delivery times. One company was able to shorten its lead time by approximately 75 percent due to this arrangement.

The companies believe that the close coordination and communication within their companies is just as important as their relationships with suppliers. The companies are training their employees that it is not necessary to maintain excess inventory to prevent stock outages. Employees are taught that, contrary to old beliefs, it is possible to reduce the amount of inventory held and improve customer service because a smaller inventory can turnover faster and problems with the inventory can be detected easier.

According to company officials, this change in culture is not easy to effect because their employees have been operating in the same way for many years. Some companies offer awards, promotions, and other rewards to employees whose behavior supports the desired organizational culture.[6] These companies believe that rewards encourage similar behavior in other employees and help managers to achieve company goals.

Some of the companies also believe that inventory managers must be strongly motivated to achieve the best possible inventory system. One company has directed that the merit pay increases for its inventory buyers be tied to their effectiveness in meeting established inventory turnover rates. Another company has established specific targets for managers, such as average inventory and service levels. The company monitors daily its managers' performance versus goals. Deviations are immediately examined, and corrective actions are taken. Achievement of targets are recognized with points toward monetary rewards. This company believes that linking monetary rewards with company profitability encourages its managers to strive for effective and efficient operation. In leading companies, those managers responsible for inventory are explicitly appraised on the basis of their performance against specific inventory targets.

[6]Organizational Culture: Techniques Companies Use to Perpetuate or Change Beliefs and Values (GAO/NSIAD-92-105, Feb. 27, 1992).

DOD Is Implementing Commercial Practices to Address Inventory Problems

In a previous report, we stated that DOD had made progress in addressing its inventory problems and in 1990 began implementing a formal plan to resize its inventories while maintaining readiness.[7] During this review, we found that DOD continues to pay close attention to management of its material inventories and is still implementing improvements. For example, DOD is consolidating storage depots under DLA to reduce distribution costs of materials, transferring responsibility for inventory management of all consumable items to DLA to reduce investment costs, and revising and consolidating its inventory management guidance.

Moreover, DOD has implemented some commercial inventory practices to address its inventory problems. For example, Navy item managers are responsible for achieving inventory reduction program objectives and are rewarded for their efforts through performance appraisals. Also, the Army has successfully tested maintaining a minimum inventory or the direct vendor delivery concept[8] at three of its inventory control points. In addition, DLA has instituted direct vendor deliveries to meet user needs. The DLA inventory control point we visited is emulating another commercial inventory practice by locating all inventory participants—item managers, buyers, and technical specialists—in the same place. This structure is expected to expedite the purchasing process and improve support to customers. The inventory control point is trying to further focus its attention on customer needs and tailor its operations accordingly, and it is forming product centers to focus efforts toward specific products, vendors, and customers.

Conclusions

DOD's perspective has been that having a larger inventory has enabled it to better fill customer requisitions, thereby ensuring supply readiness. This strategy considers the benefits of a large inventory without weighing the costs. Private companies' objective for holding inventory, however, is to make a profit and, therefore, they regard the cost of a large inventory as an unnecessary expense. To achieve this objective, the companies use newly developed replenishment strategies to balance maximum service with the minimum inventory investment. These have substantially reduced the companies' supply costs.

[7]Defense Inventory: Shortcomings in Requirements Determination Processes (GAO/NSIAD-91-176, May 10, 1991).

[8]Direct vendor delivery requires no inventory investment and eliminates the distribution costs at storage depots.

Although DOD's reason for holding inventory differs from that of private companies, it must find a balance between inventory depth and supply cost to cope with the fiscal realities of the 1990s to do more with less. To do so, we believe that DOD must seek opportunities to move away from its current replenishment formula and expand its use of commercial inventory practices.

Recommendations

Due to the many and long-standing difficulties associated with DOD's replenishment formula and the success of some private sector companies in replacing this type of formula with newer replenishment strategies, we recommend that the Secretary of Defense consider (1) for common items such as medical supplies, which have an extensive commercial manufacturing base, using quick response commercial purchasing processes similar to those being used by private sector companies to maintain a constant flow of inventory without maintaining large inventories and (2) for other items such as military-unique items, using alternative economic order quantity-based replenishment strategies reflecting the variability of demand.

