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ARMY INVENTORY

Parts Shortages Are Impacting Operations and Maintenance Effectiveness

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Abstract
Having spare parts available when needed to perform required maintenance is critical to the Department of Defenses accomplishment of its missions. Shortages of spare parts are a key indicator of supply system problems that can result in the unavailability of weapon systems to meet mission requirements. Despite additional funding provided by the Congress to address this issue, the Army is still reporting concerns about spare parts shortages. Since 1990 we have designated the Department of Defenses management of its inventory, including spare parts, as high risk because its inventory is vulnerable to fraud, waste, and abuse and its management systems and procedures were ineffective.

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Congressional Committees

Having spare parts available when needed to perform required maintenance is critical to the Department of Defense's accomplishment of its missions. Shortages of spare parts are a key indicator of supply system problems that can result in the unavailability of weapon systems to meet mission requirements. Despite additional funding provided by the Congress to address this issue, the Army is still reporting concerns about spare parts shortages. Since 1990 we have designated the Department of Defense's management of its inventory, including spare parts, as high risk because its inventory is vulnerable to fraud, waste, and abuse and its management systems and procedures were ineffective.

The National Defense Authorization Act for Fiscal Year 2000 (P.L. 106-65, sec. 364) requires us to evaluate various aspects of the military services' logistics support capability, including the provision of spare parts. Also, the Chairman, House Committee on Appropriations, and the Chairman, Subcommittee on Defense, House Committee on Appropriations, requested that we review issues related to the quality and availability of spare parts for aircraft, ships, vehicles, and weapon systems. In response to the mandate and requests, we reviewed known spare parts shortages within the services. For this report, we determined (1) the impact spare parts shortages had on three selected Army helicopters and (2) the reasons for the shortages. Additionally, we identified the overall initiatives that the Army and the Defense Logistics Agency, which are responsible for managing and providing the spare parts, have in place or planned to address spare parts shortages. We will be discussing in separate reports our reviews on the availability of spare parts in the Air Force and the Navy, the quality of spare parts, funding for spare parts, and war reserves requirements for spare parts.[1]

To address our reporting objectives, we selected the Apache, Blackhawk, and Chinook helicopters. To determine the impact spare parts shortages had on these helicopters, we reviewed data that measure the effectiveness

[1] *Defense Inventory: Information on the Use of Spare Parts Funding is Lacking* (GAO-01-472, June 11, 2001) and *Defense Inventory: Army War Reserve Spare Parts Requirements Are Uncertain* (GAO-01-425, May 10, 2001).

of inventory operations in fulfilling units' requests for spare parts. Also, we reviewed data that measure the aircraft's highest operational readiness possible with available resources. To determine the reasons for the known shortages, we selected and reviewed 90 parts that were in short supply in fiscal year 2000 for these helicopters. To identify overall initiatives that address spare parts shortages, we obtained documentation and the Army's and the Defense Logistics Agency's views. However, we did not review the initiatives.

Results in Brief

Aviation spare parts shortages for the three helicopters we reviewed have adversely affected operations and led to inefficient maintenance practices that have lowered morale of maintenance personnel. Specifically, while the Apache, Blackhawk, and Chinook helicopters generally met their mission-capable goals, indicating that parts shortages have not affected their mission capability, supply availability rates and the cannibalization[2] of parts from one aircraft to another indicate that spare parts shortages have indeed been a problem. Cannibalization is an inefficient practice that results in double the work for maintenance personnel, masks parts shortages, and lowers morale of maintenance personnel. According to the Army's Deputy Chief of Staff for Logistics, masking supply shortages through extensive use of cannibalization is a continuing problem the Army is working to resolve.

The reasons for the unavailability of the 90 parts we reviewed included actual demands for parts that were greater than anticipated, delays in obtaining parts from a contractor, and problems concerning overhaul and maintenance. For example, because a cracked gear in a Chinook transmission was discovered during an overhaul, the entire fleet was grounded in August 1999. As a result, the demand for the part has been much greater than anticipated. Also, Defense Logistics Agency records show that as a result of a contractor's late deliveries of Apache shear bolts, the Agency did not have the parts available for Apache users. Additionally, due to a shortage of parts the Army experienced problems that prevented it from repairing and overhauling Blackhawk T-700 engines in a timely

[2] The Navy and the Air Force refer to cannibalization as the removal of usable parts from one aircraft for installation on another. The Army refers to this practice as controlled exchange. The Army's definition of cannibalization is the removal of components from equipment designated for disposal. Throughout the report, we refer to controlled exchange as cannibalization.

manner. Furthermore, according to Army and Defense Logistics Agency officials, a contributing factor to the shortages was the Army's inability to obtain parts for these aging aircraft from the original part manufacturers, which may no longer be in business. However, we did not find this factor to be a reason for the shortages of the parts we reviewed.

The Army and the Defense Logistics Agency have initiatives under way or planned that are designed to improve the availability of aviation parts. The initiatives generally address the reasons we identified for spare parts shortages. For example, the Army Materiel Command established a team to analyze the spare parts programs, and the team identified issues affecting spare parts shortages, such as unanticipated demands and changes in the useful life of parts because of safety concerns. To help resolve aircraft spare parts shortages, the Defense Logistics Agency implemented an investment strategy that focuses on replenishing aviation repair parts identified as having availability problems. Additionally, the Army has developed a Strategic Logistics Plan that is designed to change its current approach to one that is more effective, efficient, and responsive. The plan's initiatives for resolving spare parts shortages are linked to the asset management process under the Army's planned change in approach. Some of these initiatives are new or in the planning stages. Once the initiatives are more fully developed, we plan to review them to determine whether there are opportunities to enhance them.

We have previously reported problems with the way the Army has implemented its logistics initiatives and recommended that it develop a management framework for its initiatives, to include a comprehensive strategy and performance plan.[3] The Army has actions under way to address the recommendation; therefore, we are not making any additional recommendations at this time. The Department of Defense generally concurred with this report.

Background

In January 2001, we reported on Department of Defense management challenges and noted that the Department has had serious weaknesses in its management of logistics functions and, in particular, inventory

[3] *Defense Inventory: Improved Management Framework Needed to Guide Army Best Practice Initiatives* (GAO/NSIAD-99-217, Sept. 14, 1999).

management.[4] We have identified inventory management as a high-risk area since 1990.[5] Despite years of efforts to resolve its inventory problems, the Department still has spare parts shortages. (See app. I for examples from our reports on management weaknesses related to the Army's spare parts shortages.) We are also reviewing Department of Defense's practice of cannibalization of parts on aircraft; this report will be completed at a later date.

In a separate report issued earlier this year, we indicated that current financial information did not show the extent to which funds were used for spare parts.[6] The Department of Defense planned to annually develop detailed financial management information on spare parts funding uses but had not planned to provide it to the Congress. When we recommended that the Secretary of Defense routinely provide this information to the Congress as an integral part of the Department's annual budget justification, the Department agreed to do so.

The Department of Defense submits quarterly reports to the Congress regarding military readiness. The reports describe readiness problems and remedial actions, comprehensive readiness indicators for active components, and unit readiness indicators. The Army's readiness reports provide assessments of its major systems, which include aircraft. The readiness goal for aircraft is to have 70 to 80 percent mission capable.[7]

The Apache (AH-64) is the Army's main attack helicopter and is equipped to destroy, disrupt, or delay enemy forces. Originally produced in fiscal year 1982, it is designed to fight and survive during the day and night and in adverse weather throughout the world. The Blackhawk (UH-60), first fielded in 1978, primarily performs air assault, air cavalry, and medical evacuation missions. The Chinook (CH-47), first used in Vietnam in 1962, moves artillery, ammunition, personnel, and supplies on the battlefield. Figure 1 shows the Apache, Blackhawk, and Chinook helicopters.

[4] *Major Management Challenges and Program Risks: Department of Defense* (GAO-01-244, Jan. 2001).

[5] *High Risk Series: An Update* (GAO-01-263, Jan. 2001).

[6] *Defense Inventory: Information on the Use of Spare Parts Funding is Lacking* (GAO-01-472, June 11, 2001).

[7] Mission-capable equipment and systems can fulfill at least one or more of their missions.

