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DEFENSE MANAGEMENT

DOD Needs Better Information and Guidance to More Effectively Manage and Reduce Operating and Support Costs of Major Weapon Systems



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Highlights of [GAO-10-717](#), a report to congressional committees

Why GAO Did This Study

The Department of Defense (DOD) spends billions of dollars each year to sustain its weapon systems. These operating and support (O&S) costs can account for a significant portion of a system's total life-cycle costs and include costs for repair parts, maintenance, and personnel. The Weapon Systems Acquisition Reform Act of 2009 directs GAO to review the growth in O&S costs of major systems. GAO's report addresses (1) the extent to which life-cycle O&S cost estimates developed during acquisition and actual O&S costs are available for program management and decision making; (2) the extent to which DOD uses life-cycle O&S cost estimates after systems are fielded to quantify cost growth and identify its causes; and (3) the efforts taken by DOD to reduce O&S costs for major systems. GAO selected seven aviation systems that reflected varied characteristics and have been fielded at least several years. These systems were the F/A-18E/F, F-22A, B-1B, F-15E, AH-64D, CH-47D, and UH-60L.

What GAO Recommends

GAO recommends that DOD take steps to retain life-cycle O&S cost estimates for major systems, collect additional O&S cost elements in its visibility systems, update life-cycle O&S cost estimates periodically after systems are fielded, and retain documentation of program changes affecting O&S costs for use in cost analysis. DOD concurred with GAO's recommendations.

[View GAO-10-717 or key components.](#)
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DEFENSE MANAGEMENT

DOD Needs Better Information and Guidance to More Effectively Manage and Reduce Operating and Support Costs of Major Weapon Systems

What GAO Found

DOD lacks key information needed to effectively manage and reduce O&S costs for most of the weapon systems GAO reviewed—including life-cycle O&S cost estimates and complete historical data on actual O&S costs. The services did not have life-cycle O&S cost estimates developed at the production milestone for five of the seven aviation systems GAO reviewed, and current DOD acquisition and cost-estimating guidance does not specifically address retaining these estimates. Also, the services' information systems designated for collecting data on actual O&S costs were incomplete, with the Army's system having the greatest limitations on available cost data. Without historic cost estimates and complete data on actual O&S costs, DOD officials do not have important information necessary for analyzing the rate of O&S cost growth for major systems, identifying cost drivers, and developing plans for managing and controlling these costs. At a time when the nation faces fiscal challenges, and defense budgets may become tighter, the lack of this key information hinders sound weapon system program management and decision making in an area of high costs to the federal government.

DOD generally does not use updated life-cycle O&S cost estimates to quantify cost growth and identify cost drivers for the systems GAO reviewed. The services did not periodically update life-cycle O&S cost estimates after production was completed for six of the seven systems. The F-22A program office had developed an updated life-cycle O&S cost estimate in 2009 and found a 47-percent (\$19 billion) increase in life-cycle O&S costs from what had been previously estimated in 2005. GAO's comparisons of estimated to actual O&S costs for two of the seven systems found some areas of cost growth. However, notable changes such as decreases in the numbers of aircraft and flying hours occurred in both programs after the production milestone estimates were developed, complicating direct comparisons of estimated to actual costs. According to federal guidance, agencies should have a plan to periodically evaluate program results as these may be used to determine whether corrections need to be made and to improve future cost estimates. However, DOD acquisition and cost estimation guidance does not require that O&S cost estimates be updated throughout a system's life cycle or that information on program changes affecting the system's life-cycle O&S costs be retained. The services' acquisition and cost-estimation guidance that GAO reviewed does not consistently and clearly require the updating of O&S cost estimates after a program has ended production.

DOD has several departmentwide and service-specific initiatives to address O&S costs of major systems. One DOD program funds projects aimed at improving reliability and reducing O&S costs for existing systems. Other initiatives are aimed at focusing attention on O&S cost requirements and reliability during the acquisition process. In a recent assessment, DOD identified weaknesses in O&S cost management, found deficiencies in sustainment governance, and recommended a number of corrective actions. Many of DOD's initiatives are recent or are not yet implemented.