We also recommend that the Secretary of Defense continue to emphasize to the services and DLA the importance of implementing other proven, innovative commercial inventory practices. These practices include, but are not limited to,

- close monitoring of stock levels, using such tools as the inventory turnover rate;
- programs to improve the performance of vendors and manufacturers that evaluate estimated product arrival time, quality, service, and ability to meet a sudden increase in demand, such as a national security emergency;
- programs to improve the performance of employees that evaluate their performance in managing inventories efficiently, eliminating wasteful practices, and achieving cost savings; and
- awards, incentives, promotions, and training (on commercial inventory practices) to foster better management of inventories.

Agency Comments

DOD generally agreed with the findings in a draft of this report and concurred with the recommendations. DOD acknowledged that it needed to consider alternative economic order quantity-based replenishment strategies to reflect the variability of demand and needed to continue to encourage the use of innovative commercial inventory practices. DOD said

that our report addressed a number of areas that had been recently covered in the DOD Materiel Management Regulation 4140.1-R, released in January 1993.

Ordering Costs Used by Defense Inventory Control Points During Fiscal Year 1992

Inventory control point	Purchase amount	
	$25,000 or less	More than $25,000
Air Force (Air Logistics Centers)		
Ogden	$874	$1,443
Oklahoma City	655	968
Sacramento	961	1,394
San Antonio	566	937
Warner Robins	761	1,219
Navy		
Aviation Supply Office	286 and 563	847 and 1,641
Ships Parts Control Center	813 and 848	1,785 and 1,919
Army (Commands)		
Armament, Munitions-Chemical	2,352	4,580
Aviation Systems	2,204	4,462
Communications-Electronics	2,459	4,622
Missile	2,044	3,473
Tank-Automotive	1,503	3,703
Troop Support	1,636	4,803
Defense Logistics Agency (DLA) (Supply Centers)		
Construction	116	116
Electronics	130	130
General	213	213
Industrial	225	225
Fuel	[a]	[a]
Personnel		
Medical	135	135
Clothing and Textiles	2,981	2,981

[a]This inventory control point does not use the Department of Defense's (DOD) replenishment formula, so ordering costs do not apply.

Holding Cost Rates Used by Defense Inventory Control Points During Fiscal Year 1992

Inventory control point	Holding cost component (in percent)				
	Investment	Storage	Obsolescence	Other losses	Total
Air Force (Air Logistics Centers)					
Ogden	6	1	5	[a]	**12**
Oklahoma City	6	1	7	[a]	**14**
Sacramento	6	1	10	[a]	**17**
San Antonio	6	1	4	[a]	**11**
Warner Robins	6	1	6	[a]	**13**
Navy					
Aviation Supply Office	10	1	10 and 12	[b]	**21 and 23**
Ships Parts Control Center	10	1	10 and 12	[b]	**21 and 23**
Army (Commands)					
Armament, Munitions-Chemical	10	1	4	0	**15**
Aviation Systems	10	1	2	2	**15**
Communications-Electronics	10	1	3	2	**16**
Missile	10	1	7	0	**18**
Tank-Automotive	10	1	4	0	**15**
Troop Support	10	1	6	0	**17**
DLA (Supply Centers)					
Construction	10	1	6	[b]	**17**
Electronics	10	1	8	[b]	**19**
General	10	1	6	[b]	**17**
Industrial	10	1	7	[b]	**18**
Fuel	[c]	[c]	[c]	[c]	[c]
Personnel					
Medical	10	1	1	[b]	**12**
Clothing and Textiles	10	1	7	[b]	**18**

[a]The Air Force includes inventory losses in its obsolescence cost rates.

[b]Neither the Navy nor DLA calculates a separate inventory loss rate.

[c]This inventory control point does not use DOD's replenishment formula, so holding cost rates do not apply.