Figure 1: Apache, Blackhawk, and Chinook Helicopters

Apache

Blackhawk

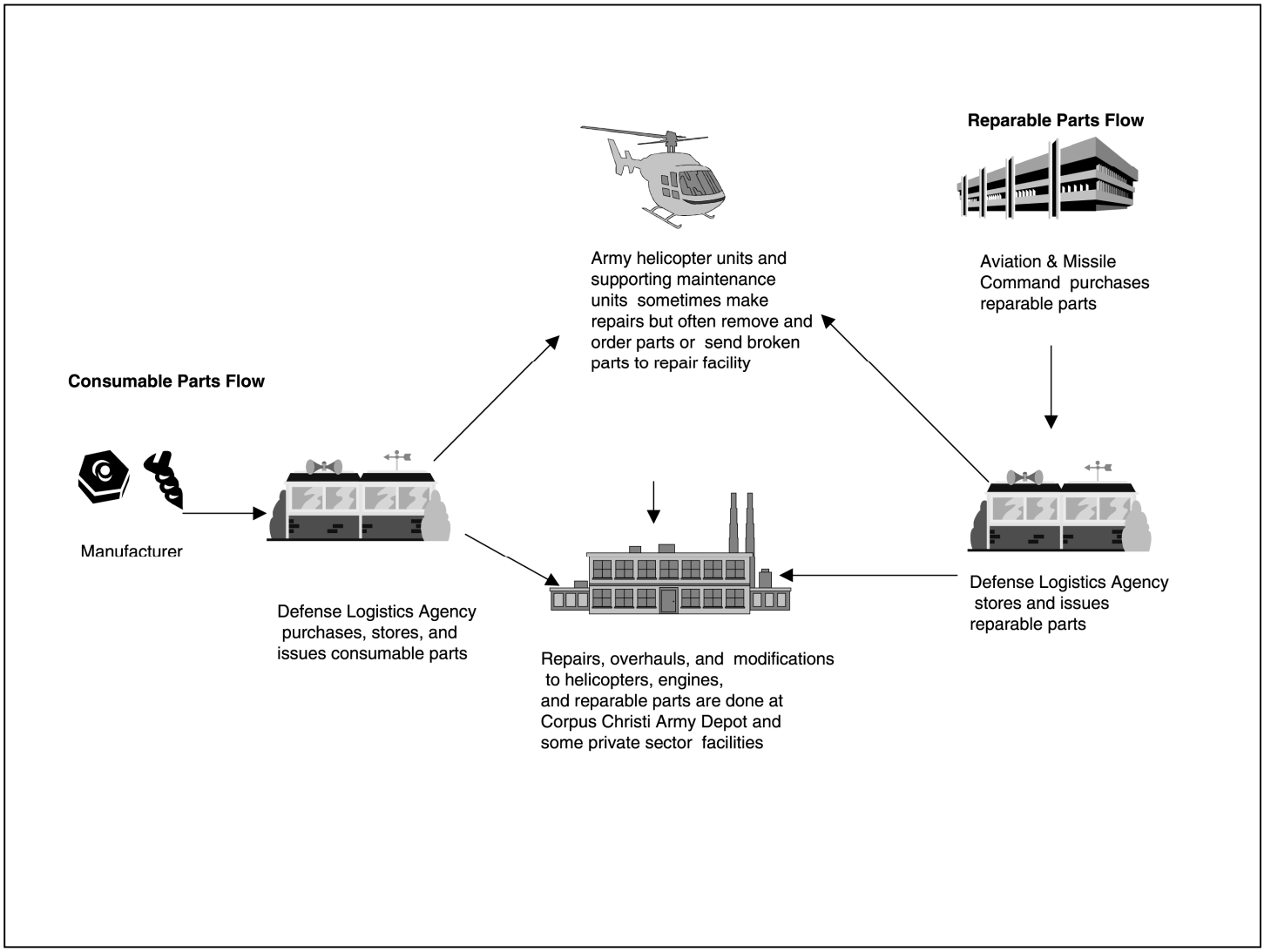
Chinook

Source: Defense Visual Information Center.

The Army's spare parts include reparable and consumable parts. Reparable parts are expensive items, such as hydraulic pumps, navigational computers, and landing gear, that can be fixed and used again. The Aviation and Missile Command manages reparable parts. The Corpus Christi Army Depot and contractors repair helicopters and aviation

reparable parts. The Defense Logistics Agency provides the Army consumable parts (e.g., nuts, bearings, and fuses), which are used extensively to fix reparable parts and aircraft, and manages a large part of the warehousing and distribution of reparable parts. The Defense Supply Center, Richmond, is the lead center for managing aviation consumable spare parts. Figure 2 shows the process for providing spare parts to Army helicopter units and the repair facilities.

Figure 2: Process for Providing Spare Parts to Customers



Source: GAO.

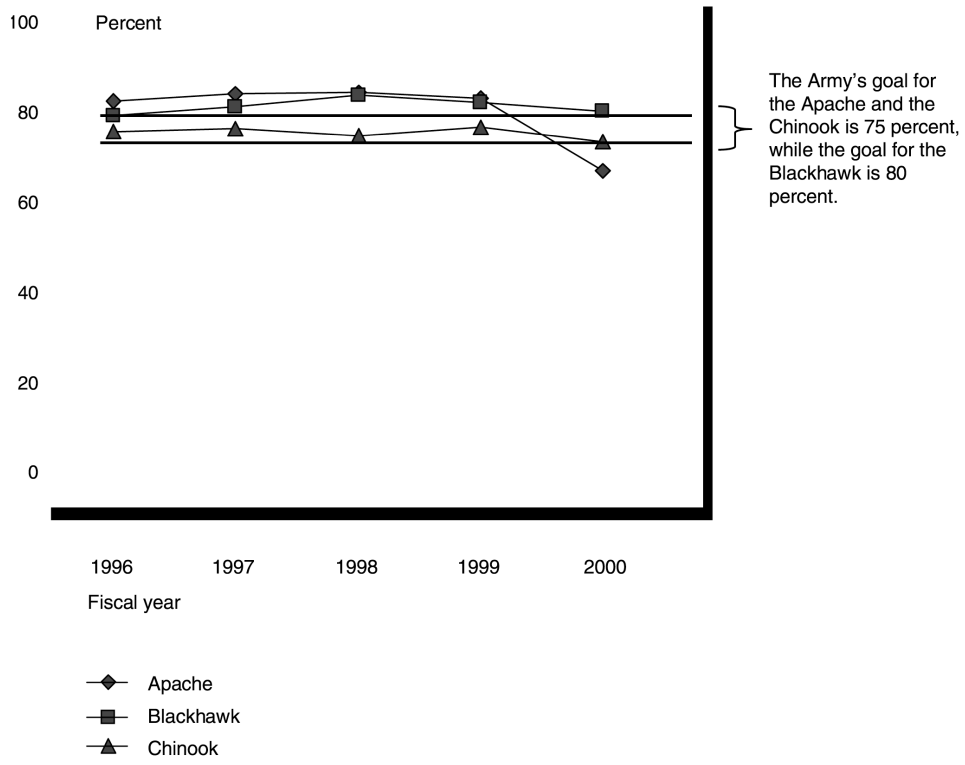
Parts Shortages Adversely Affect Operations, Maintenance, and Personnel

While the Apache, Blackhawk, and Chinook helicopters generally met their mission-capable goals during fiscal years 1999-2000, indicating that parts shortages have not affected mission capability, supply availability rates and the cannibalization of parts indicate that spare parts shortages have indeed been a problem. These parts shortages created inefficiencies in maintenance processes and procedures that have lowered morale of maintenance personnel.

Mission-Capable Goals for Helicopters Generally Met

As shown in figure 3, during fiscal years 1996-2000, the three helicopters we reviewed generally met their mission-capable goals. In fiscal year 1996, the Blackhawk's mission-capable rate was 79.25 percent, which according to an Aviation and Missile Command official, was just slightly below its readiness goal of 80 percent. Also, the Command official mentioned the Blackhawk probably did not exactly meet its mission-capable goal for many reasons, including several aviation safety action messages that were issued that year. These messages identified maintenance, technical, or general problems for which the safety condition of the aircraft had been determined to be a low to medium risk. The Chinook and the Apache did not meet their mission-capable goal of 75 percent in August and November 1999, respectively, when the entire fleet of helicopters was grounded because of "safety restrictions." A safety restriction pertains to any defect or hazardous condition that can cause personal injury, death, or damage to aircraft, components, or repair parts for which a medium to high safety risk has been determined.

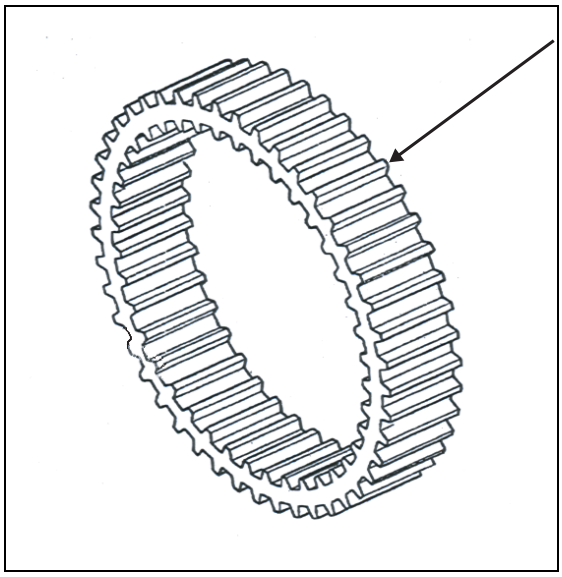
Figure 3: Mission-Capable Rates for the Apache, Blackhawk, and Chinook Helicopters during Fiscal Years 1996-2000



Source: Our analysis of Army Deputy Chief of Staff for Logistics data.

The Chinook was grounded because of a cracked gear in the transmission, which was already in short supply before the safety restriction. The gear changes the direction of power from the engine and reduces the speed that turns the rotor blades (see fig. 4). The Apache helicopters were grounded because of transmission clutch failures. According to an Army official, the clutch engages and disengages the gears in the transmission. Also, Aviation and Missile Command officials mentioned the grounding of these helicopters created demands for parts that the wholesale system did not have available. The safety concerns coupled with the lack of spare parts contributed to these helicopters' failure to meet their mission-capable goals.