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Abbreviations

DOD	Department of Defense
IDA	Institute for Defense Analyses
O&S	operating and support
OSD	Office of the Secretary of Defense
VAMOSC	Visibility and Management of Operating and Support Costs

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Congressional Committees

The Department of Defense (DOD) spends billions of dollars each year to sustain its weapon systems. These operating and support (O&S) costs can account for a significant portion of a weapon system's total life-cycle costs and include costs for, among other things, repair parts, maintenance, and contract services, as well as the personnel associated with a weapon system.¹ Weapon systems are costly to sustain in part because they often incorporate a technologically complex array of subsystems and components and need expensive spare parts and logistics support to meet required readiness levels. In addition, the high tempo of military operations in Iraq and Afghanistan has increased wear and tear on many weapon systems, escalating their O&S costs well beyond peacetime levels. Many of the key decisions affecting a weapon system's O&S costs are made while the system is still in the acquisition process. For example, acquisition-based decisions about the design, materials, and technology for the system affect the logistics support that is eventually needed to keep the system available and ready after it is fielded. Controlling O&S costs is critical to ensure future affordability of defense budgets. Life-cycle O&S costs for the F-35 Joint Strike Fighter, the newest aircraft being acquired for the Air Force, Navy, and Marines, are now estimated at about \$916 billion and its operating costs per hour are expected to exceed the legacy aircraft it is replacing.

To improve DOD's organization and procedures for acquiring weapon systems, Congress passed the Weapon Systems Acquisition Reform Act of 2009 ("the Act").² The Act contains provisions regarding improving the

¹The department recently estimated that weapon system product support costs in fiscal year 2008 were at least \$132 billion. According to DOD, product support encompasses materiel management, distribution, technical data management, maintenance, training, cataloging, configuration management, engineering support, repair parts management, failure reporting and analysis, and reliability growth. However, this amount does not include all O&S costs.

²Pub. L. No. 111-23 (2009).

accuracy of cost estimates for major defense acquisition programs.³ The Act also directs GAO to review the growth in O&S costs of major weapon systems and to provide the results of this review not later than 1 year after the date the legislation is enacted.⁴ We provided the preliminary results of our review to the congressional defense committees in May 2010. This report provides the final results of our review and addresses (1) the extent to which life-cycle O&S cost estimates developed during acquisition and actual O&S costs are available for major weapon system program management and decision making; (2) the extent to which DOD uses life-cycle O&S cost estimates for major weapon systems after they are fielded to quantify cost growth and identify its causes; and (3) the efforts taken by DOD to reduce O&S costs for major weapon systems.

The Act also requires us to review weaknesses in operations affecting the reliability of financial information on the systems and assets to be acquired under major defense acquisition programs. We are issuing a separate report in response to that provision of the Act. Furthermore, the Act directs the DOD Director of Cost Assessment and Program Evaluation,⁵ within the Office of the Secretary of Defense (OSD), to review existing DOD systems and methods for tracking and assessing O&S costs on major defense acquisition programs. In addition, we have conducted prior work on weapon system O&S cost issues and made recommendations for better managing and controlling costs. The Related GAO Products section at the end of this report provides additional information on our prior work.

³Major defense acquisition programs are estimated by the Under Secretary of Defense for Acquisition, Technology and Logistics to require an eventual total expenditure for Research, Development, Test and Evaluation of more than \$365 million, including all planned increments, based on fiscal year 2000 constant dollars (approximately \$509 million in fiscal year 2010 dollars), \$2.190 billion of Procurement funding, including all planned increments (approximately \$3.054 billion in fiscal year 2010 dollars), or are designated as a major defense acquisition program by the milestone decision authority. Throughout this report, we use the term major weapon system to describe a major defense acquisition program.

⁴Specifically, section 304 of the Act requires that we identify the original O&S cost estimates for selected major defense weapon systems; assess the actual O&S costs and the rate of growth; assess the factors contributing to high rates of O&S cost growth; and assess measures taken by DOD to reduce O&S costs for major weapon systems.

⁵The Act created this position, which includes many of the functions formerly performed by the Director of Program Analysis and Evaluation.