Replenishment Strategies Used to Determine Economic Order Quantities

Demand for DOD's secondary items varies over time. In regard to a time-varying demand pattern, we identified from a search of available literature[1] three replenishment strategies that are used to determine economic order quantities: (1) a fixed economic order quantity based on the average demand rate from the present to some future point; (2) the exact best solution to a particular mathematical model, known as the Wagner-Whitin algorithm; and (3) an approximate method, such as the Silver-Meal heuristic.

The economic order quantity formula was designed to balance the cost of ordering against the cost of holding stock. It is optimal under a set of assumptions, which include that the demand for an item is constant (level) over time. Consequently, the economic order quantity formula is the best replenishment strategy when the demand rate does not vary.

When the demand rate for an item varies, there is no simple, optimal procedure that can be implemented using the economic order quantity formula; that is, the formula no longer ensures a minimum cost solution. The Wagner-Whitin algorithm and the Silver-Meal heuristic, however, were designed for a time-varying demand pattern, and they provide an optimal procedure. The Wagner-Whitin algorithm was designed to guarantee an optimal selection of quantities in terms of minimizing the total costs of ordering and holding inventory over a specified time-varying demand period. The Silver-Meal heuristic was designed to minimize the total ordering and holding costs for the time that the replenishment quantity will last. As with the economic order quantity formula, the Silver-Meal heuristic is relatively insensitive to deviations in the order quantity.

Comparison of the Three Replenishment Strategies

Compared with the economic order quantity formula, the Wagner-Whitin algorithm and the Silver-Meal heuristic, according to available literature, are better choices for establishing order quantities for time-varying demands.

Tables III.1 and III.2 use an example on MIDAS Canada replenishment needs for 10- by 12-inch lithographic film (50 sheets of film to a box) to illustrate the application of the economic order quantity formula and the Wagner-Whitin algorithm, respectively.[2] Each table contains the following

[1]Peterson, R., and E.A. Silver. Decision Systems for Inventory Management and Production Planning. New York: John Wiley and Sons, 1979.

[2]This example was taken from the following source: Peterson, R., and E.A. Silver. Decision Systems for Inventory Management and Production Planning. New York: John Wiley and Sons, 1979.

values: ordering cost, $54 an order; average demand, 100 boxes a month; holding cost, 2 percent a month; and replacement price, $20 a box.

Table III.1: Results of Using the Fixed Economic Order Quantity Formula

Description	1	2	3	4	5	6	7	8	9	10	11	12	Total
Starting amount	0	204	142	130	0	0	0	52	0	0	0	0	
Replenishments	214				154	129	140		124	160	238	41	**1,200**
Requirements	10	62	12	130	154	129	88	52	124	160	238	41	**1,200**
Cumulative requirements	10	72	84	214	368	497	585	637	761	921	1,159	1,200	**1,200**
Ending amount	204	142	130	0	0	0	52	0	0	0	0	0	**528**

Table III.2: Results of Using the Wagner-Whitin Algorithm

Description	1	2	3	4	5	6	7	8	9	10	11	12	Total
Starting amount	0	74	12	0	0	129	0	52	0	0	0	41	
Replenishments	84			130	283		140		124	160	279		**1,200**
Requirements	10	62	12	130	154	129	88	52	124	160	238	41	**1,200**
Cumulative requirements	10	72	84	214	368	497	585	637	761	921	1,159	1,200	**1,200**
Ending inventory	74	12	0	0	129	0	52	0	0	0	41	0	**308**

With the use of the economic order quantity formula, the order quantity was determined to be 164 boxes. As shown in table III.1, this quantity lies between the cumulative requirements of 84 and 214. Therefore, the first order quantity is 214 because it is closer to 164 than 84. This approach resulted in eight replenishments for a total ordering cost of $432 (8 x $54). The total holding cost was $211.20 (528 boxes x $20 x 0.02). Thus, the total ordering and holding costs were $643.20.