Figure 4: Gear for the Chinook Helicopter



Source: Army.

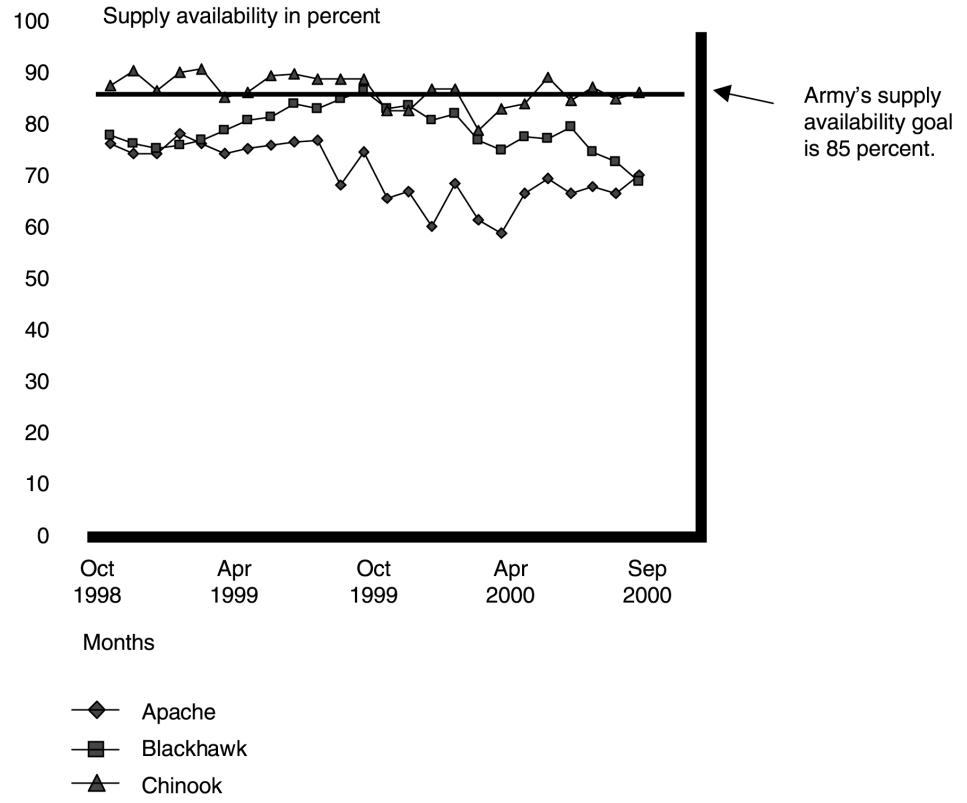
Spare Parts Not Available to Meet Supply Goals

As shown in figure 5, during fiscal years 1999-2000, parts for the Apache and Blackhawk helicopters seldom met the Army's supply availability goal of 85 percent.[8] The supply availability rate is the percentage of requisitions filled at the wholesale[9] inventory level. The goal is designed to measure the overall effectiveness of the wholesale system. While the Blackhawk met the supply availability goal only twice during the 2-year period, the Apache never met the goal. We identified several reasons for spare parts shortages, which will be discussed later.

[8] The supply availability goal is not designed as a target for individual weapon systems. It is a Department of Defense funding goal, and there is no direct correlation between this goal and the operational readiness goals established for Army weapon systems.

[9] The wholesale system is comprised of subordinate commands that procure supplies directly from vendors and hold inventories of stock to meet demands of retail customers. Retail customers are field-operating commands, which receive support from the wholesale level.

Figure 5: Supply Availability Rates for the Apache, Blackhawk, and Chinook Helicopters during Fiscal Years 1999-2000



Note: The Army maintains supply availability rates for individual helicopters for only 2 years but maintains overall aviation supply rates up to 9 years. Therefore, we selected supply availability rates for individual helicopters for the past 2 fiscal years.

Source: Our analysis using Army Materiel Command data.

Parts Shortages Have Resulted in Cannibalizations That Have Lowered Morale of Maintenance Personnel

To compensate for the lack of spare parts, maintenance personnel use cannibalizations or substitutions of parts from one aircraft to another. According to the Army Aviation Maintenance Field Manual 3-04.500, cannibalization is done when, among other things, (1) the aircraft from which the exchanged parts will be used is grounded and awaiting repair parts; (2) needed repair parts are on order before the cannibalization; (3) the parts will return the other aircraft to a mission-capable status; and (4) all possible alternatives (local procurement or manufacturers) have been tried without success. A January 2000 aviation logistics study showed

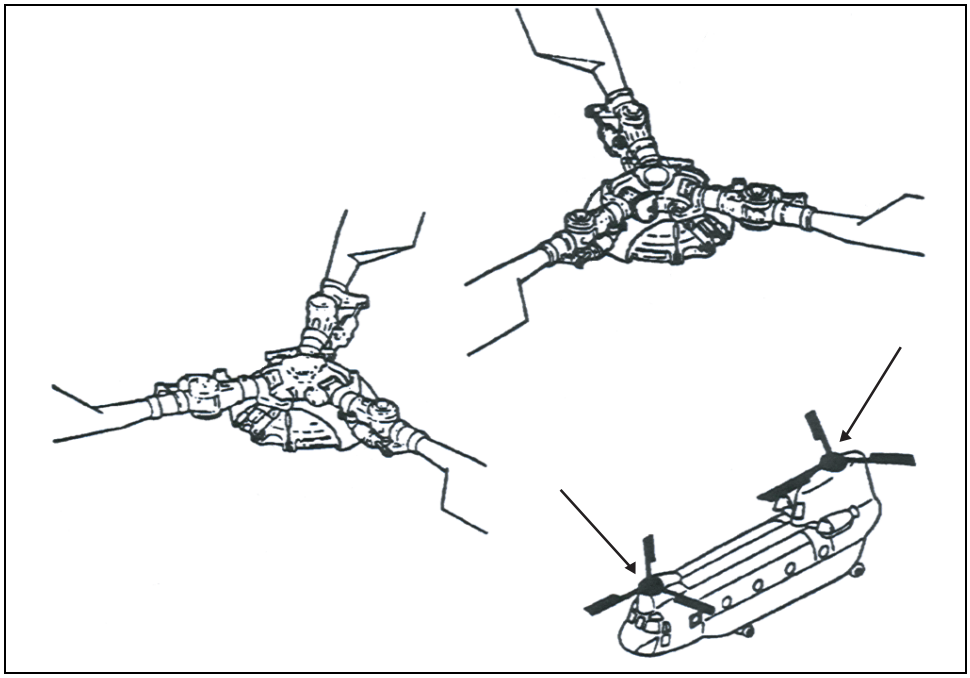
that cannibalization is an accepted maintenance practice at the unit level to return aircraft to mission-capable status.[10] According to a Fort Campbell 101st Airborne Division official, the principal reason for cannibalizations is the nonavailability of serviceable repair parts. The results from our spare parts review showed that cannibalizations at Fort Campbell were done on the Apache and Blackhawk main fuel controls, the Blackhawk engines, and the Chinook rotary wing head. The rotary wing head is the main assembly of the rotor system that produces lift, thrust, and directional control needed for helicopter flight. Figure 6 shows the rotary wing head. Fort Campbell's contractor maintenance personnel also used cannibalizations on the Apache housing assembly and actuator bracket and the Chinook aircraft access door. The actuator bracket anchors the servocylinder[11] to the aircraft. Although the previous examples show units' reliance on cannibalization to overcome the unavailability of parts, the practice does not resolve spare parts shortages. According to the Army's Deputy Chief of Staff for Logistics, supply shortages, which are masked through extensive use of cannibalizations, are a continuing problem the Army is working to resolve.[12]

[10] *Aviation Logistics Study 99: Controlled Substitution Study*, Jan. 7, 2000. The Army study further states that the three primary reasons for the practice of controlled substitution are to (1) keep operational rates up, (2) circumvent long lead times for requisitioned parts, and (3) have parts available when funds are limited at the end of the fiscal year.

[11] The servocylinder is a hydraulically controlled cylinder that is attached to the main rotors and responds to the pilot's steering the helicopter forward, backward, or from side to side.

[12] Statement by Lieutenant General Charles S. Mahan, Jr., Deputy Chief of Staff for Logistics, U.S. Army, to the Subcommittee on National Security, Veterans Affairs, and International Relations, House Committee on Government Reform, May 22, 2001.

Figure 6: Rotary Wing Heads for Chinook



Note: The arrows point to the rotary wing heads.

Source: Army.