To conduct this review, we collected and analyzed data on seven major aviation weapon systems: the Navy's F/A-18E/F; the Air Force's F-22A, B-1B, and F-15E; and the Army's AH-64D, CH-47D, and UH-60L. We focused on aviation systems to allow us to compare O&S cost growth, where possible, across the selected systems. We selected systems that had reached initial operating capability after 1980, incurred several years of actual O&S costs, and had relatively large fleets. We also selected the systems to reflect varied characteristics in terms of military service,⁶ mission, support strategy, and aircraft age. We did not select weapon systems with known limitations of available cost data.⁷ The results from this nonprobability sample cannot be used to make inferences about all aviation systems or major weapon systems because the sample may not reflect all characteristics of the population. We obtained life-cycle O&S cost estimates, where available, that the services had developed to support the decision to proceed with production of the aircraft.⁸ We obtained data on actual O&S costs from the services' Visibility and Management of Operating and Support Costs (VAMOSC) systems, which are information systems designated by DOD as the authoritative sources to provide visibility over these historical data. In our analysis of O&S costs, we have adjusted DOD data to reflect constant fiscal year 2010 dollars, unless otherwise noted. We also interviewed and obtained pertinent documents, including directives, instructions, regulations, memorandums, and manuals, from acquisition, program management, cost analysis, and logistics officials to understand how O&S costs were estimated, tracked, managed, and controlled in accordance with applicable laws and policies; and to identify factors that have led to cost growth. Our scope and methodology is discussed further in appendix I.

We conducted this performance audit from June 2009 to July 2010 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient,

⁶We did not include a Marine Corps aviation system in our sample because the Naval Air Systems Command manages and supports all Marine Corps aircraft. References to the military services in this report do not include the Marine Corps.

⁷For example, we previously reported that detailed historical cost data were not available for many weapon systems supported under performance-based logistics arrangements.

⁸While life-cycle cost estimates may be developed during earlier stages of the acquisition process, DOD guidance states that the cost estimate for the production milestone should be based on the current design characteristics of the weapon system, the latest deployment schedule, and the current logistics and training support plans. The production milestone is also known as milestone C or, for older systems, milestone III.

appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. However, O&S cost data for individual weapon systems have certain data reliability limitations and are not consistent across all major systems. We discuss some of these data limitations in our report.

Results in Brief

DOD lacks key information needed to effectively manage and reduce O&S costs for most of the weapon systems we reviewed—including life-cycle O&S cost estimates and complete historical data on actual O&S costs. The services did not have life-cycle O&S cost estimates developed at the production milestone for five of the seven aviation systems we reviewed, and the services did not have complete data on actual O&S costs in their VAMOSC systems, with the Army system having the greatest limitations on its available cost data. Without historical life-cycle O&S cost estimates and complete data on actual O&S costs, DOD officials do not have important information necessary for analyzing the rate of O&S cost growth for major weapon systems, identifying cost drivers, and developing plans for managing and controlling these costs. In addition, at a time when the nation faces fiscal challenges and defense budgets may become tighter, the lack of this key information hinders sound weapon-system program management and decision making in an area of high costs to the federal government. DOD officials we interviewed noted that the department has not placed emphasis on assessing and managing weapon system O&S costs compared with other priorities. More specifically, our review showed the following:

- Life-cycle O&S cost estimates developed during weapon system acquisition to support production decisions were available for two aviation systems—the Air Force’s F-22A and the Navy’s F/A-18E/F. Neither the services nor OSD could produce the production milestone O&S cost estimates for the other five systems. Under cost-estimating best practices, the thorough documentation of cost estimates and the retention of these estimates are essential in order to analyze changes that can aid preparation of future cost estimates. However, current DOD acquisition and cost-estimating guidance does not specifically address retaining life-cycle O&S cost estimates and the support documentation used to develop these estimates.
- The services’ VAMOSC systems do not collect complete data on O&S costs, and some cost data in these systems are inaccurate. While DOD

guidance recommends that the services collect actual data on O&S costs using the same cost element structure used to develop life-cycle O&S cost estimates, the guidance does not require use of this structure in collecting and presenting these data. Our review showed that the Air Force's and Navy's VAMOS systems do not collect actual cost data for several cost elements, and the Army's system collects actual data on unit-level consumption costs (such as fuel, spare parts, and training munitions) but does not consistently capture data for other major O&S cost elements. Although we recommended in 2000 that the Army improve its VAMOS system, the Army has not made significant improvements. According to Army officials, additional cost data in existing information systems do not feed into the VAMOS system.