The Wagner-Whitin algorithm works backward in time, establishing various options.[3] These options are then compared, and the least cost option is selected. This approach continues month by month until the calculation is finally made for month 1; its results gives the size of the first order—84 boxes—as shown in table III.2. This approach resulted in seven replenishments for a total ordering cost of $378 (7 x $54). The total

[3]The Wagner-Whitin algorithm approach requires a starting point (somewhere in the future) where it is known that the inventory level is to be at zero or some other specified value.

holding cost was $123.20 (308 boxes x $20 x 0.02). The total ordering and holding costs were $501.20. A comparison of the tables shows that the Wagner-Whitin algorithm reduced the total of ordering and holding costs from $643.20 to $501.20, or 22 percent less than those of the fixed economic order quantity formula.[4]

The Silver-Meal heuristic evaluates the total ordering and holding cost over forecasted periods of demand and selects the period in which this cost is the lowest or starts to increase. At this point, the heuristic calculates the order quantity that will cover the number of time periods selected. In this example, the heuristic gives the exact same solution as the Wagner-Whitin algorithm shown in table III.2.

[4]The turnover rate increased from 27 percent using the economic order quantity to 47 percent using the Wagner-Whitin algorithm.

Comments From the Department of Defense

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, DC 20301-8000

PRODUCTION AND LOGISTICS

JUL 0 8 1993

(L/MRM)

Mr. Frank C. Conahan
Assistant Comptroller General
National Security and International
Affairs Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Conahan,

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "DEFENSE INVENTORY: Applying Commercial Purchasing Practices Should Help Reduce Supply Costs," dated April 21, 1993 (GAO Code 398106), OSD Case 9376. The DoD generally concurs with the draft report.

As recognized by the GAO, the Department continues to make progress in improving DoD inventory management and has implemented a number of commercial inventory practices. Further, in January 1993, the DoD issued Materiel Management Regulation 4140.1-R providing additional guidance on expanded use of the types of commercial practices identified in the GAO draft report. The DoD also agrees that alternatives should be considered to the economic order quantity-based replenishment strategies to better reflect variability of demand.

The detailed DoD comments on the report findings and recommendations are provided in the enclosure. The DoD appreciates the opportunity to comment on the draft report.

Sincerely,

David J. Berteau
Principal Deputy

Enclosure

**GENERAL ACCOUNTING OFFICE DRAFT REPORT--DATED APRIL 21, 1993
(GAO CODE 398106) OSD CASE 9376**

"DEFENSE INVENTORY: APPLYING COMMERCIAL PURCHASING PRACTICES SHOULD HELP REDUCE SUPPLY COSTS"

DEPARTMENT OF DEFENSE COMMENTS

* * * * *

FINDINGS

Now on pp. 2-3.

- **FINDING A: The Defense Inventory System.** The GAO observed that Defense inventory control points are primarily responsible for managing secondary items to support the supply needs of customers--i.e., bases and ships. The GAO observed the inventory control points use the DoD replenishment formula to calculate order quantities for secondary items with frequent or high demand (demand-based items). The GAO explained that order quantities are derived from a mathematical technique to determine the lowest (optimum) total variable costs for ordering and holding inventory. The GAO pointed out that ordering and holding cost values influence the quantity of a purchase--when the values change, the order quantity changes. The GAO concluded that, as order quantities decline, the number of purchases and (accordingly) ordering cost should increase--and, as order quantities increase, the number of purchases and the procurement work load should decrease. The GAO observed that previous GAO reviews identified problems with the DoD replenishment formula as early as 1969. (Specific references to prior GAO reports are provided throughout the findings which follow). (pp. 2-4/GAO Draft Report)

  DOD RESPONSE: Concur.