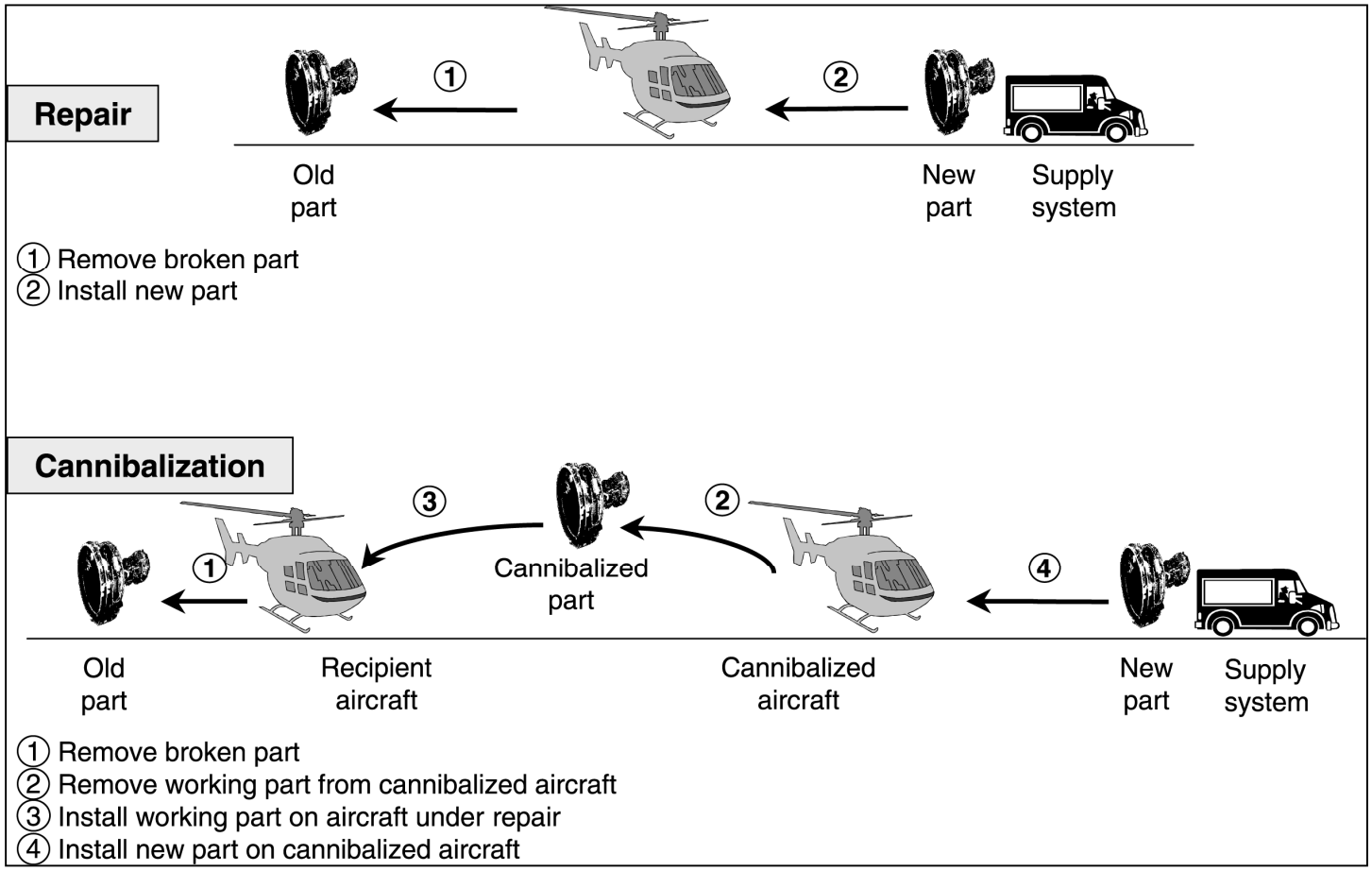
As we testified in May 2001, according to Army officials, only a small portion of Army cannibalizations are reported (only for serial-numbered parts).[13] The Army does not track cannibalizations servicewide and does not require subordinate commands to do so. Therefore, the full extent to which this practice is used is unknown. However, the Floyd D. Spence National Defense Authorization Act for Fiscal Year 2001 (P.L. 106-398, sec. 371) requires the Department of Defense to measure, on a quarterly basis, the extent to which units remove usable parts, supplies, or equipment from one vehicle, vessel, or aircraft in order to render a different system operational. The Department is working to establish definitions, standards, and a shared framework for the collection and reporting of data on cannibalization. The first report of these data is

[13] *Military Aircraft: Cannibalizations Adversely Affect Personnel and Maintenance* (GAO-01-693T, May 22, 2001).

targeted for the April-June 2001 Quarterly Readiness Report to the Congress.

Although cannibalization may keep aircraft flying, it is not an efficient practice. According to the January 2000 aviation logistics study, this practice doubles the hours dedicated to a single maintenance effort. With limited hours available to conduct repairs and maintenance, the duplication of effort is a significant factor in whether or not to use the practice. Also, as we testified in May 2001, this practice requires at least twice the maintenance time of normal repairs because it involves removing and installing components from two aircraft instead of one (see fig. 7). Additionally, when a mechanic removes a part from an aircraft to place on another one, the risk of damaging the aircraft and/or the "good" part in the process is magnified.

Figure 7: Repairs Require Two Steps, Cannibalizations Four



Source: GAO.

As we testified in May 2001, evidence suggests that cannibalizations have negatively affected morale because they are sometimes seen as routinely making unrealistic demands on maintenance personnel. According to a Fort Campbell official, the added workload of cannibalization detracts from the quality of life for aircraft maintenance soldiers. Also, an Army official said the added workload degrades maintenance soldiers' morale.[14] Cannibalizations may need to be quickly performed at any time, day or

[14] Statement by Lieutenant General Charles S. Mahan, Jr., Deputy Chief of Staff for Logistics, U.S. Army, to the Subcommittee on National Security, Veterans Affairs, and International Relations, House Committee on Government Reform, May 22, 2001.

night, to meet operational commitments. In such cases, personnel must continue working until the job is done, regardless of how much time it takes. Further, in August 1999 we reported that the majority of factors cited by military personnel as sources of dissatisfaction and reasons for leaving the military were work-related circumstances such as the lack of parts and materials to successfully complete daily job requirements.[15]

Key Reasons for Shortages Were Unanticipated Demands and Delays in Obtaining Parts From Contractors

Our review showed that the primary reasons for shortages of spare parts for the Apache, Blackhawk, and Chinook helicopters were demands not anticipated for parts and delays in obtaining parts from a contractor. Also, problems concerning overhaul and maintenance of spare parts created shortages. A contributing factor, which was not identified in our review but which Army and Defense Logistics Agency officials acknowledged, was the difficulty in obtaining parts for these aging helicopters because original manufacturers may no longer be in business.

Selected Systems Have Experienced Parts Shortages for Several Reasons

We selected for review 90 spare parts for the Apache (32 parts), Blackhawk (34 parts), and Chinook (24 parts) helicopters. Officials at the units and repair facilities identified shortages of these 90 parts as not being available to complete repairs. (See app. II for a list of these parts.) Table 1 shows the reasons for the shortages, by helicopter, for the 90 spare parts we reviewed.

Table 1: Reasons for Shortages of 90 Spare Parts Reviewed

Reason[a]	Apache	Blackhawk	Chinook	Total	Percent
Actual demand was greater than anticipated	21	23	13	57	63
Contractual delays	11	4	6	21	23
Problems concerning overhaul/maintenance	0	4	2	6	7
Other[b]	0	3	3	6	7
Total	**32**	**34**	**24**	**90**	

[15] *Military Personnel: Perspectives of Surveyed Service Members in Retention Critical Specialties* (GAO/NSIAD-99-197BR, Aug. 16, 1999).

[a] There were multiple reasons for parts shortages, but for the purpose of our analysis, we used the most predominant reason.

[b] Includes unknown reasons for shortages and incorrect inventory records.

Source: GAO.

Actual Demand Was Greater Than Anticipated

The major reason for the shortages of the 90 spare parts we reviewed was that demands for parts were not anticipated due to unforeseen safety concerns, the recalculation of parts' useful life, and other sudden increases in demands. The Army and the Defense Logistics Agency forecast the demand for parts using past data on the usage of parts, when available.[16] According to an Army document, a demand that was not anticipated results in the need for parts that the Army had not planned for when determining requirements for parts. A June 2000 Army Audit Agency report also cited demands that were not anticipated as a main factor causing parts shortages.[17]

Parts identified as causing safety problems resulted in unanticipated demands for spare parts and created shortages. For example, according to a safety message, because a cracked gear in a Chinook transmission was discovered during an overhaul, the entire fleet was grounded in August 1999. According to an Aviation and Missile Command item manager, units sent transmissions suspected of having problems to the Corpus Christi Army Depot for repair. Also, the item manager mentioned the safety issue exacerbated an already existing condition because the Command never had enough transmissions on hand to meet the average monthly demand. Causes of this condition were identified as long lead times to (1) award contracts and (2) manufacture and repair transmissions. Since the safety concerns, the demands have increased significantly; and as of March 2001, 75 transmissions were on back order.[18] Similarly, according to a February 2000 safety message, an engineering analysis indicated that the retirement life for the Apache main rotor blade attach pins (see fig. 8) needed to be reduced because specific pins might not provide the proper fit and would result in significant degradation of the pins' life due to fatigue. (The pins attach the helicopter blade to the main rotor.) Units were required to