DOD generally does not use updated life-cycle O&S cost estimates to quantify cost growth and identify cost drivers for the weapon systems we reviewed. Even though most of these weapon systems have been fielded for at least a decade, the services did not periodically update life-cycle O&S cost estimates for six of the seven systems. According to Office of Management and Budget guidance on benefit-cost analysis, agencies should have a plan for periodically evaluating program results as these evaluations may be used to determine whether corrections need to be made and to improve future cost estimates. Further, cost-estimating best practices call for regular updating of estimates to determine whether the preliminary information and assumptions remain relevant and accurate, record reasons for variances, and archive cost and technical data for use in future estimates. However, for six of the seven aviation weapon systems we reviewed, service officials could not provide current life-cycle O&S cost estimates that updated previous estimates by, for example, incorporating actual historical costs or comparing actual costs to the prior estimates. In contrast, the F-22A program office had updated the production milestone cost estimate, found a 47 percent (\$19 billion) increase in life-cycle O&S costs from what had been previously estimated, and identified cost drivers for this increase. Our comparisons of estimated to actual O&S costs for the two aviation systems where data were available—the F-22A and the F/A-18E/F—indicated there were some areas of cost growth. However, notable program changes that occurred after the production milestone estimates were developed, such as decreases in the total numbers of aircraft and flying hours, complicated direct comparisons between estimated and actual costs. Our analysis of actual O&S costs for the other five weapon systems showed that costs had increased over time, but the extent to which this cost growth was planned is uncertain because the production milestone O&S cost estimates were not available. Despite the Office of Management and Budget guidance and cost-estimating best

practices, current DOD acquisition and cost estimation guidance does not require that O&S cost estimates be updated after a program has been fielded, and service guidance that we reviewed is not clear and consistent regarding the updating of O&S cost estimates. In addition, although weapon system programs may experience significant changes over time that affect the assumptions used to develop earlier life-cycle O&S cost estimates, the DOD and service guidance that we reviewed does not explicitly require the services to maintain documentation of program changes for use in future cost analysis. Without assessments aimed at quantifying and analyzing changes in a weapon system's life-cycle O&S costs after it is fielded, the services may miss opportunities to take corrective actions aimed at reducing these costs and to improve future cost estimating.

DOD has several departmentwide and service initiatives to address O&S costs of major weapon systems. DOD, for example, has a \$25 million program that funds specific projects aimed at improving reliability and reducing O&S cost for existing systems. Other departmentwide initiatives are aimed at focusing attention on O&S cost requirements during the acquisition process, improving system reliability during acquisition, and improving cost estimates and the availability of contractor cost data. Some of these initiatives address factors we previously identified as negatively affecting DOD's ability to manage O&S costs. For example, DOD has introduced a total ownership cost performance requirement for new weapon systems. The services also identified initiatives to help them better manage O&S costs for aviation systems. Although one Army command had an O&S cost-reduction program, none of the services had cost-reduction programs implemented servicewide. Moreover, in a recent departmentwide assessment, DOD identified problems with weapon system product support. In addition to identifying weaknesses in O&S cost management, DOD's study team also found deficiencies in sustainment governance and recommended a number of corrective actions. Many of DOD's initiatives are recent or have not yet been implemented.

We are recommending that DOD take steps to retain life-cycle O&S cost estimates for major weapon systems, collect additional O&S cost elements in their VAMOS systems, update life-cycle O&S cost estimates periodically after systems are fielded, and retain documentation of program changes affecting O&S costs for use in cost analysis. We are also recommending that the Army develop a strategy for improving its VAMOS system. DOD, in its comments on a draft of this report, concurred with our recommendations.

Background

O&S Costs Constitute a Significant Portion of a System's Life-Cycle Costs

A system's life-cycle costs include the costs for research and development, procurement, sustainment, and disposal. O&S costs include the direct and indirect costs of sustaining a fielded system, such as costs for spare parts, fuel, maintenance, personnel, support facilities, and training equipment. According to DOD, the O&S costs incurred after a system has been acquired account for at least 70 percent of a system's life-cycle costs and depend on how long a system remains in the inventory.⁹ Many of the key decisions affecting O&S costs are made during the acquisition process, and a weapon system's O&S costs depend to a great extent on its expected readiness level and overall reliability. In general, readiness can be achieved either by building a highly reliable weapon system or supporting it with a more extensive logistics system that can ensure spare parts and other support are available when needed. If a weapon system has a very high expected readiness rate but its design is not reliable, O&S costs may be high and more difficult to predict. Conversely, if the weapon system design has been thoroughly tested for reliability and is robust, O&S costs may be more predictable.

O&S Costs Are Required to Be Estimated at Various Points during the Acquisition Process

DOD's acquisition process includes a series of decision milestones as the systems enter different stages of development and production. As part of the process,¹⁰ the DOD component or joint program office responsible for the acquisition program is required to prepare life-cycle cost estimates, which include O&S costs, to support these decision milestones and other reviews. Under the current acquisition process,¹¹ decision makers at milestone A determine whether to approve a program to enter into technology development. Although very little may be known about the system design, performance, physical characteristics, or operational and

⁹DOD, *Weapon System Acquisition Reform Product Support Assessment* (November 2009).