- **FINDING B: The DoD Management of Secondary Items.** The GAO pointed out that the Office of the Assistant Secretary of Defense (Production and Logistics) had established regulations for the inventory control points to follow when making secondary item purchase decisions. The GAO found the inventory control points use an automated inventory management system that periodically compares inventory requirements with assets and then forecasts demand for the items. The GAO noted that the DoD demand for secondary items is highly variable--with even greater fluctuations in demand (1) during military hostilities, such as OPERATION DESERT SHIELD/ DESERT STORM, and (2) during force structure changes, such

Now on pp. 10-11.

as the current downsizing of the military. The GAO noted that items with infrequent or low demand (non-demand-based items) are ordered on an as needed basis--or, if considered sufficiently critical, can be held in minimum quantities. The GAO stated that order quantities of items with frequent or high demand (demand-based items) are determined by using the DoD replenishment formula. The GAO determined that over 90 percent of the DoD investment in secondary items is for demand-based items. (pp. 12-14/GAO Draft Report)

DOD RESPONSE: Concur.

- **FINDING C**: **Replenishment Formula**. The GAO explained that the DoD replenishment formula is a modification of the economic order quantity formula. The GAO observed that, by making certain assumptions (such as the demand is constant), the formula determines the economic quantity to be purchased by computing the amount that meets replenishment needs at the lowest total variable costs for ordering and holding inventory. The GAO stated that, according to the economic order quantity principle, whenever an amount other than the optimum order quantity is purchased, the economic order principle is not adhered to--so ordering and holding costs are not minimized and costs would increase.

  The GAO found that the ordering cost includes the costs of (1) determining replenishment needs, (2) processing purchases, and (3) receiving orders. The GAO further found that the holding cost consists of investment cost (funds tied up in inventory), which represents the following:

  - the value of money over time;
  - storage cost, which includes the amortized cost of warehouses;
  - obsolescence cost, which represents the effect of all factors that render an item superfluous to need; and
  - inventory losses, which include pilferage, theft, and inventory adjustments.

  The GAO reported that the Military Services and the Defense Logistics Agency ordering costs range from $116 to $4,803--and holding costs range from 11 to 23 percent.

  The GAO illustrated that the ordering cost decreases as the order quantity increases, resulting in fewer replenishments--whereas the holding cost increases with the quantity, resulting in a larger average inventory. The GAO pointed

Now on pp. 11-15.

out that ordering and holding costs are minimized at the economic order quantity. The GAO noted that, in determining total replenishment needs, the DoD also considers safety level and lead time requirements. The GAO explained that the safety level and lead time requirements are established by the inventory control points as the reorder point. The GAO noted that, if on-hand and on-order stocks fall below the reorder point when the optimum order quantity is determined, then the quantity to be ordered is increased to cover that deficiency. The GAO referenced previous reports, in which it found that the Services did not have, or were not using, current and accurate cost data in computing optimum order quantities (OSD Cases 7355, 8869 and 8961). (pp. 14-19/GAO Draft Report)

DOD RESPONSE: Concur.

- **FINDING D**: **Formula Is Often Not Used or Modified**. The GAO found that the Air Force does not use the DoD replenishment formula to determine order quantities for reparable secondary items because of the limitations of the formula. The GAO reported that an Air Force supply official stated that replenishment of reparable items should occur only when a condemned item needs to be replaced. The GAO further reported that, according to the Air Force official, the Air Force condemned reparable items represent less than ten percent of the total Air Force reparable inventory; therefore, the formula is not the best method for determining order quantities for those items. The GAO found that the Air Force bases order quantities on past and projected usage, using readiness-based sparing models to determine quantities. The GAO pointed out that the model does not incorporate economic order principles because the high price of the items, coupled with their high reliability and maintainability, result in recommended order quantities between zero and one. The GAO stated the Air Force items are valued at over $25 billion, which is more than 80 percent of the Air Force investment in demand-based items.

  The GAO reported that the Defense Logistics Agency uses the DoD replenishment formula to establish order quantities that will allow the Agency to stay within self-imposed funding limits. The GAO noted that, unlike the Military Services (where multiple costs can be incorporated into the automated purchasing processes), the Defense Logistics Agency is limited to one cost factor--which represents a ratio of the holding cost rate to the ordering cost. The GAO noted that the Defense Logistics Agency inventory control points set the value of the factor at 100, which equates to a holding cost rate of 17 percent and an ordering cost of $213. The

Now on pp. 3-4, 18-19.