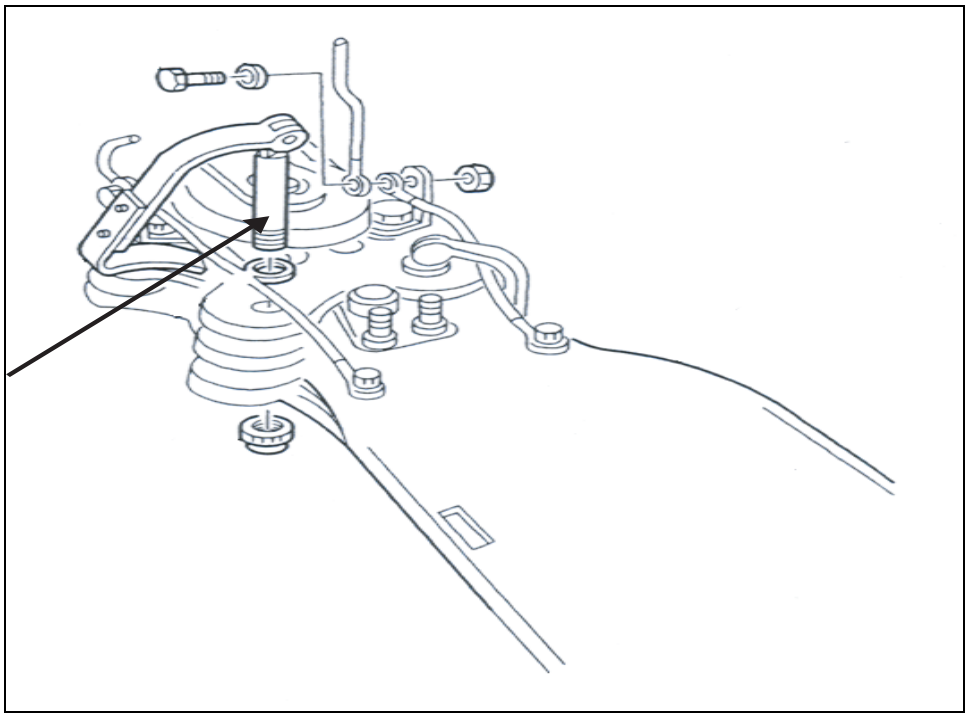
[16] When demand data is not available, the Army uses engineering estimates to determine the quantities of spare parts to purchase.

[17] *Army Audit Agency Report: Survey of Quality of Spare Parts Report* (AA 00-745, June 2000).

[18] A back order is the quantity of an item requested by units that is not immediately available for issuance but is recorded as a stock commitment for future issuance.

inspect all main rotor pins and replace defected pins with new ones that last longer. In June 2000, demands for the pins increased, and the Command's record shows that 81 pins were on back order and 14 pins were on hand to support the average monthly demands for 30 pins.

Figure 8: Apache Main Rotor Blade Attach Pin



Note: The arrow points to the main rotor blade attach pin.

Source: Army.

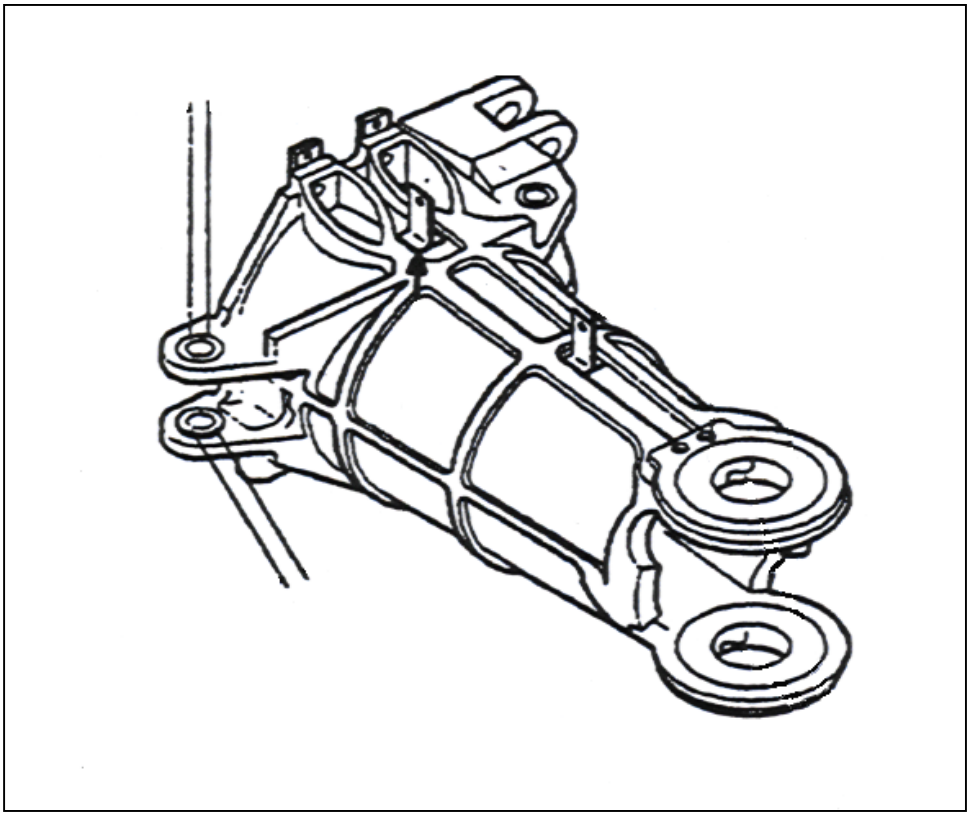
The recalculated useful life of parts also resulted in unanticipated demands for parts that the Army had not planned for and created shortages. According to an Aviation and Missile Command team leader of the Apache Systems Engineering Office, the useful life of the Apache's housing assembly[19] (see fig. 9) and rotor damper[20] (see fig. 10) changed because the Command conducted test flights that recorded the accurate fatigue factors for parts. The official said that recalculating the parts'

[19] The housing assembly holds the Apache's rotor blades.

[20] The rotor damper is used on the helicopter's rotor head assemblies and tail rotor hub assemblies to control and stabilize movements of rotor blades.

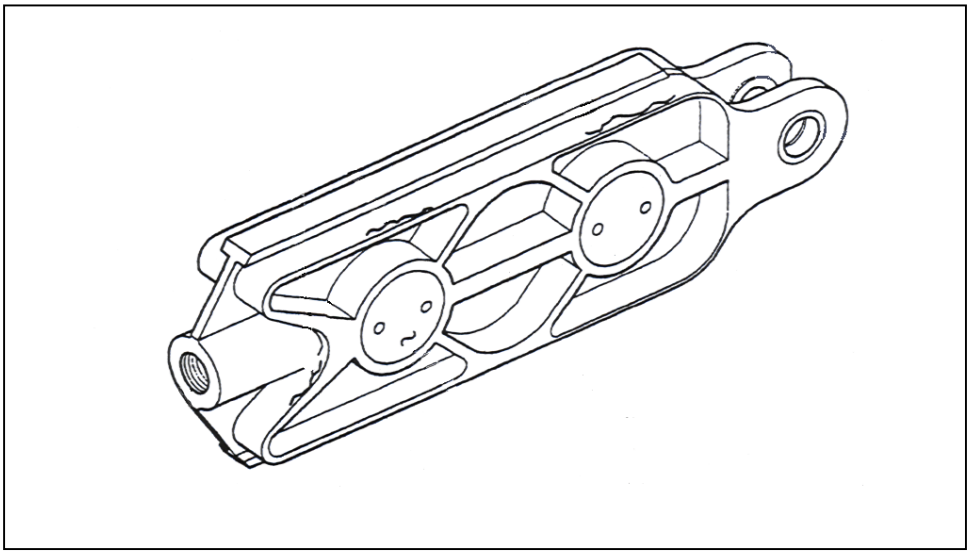
useful life based on accurate data instead of estimates reduced their useful life. In August 2000, the Aviation and Missile Command records show that the Command had only three usable Apache housing assemblies on hand when its useful life was recalculated and reduced from 1,981 to 1,193 hours, about a 40-percent reduction. As a result, repairs had to be made more frequently, and there were more demands for the housing assemblies than were available. Similarly, the Command's record shows that the Command had only seven usable Apache rotor dampers on hand when its useful life was reduced from 3,710 to 2,057 hours, about a 45-percent reduction. In September 2000, demands for the rotor dampers increased, and the Command's record shows that 53 were on back order and the average monthly demand was 65.

Figure 9: Housing Assembly for Apache



Source: Army.

Figure 10: Rotor Damper for Apache



Source: Army.