GAO further noted the inventory control points continue to use that factor, even though a 1989 Defense Logistics Agency contracted study showed that ordering costs actually ranged from $45 to $853 for various types of small purchases ($25,000 or less)--and was $1,174 for large purchases (more than $25,000). The GAO reported that, according to inventory control point officials, the factor being used reflects an artificial ceiling the Agency has imposed on stock operations to stay within funding limits. (pp. 4-6, pp. 22-24/GAO Draft Report)

DOD RESPONSE: Concur.

- **FINDING E**: **Lack of Reliable Data Affects the Formula's Results**. The GAO stated that most of the DoD ordering and holding costs are not current or accurate, and the procedure for computing the obsolescence rate is not valid. The GAO noted that the Navy and, more significantly, the Army had reviewed and updated ordering costs to ensure that cost data reflected the major changes in contracting that have occurred since ordering costs were first established in 1970. In contrast, the GAO found that the Air Force, and the Defense Logistics Agency still use old and questionable baseline data.

  The GAO reported that, in 1970, the DoD fixed 10 percent as the annual charge for funds invested in inventory (generally the largest component of the holding cost rate), and one percent of the annual value of inventory as the rate to represent the cost of fixed storage points. The GAO noted that the DoD had not adjusted the rates since 1970. The GAO observed that, on the basis of the results of a contracted study, the Air Force lowered the investment cost rate to 6 percent in 1985. The GAO pointed out that the new figure increased order quantities by 10 to 15 percent.

  The GAO concluded the DoD methods for setting the investment cost and storage cost rates are questionable and probably increase inaccuracies in computing order quantities. In addition, the GAO concluded that some inventory control points do not properly calculate the loss rate for other inventory losses. The GAO also concluded that the procedure used to compute obsolescence cost is not valid. The GAO pointed out that the Air Force, the Army, and the Defense Logistics Agency base the obsolescence rates on historical disposal data. The GAO determined that the procedure is questionable because it does not consider changes in inventory retention and disposal policies or the remaining useful life of an item.

Now on pp. 4-5. 19-23.

The GAO explained the DoD defines obsolescence cost as inventory losses due to all causes that render on-hand inventory superfluous to need--technological obsolescence or deterioration beyond the point of use. The GAO noted, however, that the Services, except for the Navy, and the Defense Logistics Agency follow DoD instructions to calculate the obsolescence rate by dividing the total value of items transferred to disposal during a fiscal year by the average annual value of on-hand inventory plus items on-order. As an example, the GAO observed that this method leaves out obsolete items still in stock but not yet transferred to disposal. (pp. 24-29/GAO Draft Report)

DOD RESPONSE: Concur. While it is true that many DoD ordering and holding costs are not current or accurate, in January 1993 the DoD issued the new DoD Materiel Management Regulation (DoD 4140.1-R) that requires such costs to be validated annually and updated whenever significant changes occur. Nevertheless, the economic order quantity formula produces near optimal results, even when the inputs in terms of ordering and holding costs are in error. As stated by the GAO, the total cost curve is shallow near the economic order quantity -- thus, deviations in the order quantity tend to have little effect on total costs.

- **FINDING F**: **Non-Cost Constraints Limit Use of the Formula**. The GAO reported that, in some cases, policy restrictions have prevented the Services and the Defense Logistics Agency from purchasing order quantities recommended by the DoD replenishment formula. The GAO found that, in February 1992, the DoD changed the minimum purchase to the lesser of either the demand during the administrative lead time or 6 months of demand, and decreased the maximum to 24 months of supply, as required by the Congress. The GAO contended that the effects of such restrictions, however, increase ordering or holding costs when buying less or more, respectively, than the recommended quantity. The GAO further found that local procedures within the Army and the Navy also have precluded buying the recommended amounts and have resulted in excess inventory.