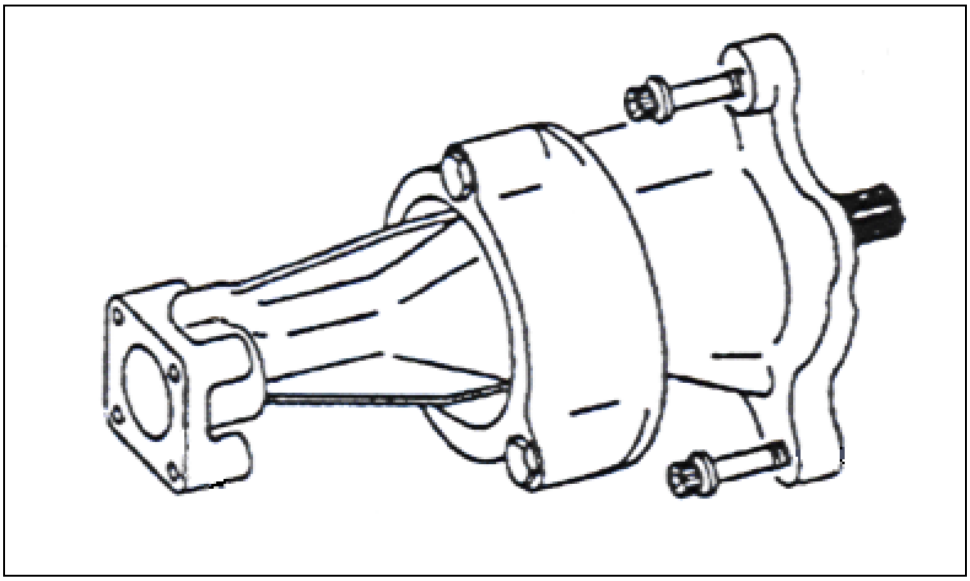
Finally, parts that were ordered more frequently than expected caused shortages when increases in demand for the items were not anticipated. For example, field units' demands for bearings used on the Blackhawk helicopters outpaced the contractor's production. According to an Aviation and Missile Command item manager, a new bearing was introduced in 1996. The Command's records show that before the new, improved bearing was introduced, units replaced this bearing every 70 hours. This new bearing lasts 4,000 hours and the contractor could not produce enough to meet the demand. In March 2000, Army records show that 976 bearings were on back order. According to a Command item manager, the increase in demand for the bearings occurred because (1) units were stockpiling the bearings and (2) the parts were being replaced worldwide on all Blackhawk helicopters because they lasted longer. The item manager stated the units were no longer ordering excessive quantities of bearings and that as of May 2001, there were 300 on hand and 423 on back order.

Likewise, the Command experienced a 25-percent increase in demands for Apache fuel boost pumps[21] (see fig. 11). A Command team leader for the

[21] Fuel enters the engine through the fuel boost (suction-type) pump, which is mounted on the engine.

Apache airframe was uncertain as to what caused the surge in demand but commented that it was not unusual for parts to fail because of the aircraft's age. The Command's record shows that unexpected failures of motors occurred during repairs, which delayed production of fuel boost pumps to meet increased demands. Also, the Command's record shows that in October 2000, there were 45 back orders and no usable fuel boost pumps on hand to meet the average monthly demand for three.

Figure 11: Fuel Boost Pump



Source: Army.

Contract Delays

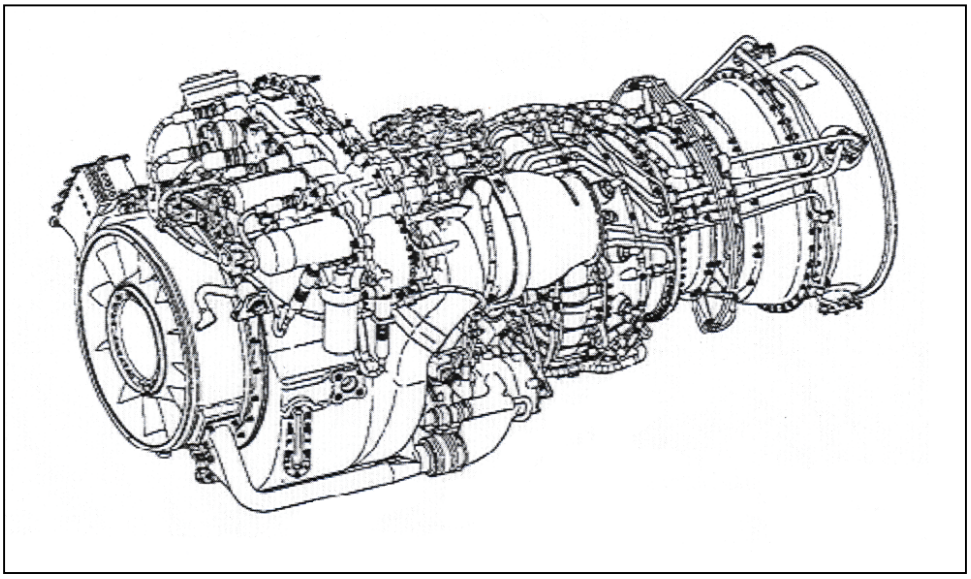
Poor contractor performance and delays in negotiating a contract also resulted in parts shortages. For example, Defense Logistics Agency records show that as a result of a contractor's late deliveries of Apache shear bolts, the Agency did not have the parts available for Apache users. Agency records show that the contract was terminated and another one was awarded to a different contractor. Also, Army records show that the Command had difficulty negotiating with a sole-source contractor to provide Apache servocylinders at reasonable prices. Because of the time it took the Aviation and Missile Command to award the contract, the parts were not provided to the users when needed.

Problems Concerning Overhaul and Maintenance

Due to a shortage of parts, the Corpus Christi Army Depot experienced problems that prevented it from repairing and overhauling aviation parts

in a timely manner. In May 1999, the Corpus Christi Army Depot received a requirement to overhaul 20 Blackhawk T-700 engines (see fig. 12). In July 1999, the depot received the fiscal year 2000 requirement to overhaul 30 engines, which increased to 65 in October 1999 and to 80 in December 1999. Because of these increases, the depot did not have enough time to determine the parts needed to support the overhaul requirements and the parts were not available to complete repairs in a timely manner. Also, the depot did not have the personnel available to respond quickly to the dramatic increases in overhaul requirements and thus the Depot could not repair parts in a timely manner. Further, in June 2000 an Aviation and Missile Command record showed that the average demand for Blackhawk T-700 engines was 7 per month, 66 engines were on back order, and 249 engines needed to be repaired. Another maintenance problem we identified was a shortage of parts used to repair cold section modules, a compressor section in the T-700 engine. The repair of cold section modules was also impacted by the need for personnel to support the overhauls of Blackhawk T-700 engines.

Figure 12: Blackhawk T-700 Engine



Source: Army.

Problems With Aging Aircraft

Aircraft age was not a reason for the 90 spare parts shortages we reviewed. However, Army and Defense Logistics Agency officials informed us the age of the Apache, the Blackhawk, and the Chinook is a factor

contributing to parts shortages for these systems. The aircraft were originally developed in the 1980s, 1970s, and 1960s, respectively, and they are expected to be useful for a number of years. The Commander of the Army Materiel Command said in 1999 that the Army expects to maintain an upgraded model of the almost 40-year-old Chinook for an additional 30 years.[22] He added that because of the aircraft's ages, parts consumption increases, inventory is depleted, cannibalization is necessary, and procurement costs of replenishment stocks increase.

According to the Defense Logistics Agency's November 2000 Aging Aircraft Program Management Plan, because of the extended age of these systems, the Army is concerned about the degradation of their structural integrity and the hard-to-find structural and electrical parts. Also, according to a report prepared for the Defense Microelectronics Activity, manufacturing sources for spare parts can be diminished because of uneconomical production requirements and the limited availability or increasing cost of items and raw materials used in the manufacturing process.[23] Army and Defense Logistics Agency officials commented, and the plan states, that this issue is serious because the original contractors that produced some spare parts for aging weapon systems may no longer be in business or may have upgraded their production lines to accommodate technologically advanced parts. However, we did not find this factor to be a reason for the shortages of the parts we reviewed.

Overall Initiatives May Address Parts Shortages

The Army and the Defense Logistics Agency have initiatives under way or planned to revolutionize and integrate logistics processes, upgrade aging aircraft, and improve the supply of aviation parts. The concept for the initiatives generally addresses the reasons we identified for spare parts shortages. The Army has developed a Strategic Logistics Plan intended to integrate the modernization and transformation of logistics processes throughout many organizations. The Army initiatives we identified are linked to the plan's asset management process, which is designed to match available assets with needs, identify shortages of assets, and interface with government and industry suppliers to buy additional assets. We have

[22] Statement by Commander, U.S. Army Materiel Command, to the Subcommittee on Military Readiness, House Committee on Armed Services, Oct. 7, 1999.

[23] *Resolution Cost Factors for Diminishing Manufacturing Sources and Material Shortages*, February 1999 (revised May 1999).

previously reported problems with the way Army has implemented its logistics initiatives and recommended that it develop a management framework for its initiatives, to include a comprehensive strategy and performance plan. The Army has actions under way to address the recommendation; therefore, we are not making any additional recommendations at this time. The various Army-wide, Army Materiel Command, and Defense Logistics Agency initiatives are described in the following sections.

Army-wide Initiatives

Among the efforts the Army has under way to improve the availability of spare parts are its Strategic Logistics Plan, Logistics Transformation Plan, Single Stock Fund, Velocity Management, and National Maintenance Program.

Army Strategic Logistics Plan

The Army has developed a Strategic Logistics Plan intended to integrate the modernization and transformation of logistics processes throughout many organizations. Under its Strategic Logistics Plan, the Army hopes to change from its current reactive approach to one that is more effective, efficient, and responsive. The initiatives planned or under way that are designed to resolve spare parts shortages are linked to the asset management process under the Army's planned change in approach. The plan was last updated on May 11, 2000, to show how the Army will achieve its synchronization goals by meeting the requirements of the Government Performance and Results Act (P.L. 103-62 (1993)). The next update is planned for the fall 2001 and is to include a timeline with milestones and metrics to track, measure, and better manage the transformation process.

Army Logistics Transformation Plan

In September 1999, we recommended that the Army develop a management framework to include a comprehensive strategy and a performance plan for implementing its initiatives.[24] In March 2000, the Department of Defense issued Defense Reform Initiative 54, which requires each military service to submit an annual logistics transformation plan. The purpose of this plan is to document, on an annual basis, the planned actions and related resources for implementing logistics initiatives, including actions that directly support the Department's Logistics Strategic Plan. Initiative 54 requires that the services' transformation plans include each of the key management framework elements specified in our prior reports.

[24] *Defense Inventory* (GAO/NSIAD-99-217, Sept. 14, 1999).

In response to our previous recommendation, in May 2000 the Army decided to combine preparation of its Strategic Logistics Plan with its response to Defense Reform Initiative 54. In July 2000, the Army developed its Logistics Transformation Plan in response to initiative 54. However, we did not evaluate this plan to determine whether its management framework included a comprehensive strategy and performance plan. Since the Army is taking actions on our previous recommendation to develop a management framework, we are not making new recommendations at this time. We are now reviewing the adequacy of the strategic logistics planning process within the Department of Defense and component commands, and this review will include the services' logistics transformation plans. This report will be completed later this year.

Army Single Stock Fund

The Army's single stock fund is a business process reengineering initiative to improve the availability of secondary items[25] logistics and financial processes in the Army Working Capital Fund, Supply Management business area. The fund is aimed at improving the availability of spare parts by, among other things, (1) providing worldwide access to parts down to the installation levels, (2) consolidating separate national-level and retail elements into a single fund, and (3) integrating logistics and financial automated information systems. In 1987 the Army began to study its stock fund operations. The Army's single stock fund program campaign plan was approved by the Vice Chief of Staff in November 1997, and during the first quarter of fiscal year 2002, the Army plans to transfer all stocks, which include wholesale and retail inventories, to the single management by Army Materiel Command.

Velocity Management

In September 1995, the Army established its Velocity Management Program to develop a faster, more flexible, and more efficient logistics pipeline. The program's goals, concept, and top management support parallel improvement efforts in private sector companies. The program's overall goal is to eliminate unnecessary steps in the logistics pipeline that delay the flow of supplies through the system. The program consists of Army-wide process improvement teams for the following four areas: the ordering and shipping of supplies, repair cycle, inventory levels and locations (also known as stockage determination), and financial management.

[25] Secondary inventory includes spare parts, clothing, and medical supplies to support Department of Defense operating forces worldwide.

National Maintenance Program

This Army-wide initiative, which was announced in July 1999, is designed to maximize repair capabilities and optimize the use of available resources at all maintenance levels within the Army. The initiative centralizes the management of all Army sustainment maintenance programs while decentralizing the actual repair of components and parts. The workload will be distributed across depot and installation activities, and repairs will be made based on national need for an item.

Additionally, the Army plans to upgrade its aging aircraft through its Recapitalization Program (a part of the National Maintenance Program), which it will achieve by overhauling components of and upgrading its aircraft. The purpose of this program is to (1) extend aircraft service life; (2) reduce operating and support costs; (3) improve reliability, maintainability, safety, and efficiency; and (4) enhance capability. A limited number of weapon systems will begin this process in fiscal year 2002, with full-scale upgrades beginning in fiscal year 2003. The Apache, Blackhawk, and Chinook helicopters have been identified as candidates for the program.

Army Materiel Command Initiatives

The Army Materiel Command has several initiatives under way to help resolve spare parts shortages, including (1) identifying processes for forecasting requirements for spare parts, (2) analyzing the spare parts program to identify issues that affect aviation spare parts shortages, and (3) working with contractors to provide spare parts. These initiatives are separate from those in the Army's Strategic Logistics Plan.

Plan to Resolve Forecasting Problems

In July 2000, the Army Materiel Command established the Forecasting and Support Techniques Working Group to identify processes for forecasting requirements for spare parts and to develop a plan to resolve any identified problems. The Army uses forecasting to develop quantity and resource requirements for inventory. Its basic principles are to maintain current data on customer demand, lead times for obtaining parts, internal process costs, stock levels, and replenishment of parts in a timely manner. In January 2001, the working group had prioritized several issues for its review.

Analysis of Spare Parts Program

In August 2000, the Army Materiel Command established the Spare Parts Shortages Integrated Process Team to analyze the spare parts program and to initially focus on aviation parts managed by the Aviation and Missile Command. The team identified issues that have affected spare parts shortages, including (1) an increase in demands that led to reduced availability of reparable parts; (2) understated times for administration and

production of spare parts, which resulted in the reduced availability of consumable and reparable parts; and (3) changes in requirements as the result of problems with parts that affected aircraft safety and readiness and minimally affected the availability of spare parts. The team recommended the issues be used to influence the next budget submission.

Contractor and Partnering Relationships

The Aviation and Missile Command is attempting to help resolve spare parts shortages by establishing partnerships with key contractors to reduce the time it takes to provide spare parts once a need has been identified. The Aviation and Missile Command focuses on ensuring that the prime contractors' focus is maintained on readiness, lead times, spare parts reliability, and rapid response to customer needs.

Defense Logistics Agency Initiatives

Among the efforts the Defense Logistics Agency has under way to improve the availability of spare parts are its Aviation Investment Strategy, Aging Aircraft Program, and contracts for consumable parts.

Aviation Investment Strategy

The Defense Logistics Agency's major initiative to resolve aircraft spare parts shortages is its Aviation Investment Strategy. This fiscal year 2000 initiative focuses on replenishing consumable aviation repair parts that have been identified as having availability problems that affect readiness. To achieve this initiative, the Agency plans to invest $17.3 million in aviation spare parts for the Army from fiscal years 2000 through 2003. As of fiscal year 2000, about $4.8 million had been obligated for this purpose.

Aging Aircraft Program

The purpose of the Defense Logistics Agency's Aging Aircraft Program is to consistently meet the goals for spare parts availability for the Army, Navy, and Air Force aviation weapon systems. The program's focus will be to (1) provide inventory control point personnel with complete, timely, and accurate information on current and projected parts requirements; (2) reduce customers' wait times for parts for which sources or production capability no longer exist; and (3) create an efficient and effective program management structure and processes that will achieve the stated program goals. The Aging Aircraft Program Management Plan was issued in November 2000, and the Agency plans to invest about $20 million on this program during 2001-2007.

Long-Term Contracts for Consumable Parts

The Defense Supply Center Richmond has a 2-year contract with an option for 3 years with one contractor and a 5-year contract with another contractor for consumable Army aircraft spare parts. According to a

Defense Supply Center Richmond document, the use of best commercial practices[26] will benefit aircraft users through improved delivery schedules and reduced inventory storage and administrative costs.

Agency Comments

In written comments on a draft of this report, the Principal Assistant Deputy Under Secretary of Defense for Logistics and Materiel Readiness indicated that the Department of Defense generally concurred with the report. The Department's comments are reprinted in their entirety in appendix III.

Scope and Methodology

To determine the impact spare parts shortages had on three selected Army helicopters, we obtained and reviewed (1) *Department of Defense Quarterly Readiness Reports to the Congress for April 1999 through September 2000* and (2) additional readiness data from the Army's Deputy Chief of Staff for Logistics, Arlington, Virginia. Additionally, we had discussions with officials at the Army Materiel Command, Alexandria, Virginia. We did not independently verify the readiness data. We selected the three helicopters for review because the helicopters experienced spare parts shortages during fiscal year 2000. To determine whether selected helicopters met supply availability goals, we obtained and reviewed the Army Materiel Command's fiscal year 1999-2000 supply availability rates for the Apache, Blackhawk, and Chinook helicopters. We did not independently verify the supply availability data. To determine why the helicopters experienced spare parts shortages, we interviewed officials at the Army Aviation and Missile Command, Huntsville, Alabama, and reviewed selected Army safety messages from August 1999 through February 2000 to identify the parts that caused the safety concerns. To determine the impact of parts shortages on maintenance practices and personnel, we reviewed the Army regulation on materiel policy and retail maintenance operations and an Army study on cannibalizations. We also reviewed our previous work on how cannibalizations adversely affect personnel and maintenance and our report that cited the lack of spare parts as hampering retention of military personnel. Additionally, we interviewed an official at the 101st Airborne Division, Fort Campbell, Kentucky, on the impact cannibalizations had on maintenance.

[26] Best commercial practices are defined as practices that enable Department of Defense to reduce inventory levels while making the supply system more responsive to users' needs.