  The GAO observed that limits have been put on purchases of secondary items as a result of budget reductions. The GAO reported that supply officials were ordering smaller quantities more frequently, which was driving up the ordering cost. The GAO concluded that practice reduced holding cost, but was offset by the increase in ordering cost. In addition, the GAO reported that officials had not been able to take advantage of many quantity discounts from suppliers. To cope with limited funds, the GAO reported that the Army

Now on pp. 5, 23-24.

inventory control points cut the ceiling on purchased quantities for low-cost items from 24 months to 18 months of supply--and the Defense Logistics Agency inventory control points cut the ceiling for all items from 24 to 6 months. (pp. 6-7, pp. 29-32/GAO Draft Report)

DOD RESPONSE: Concur. Component unique limits such as a minimum award price equal to cost to order are not economically sound, since the economic order quantity formula already trades off ordering costs against holding costs. The DoD agrees such limits are not compatible with minimizing total variable cost. The Office of the Secretary of Defense will pursue that issue with the Services.

- **FINDING G: Economic Order Quantity Formula Has Some Shortcomings**. The GAO reported that, according to academic logisticians, the economic order quantity formula is a simple model not widely used. The GAO observed that, because the formula is based on some rarely met assumptions, it has some shortcomings. The GAO indicated that private sector companies consider the formula to be antiquated and undesirable because of the assumptions made. In addition, the GAO found the formula is not consistent with actual business operations, since it assumes that the demand rate is known and constant. The GAO reported that companies also dislike the formula because it causes large quantities of items to be purchased at one time, which tends to build up excess inventory. (pp. 32-33/GAO Draft Report)

Now on p. 25.

DOD RESPONSE: Concur. It should be recognized, however, that within the framework of its required assumptions, the economic order quantity formula does optimize purchasing cost against holding cost. Since the GAO was unable to obtain actual replenishment strategies from the six private sector companies identified in the report, the DoD is unable to comment on application of those strategies.

- **FINDING H: Private Sector Companies Use Alternative Purchasing Methods**. The GAO reported that, according to private sector companies, inventory should not exceed the minimum amount needed, because excess inventory (1) masks operational inefficiencies, (2) hinders good capital investment policy, and (3) reduces profit. The GAO found that, to minimize on-hand stock, the six companies it visited had either eliminated the use of the economic order quantity formula or severely limited its use. The GAO determined that the six companies now rely on alternative purchasing methods--which have been tailored to operations and which emphasize having the right quantity of materials

at the right place when needed.

The GAO noted that most of the companies they visited would not identify the specific purchase methods used, because they consider them proprietary. As a result, the GAO conducted a search of available literature and identified the following three replenishment strategies that are based on economic order quantity principles and can be used for varying demand patterns, such as those experienced by the DoD:

- a fixed economic order quantity based on the average demand rate from the present to some future point;

- the Wagner-Whitin algorithm -- the exact best solution to a particular mathematical model of the situation;

- the Silver-Meal heuristic -- the approximate model strategy which selects the order quantity so that the total relevant costs are minimized for the time that the replenishment quantity will last.

The GAO reported the heuristic is considered to be the better strategy, because it is a simple modification of the economic order quantity formula and is less complicated than the algorithm.

The GAO reported that the companies had implemented automated multiple forecasting models and replenishment strategies that primarily considered past and projected demand to compute the number of items to purchase. The GAO stated other factors considered included (1) the criticality of the item, (2) future trends, (3) vendor lead time, (4) the desired safety level, and (5) the target levels of inventory to be maintained. The GAO stated the companies included in the review are closely monitoring operations to avoid excessive inventory buildup. The GAO reported, generally, the higher the turnover rate, the lower the amount of inventory being held. (pp. 7-9, pp. 33-37/GAO Draft Report)

Now on pp. 5-7, 26-28.

DOD RESPONSE: The DoD defers comment to the six companies. Since the GAO was unable to obtain specific replenishment strategies from the companies identified in the draft report, the DoD is unable to comment on those strategies at the six private sector companies, or their application to DoD.