To determine the reasons for the shortages of spare parts for the Apache, Blackhawk, and Chinook helicopters, we obtained computerized lists of spare parts that caused the helicopters to be not mission capable from the Army Aviation and Missile Command from October 1999 through July 2000 and from the Defense Supply Center, Richmond, Virginia, for fiscal year 2000. Also, we visited and obtained lists of spare parts shortages that caused delays in repairing helicopters from (1) Fort Campbell's 101st Airborne Division as of September 13, 2000; (2) Fort Campbell's Aviation Logistics Management Division, DynCorp Aerospace Operations, as of April 18, 2000; and (3) the Corpus Christi Army Depot, Corpus Christi, Texas, as of August 23, 2000. From the lists, we selected all 15 parts from the Fort Campbell's 101st Airborne Division and randomly selected 75 spare parts from the other locations for the Apache (32), Blackhawk (34), and Chinook (24) for further review (a total of 90 parts). Because of the size of our sample, we did not project the results of the sample to the universe of all helicopters' parts shortages. Once we identified the 90 spare parts shortages, we provided them to the inventory control points, the Army Aviation and Missile Command, and the Defense Supply Center, Richmond, to obtain their reasons for the shortages along with supporting documentation. To determine whether the aging of the aircraft contributed to spare parts shortages, we reviewed congressional Army testimony and documentation from the Defense Logistics Agency, Fort Belvoir, Virginia, and interviewed Army and Defense Logistics Agency officials. To determine whether management weaknesses contributed to spare parts shortages, we reviewed our prior reports on Army and Department of Defense inventory and financial management problems.

To determine what overall actions are planned or under way to address spare parts shortages for Army aircraft, we visited and obtained documentation and views from program officials at the Army's Office of the Deputy Chief of Staff, Logistics; the Army Materiel Command; the Army Aviation and Missile Command; the Defense Logistics Agency; and the Defense Supply Center, Richmond. We also compared the reasons for the spare parts shortages we found with the overall initiatives under way or planned to determine whether they were being addressed. We did not review the plans or the specific initiatives.

Our review was performed from August 2000 to June 2001 in accordance with generally accepted government auditing standards.

We are sending copies of this report to the Secretaries of Defense and the Army; the Director, Defense Logistics Agency; and the Director, Office of

Management and Budget. We will make copies available to other interested parties upon request.

Please contact me at (202) 512-8412 if you or your staff have any questions regarding this report. Key contributors to this report were Lawson Gist, Jr.; Jose Watkins; Carleen Bennett; and Nancy Ragsdale.

David R. Warren
Director, Defense Capabilities
and Management

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United States Senate

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The Honorable Jerry Lewis
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House of Representatives

Appendix I: Management Weaknesses Have Contributed to Spare Parts Shortages

In January 2001, we reported that the Department of Defense had serious weaknesses in its management of logistics functions and, in particular, inventory management.[1] Although not specifically identified with the systems we reviewed, these management weaknesses directly or indirectly contribute to the shortage of spare parts the Army is facing. For example:

- We reported in April 1997 that the Army needed to improve its logistics pipeline for aviation parts and reduce logistics costs by incorporating private sector best practices.[2] We found that the Army's repair pipeline was slow, unreliable, and inefficient. One contributing factor was a lack of consumable parts needed to complete repairs.
- We reported in October 1997 that the Army needed to improve its management of the weapon system and equipment modification program to eliminate difficulties in obtaining spare parts.[3] We found that program sponsors had been inconsistent in providing initial spare parts and ensuring spare parts were added to the supply system.
- We reported in June 2000 that the Army needed to strengthen and follow procedures to control shipped items, which include spare parts and other inventory items.[4] We found that the Army did not know the extent to which shipped inventory had been lost or stolen because of weaknesses in its inventory control procedures and financial management practices.

In addition, the Department of Defense's long-standing financial management problems may contribute to the Army's spare parts shortages. As we recently reported, weaknesses in inventory accountability information can affect supply responsiveness.[5] Lacking reliable information, the Department of Defense has little assurance that all items purchased are received and properly recorded. The weaknesses increase the risk that responsible inventory item managers may request

[1] *Major Management Challenges and Program Risks: Department of Defense* (GA0-01-244, Jan. 2001).

[2] *Inventory Management: The Army Could Reduce Logistics Costs for Aviation Parts by Adopting Best Practices* (GAO/NSIAD-97-82, *Apr. 15, 1997*).

[3] *Army Equipment: Management of Weapon System and Equipment Modification Program Needs Improvement* (GAO/NSIAD-98-14, *Oct. 10, 1997*).

[4] *Defense Inventory: Army Needs to Strengthen and Follow Procedures to Control Shipped Items* (GAO/NSIAD-00-109, *June 23, 2000*).

[5] *Major Management Challenges and Program Risks* (GAO-01-244, Jan. 2001).

funds to obtain additional, unnecessary items that may be on hand but not reported.

Appendix II: Reasons for Shortages of Apache, Blackhawk, and Chinook Helicopters' Spare Parts

Reason for shortage[a]	Apache part	Blackhawk part	Chinook part
Actual demand was greater than anticipated	1. Cylinder charge 2. Elbow assembly 3. Electric fan cover 4. Fuel booster pump 5. Housing assembly 6. Main pin blade 7. Nonmetallic seal[b] 8. Nonmetallic seal[b] 9. Plain encased seal 10. Plain hexagon nut 11. Relay assembly 12. Roller-droop stop 13. Rotor blade damper 14. Rotor pump 15. Shock head 16. Socket screw cap 17. Straight-headed pin 18. Striker plate 19. Swivel caster 20. Threaded pin-rivet 21. Transmission main	1. Actuating cylinder 2. Bearing ball 3. Bearing plan 4. Cable assembly 5. Circuit card assembly 6. Connecting link 7. Digital microcircuit 8. Fuel tank 9. G axis seal kit 10.Gear box assembly 11. Magnetic compass 12. Metallic tube 13. Packing with retain 14. Pipe hanger 15. Preformed packing 16. Pressurizing 17. Protective dust cap 18. Repair kit 19. Sas actuator assembly 20. Shaft assembly 21.Shaft fitting 22. Solid rivet 23. Tubeless tire	1. Engine gas turbine 2. Machine bolt 3. Machine transmission 4. Nonmetallic bumper 5. O-ring 6. Plain encased seal 7. Plain seal 8. Preformed packing 9. Quick coupling half[b] 10. Quick coupling half[b] 11. Ring spacer 12.Support structural 13.Time meter
Contractual delays	22. Assembly actuator bracket 23. Left-hand nacelle 24. Modification kit 25. Mounting bracket 26. Power supply 27. Servocylinder[b] 28. Servocylinder[b] 29. Servocylinder[b] 30. Servocylinder[b] 31. Shear bolt 32. Shock strut assembly	24. Armored wing assembly 25. Belt aircraft safety 26. Electro actuator 27. Roller bearing	14. Aircraft access door 15. Annular bearing ball 16. Control swashplate 17. Hydraulic cylinder 18. Shouldered shaft 19. Time totalizator meter
Problem concerning overhaul/maintenance		28.Cold section module 29. Engine aircraft 30. Main fuel control 31. T-700 engine aircraft	20. Aircraft engine 21. Rotary wing head
Other[c]		32. Cylinder assembly 33. Flutter dampener 34. Multimeter	22. Close tolerance bolt 23. Plastic spir tubing 24. Sleeve bushing

[a] There were multiple reasons for parts shortages, but for the purposes of our analysis, we used the most predominant reason.

[b] The spare parts with the same name have different stock numbers.

[c] Includes agency's lack of knowledge of reason for shortages and incorrect inventory records

Appendix III: Comments From the Department of Defense

DEPUTY UNDER SECRETARY OF DEFENSE FOR
LOGISTICS AND MATERIEL READINESS
3500 DEFENSE PENTAGON
WASHINGTON, DC 20301-3500

JUL 26 2001

Mr. David R. Warren
Director, Defense Capabilities
and Management
National Security and International
Affairs Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Warren:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "ARMY INVENTORY: Parts Shortages are Impacting Operations and Maintenance Effectiveness," dated June 25, 2001 (GAO Code 709529/OSD Case 4029). The DoD generally concurs with the draft report.

The DoD appreciates the opportunity to comment on the draft report.

Sincerely,

Allen W. Beckett
Principal Assistant

Related GAO Products

Defense Logistics: Information on Apache Helicopter Support and Readiness (GAO-01-630, July 17, 2001).

Defense Inventory: Opportunities Exist to Expand the Use of Defense Logistics Agency Best Practices (GAO/NSIAD-00-30, Jan. 26, 2000).

Army Logistics: Status of Proposed Support Plan for Apache Helicopter (GAO/NSIAD-99-140, July 1, 1999).

Defense Inventory: Status of Inventory and Purchases and Their Relationship to Current Needs (GAO/NSIAD-99-60, Apr. 16, 1999).

Defense Inventory: DOD Could Improve Total Asset Visibility Initiative With Results Act Framework (GAO/NSIAD-99-40, Apr. 12, 1999).

Major Management Challenges and Program Risks: Department of Defense (GAO/OCG-99-4, Jan. 1, 1999).

Defense Depot Maintenance: Use of Public-Private Partnering Arrangements (GAO/NSIAD-98-91, May 7, 1998).

Inventory Management: DOD Can Build on Progress by Using Best Practices for Reparable Parts (GAO/NSIAD-98-97, Feb. 27, 1998).

Defense Inventory: Management of Surplus Usable Aircraft Parts Can Be Improved (GAO/NSIAD-98-7, Oct. 2, 1997).

Inventory Management: The Army Could Reduce Logistics Costs for Aviation Parts by Adopting Best Practices (GAO/NSIAD-97-82, Apr. 15, 1997).

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