- **FINDING I: Success of Alternative Methods Depends on Suppliers and Employees**. The GAO reported that, according

to company officials, the change in purchasing methods depended heavily on the relationships with suppliers and employees. The GAO also reported that some of the companies had connected certain suppliers to inventory computer systems to initiate orders automatically when the quantity of an item reaches a predetermined level. The GAO also reported the companies are teaching their employees that it is not necessary to maintain excess inventory to prevent stock outages. The GAO indicated that according to company officials, the change in culture is not easy to effect because employees have been operating in the same way for many years. The GAO also found some of the companies held that inventory managers must be strongly motivated to achieve the best possible inventory system. The GAO noted that, to accomplish that objective, one company directed the merit pay increases for its inventory buyers be tied to effectiveness in meeting established inventory turnover rates. (pp. 37-39/GAO Draft Report)

Now on pp. 28-29.

DOD RESPONSE: Concur. As stated in the GAO draft report, DoD has implemented similar motivation programs.

- **FINDING J**: **The DoD Is Implementing Commercial Practices to Address Inventory Problems**. The GAO referenced a previous report (OSD Case 8645), in which it stated the DoD had made progress in addressing inventory problems and, in 1990, began implementing a formal plan to resize inventories while still maintaining readiness. The GAO acknowledged that the DoD continues to pay close attention to management of material inventories and is still implementing improvements. In addition, the GAO noted that the DoD had implemented some commercial inventory practices to address inventory problems. (pp. 39-40/GAO Draft Report)

Now on p. 30.

DOD RESPONSE: Concur.

* * * * *

RECOMMENDATIONS

- **RECOMMENDATION 1**: The GAO recommended that the Secretary of Defense consider using:

  - quick response commercial purchasing processes similar to those being used by private sector companies to maintain a constant flow of inventory without maintaining large inventories where there is an extensive commercial manufacturing base; and

Now on pp. 7 and 31.

- alternative economic order quantity based replenishment strategies reflecting the variability of demand for other items, such as military unique items. (p. 9, pp. 40-41/GAO Draft Report)

DOD RESPONSE: Concur. The GAO recommendation reflects current DoD policy. As recognized by the GAO, the DoD Components are actively pursuing the use of direct delivery contracts and other commercial inventory practices. The DoD also recently issued a new DoD Materiel Management regulation providing additional guidance on expanding the use of commercial inventory practices (see the DoD response to Recommendation 2). In line with the GAO observation that demand variability is a problem, the DoD is strengthening its demand forecasting and economic order quantity methodologies under the joint systems development Corporate Information Management effort.

o **RECOMMENDATION 2**: The GAO recommended that the Secretary of Defense continue to emphasize to the Military Services and Defense Logistics Agency the importance of implementing other proven, innovative commercial inventory practices. The GAO observed that those practices should include, but are not limited to:

- close monitoring of stock levels, using such tools as the inventory turnover rate;
- programs to improve the performance of vendors and manufacturers that evaluate estimated product arrival time, quality, service, and ability to meet a sudden increase in demand, such as a national security emergency;
- programs to improve the performance of employees that evaluate their performance in managing inventories efficiently, eliminating wasteful practices, and achieving cost savings; and
- awards, incentives, promotions, and training (on commercial inventory practices) to foster better management of inventories. (p. 41/GAO Draft Report)

Now on p. 31.

DOD RESPONSE: Concur. In January 1993, the DoD issued a new Materiel Management regulation (DoD 4140.1-R) providing guidance on expanding use of commercial inventory practices such as those recommended by the GAO. The following are some additional examples of innovative practices currently in place:

- each Component closely monitors stock levels using a

variety of inventory stratification tools and measures;

- the Navy has achieved significant procurement leadtime reductions as part of the Inventory Reduction Plan; and

- the Air Force Blue Ribbon Contractor Program is used to identify contractors who meet program performance standards.

Major Contributors to This Report

National Security and International Affairs Division, Washington, D.C.	John J. D'Esopo, Assistant Director
Norfolk Regional Office	Harry E. Taylor, Jr., Regional Management Representative Johnnie Phillips, Evaluator-in-Charge George Morse, Site Senior Tracy Banks, Evaluator

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