¹⁰The principal DOD policies on the weapon system acquisition process are DOD Directive 5000.01, *The Defense Acquisition System* (May 12, 2003), and DOD Instruction 5000.02, *Operation of the Defense Acquisition System* (Dec. 8, 2008).

¹¹DOD's acquisition policies and terminology related to major decision reviews have varied over the years. Most of our selected weapon systems passed through the acquisition process prior to the current structure. Although under the current process the milestone names have changed, the milestone reviews held in the past similarly focused on approvals for concept demonstration, system development, and production.

support concepts, DOD guidance states that rough O&S cost estimates are expected to primarily support plans that guide refinement of the weapon system concept.¹² At milestone B, a decision is made whether to approve the program to enter into engineering and manufacturing development. At this point, according to the guidance, O&S cost estimates and comparisons should show increased fidelity, consistent with more fully developed design and support concepts. At this stage, O&S costs are important because the long-term affordability of the program is assessed, program alternatives are compared, and O&S cost objectives are established. The program must pass through milestone C before entering production and deployment. DOD's guidance states that at milestone C and at the full-rate production decision review, O&S cost estimates should be updated and refined, based on the system's current design characteristics, the latest deployment schedule, and current logistics and training support plans. Further, the guidance states that O&S experience obtained from system test and evaluation should be used to verify progress in meeting supportability goals or to identify problem areas. Lastly, O&S cost objectives should be validated, and any O&S-associated funding issues should be resolved, according to the guidance.

OSD's Cost Assessment and Program Evaluation¹³ office has established guidance regarding life-cycle O&S cost estimates that are developed at acquisition milestone reviews and has defined standards for preparing and presenting these estimates.¹⁴ Current guidance issued in October 2007 identifies O&S cost elements and groups them into several major areas.¹⁵ This 2007 guidance—which went into effect after the systems selected for our review passed through the production milestone—updated and refined the guidance issued in May 1992. The cost element structure in the 2007 guidance is similar to that of the 1992 guidance, with some key differences. For example, separate cost elements for intermediate-level and depot-level maintenance under the 1992 structure were combined into one maintenance cost element area in 2007. Cost elements for continuing

¹²OSD, *Operating and Support Cost Estimating Guide* (October 2007) and *Operating and Support Cost Estimating Guide* (May 1992).

¹³The 2009 Weapon Systems Acquisition Reform Act transfers the functions and personnel of the Cost Analysis Improvement Group to the Deputy Director for Cost Assessment, under the OSD Director for Cost Assessment and Program Evaluation. For the purposes of this report, we will refer to the current organization.

¹⁴DOD Directive 5000.04, *Cost Analysis Improvement Group* (Aug. 16, 2006).

¹⁵OSD, *Operating and Support Cost Estimating Guide* (October 2007).

system improvements were included under sustaining support in 1992 but separately identified in the 2007 structure. Also, cost elements for contractor support are no longer separately identified as a single cost area in the 2007 structure but are spread over other areas. Table 1 summarizes the 2007 and 1992 cost element structure for O&S cost estimating and provides a description of DOD's cost elements.

Table 1: DOD's Current and Former Structure for Preparing and Presenting O&S Cost Estimates

2007 cost element structure	1992 cost element structure	2007 description of cost elements
Unit-level personnel	Mission personnel	The direct costs of all operator, maintenance, and other support personnel at operating units (or at maintenance and support units that are organizationally related and adjacent to the operating units).
Unit operations	Unit-level consumption	The unit-level consumption costs of operating materials such as fuel, electricity, expendable stores, training munitions, and other operating materials. Also included are costs of any unit-funded support activities, training devices, or simulator operations that uniquely support an operational unit, temporary additional duty / temporary duty associated with the unit's normal concept of operations, and other unit-funded services.
Maintenance	Intermediate maintenance Depot maintenance	The costs of labor (outside of the scope of unit-level) and materials at all levels of maintenance in support of the primary system, simulators, training devices, and associated support equipment.
^a	Contractor support	The cost of contractor labor, materials, and overhead incurred in providing all or part of the logistics support to a weapon system. ^b
Sustaining support	Sustaining support	Costs for support services provided by centrally managed support activities external to the units that own the operating systems and that can be identified to a specific system (excludes costs that must be arbitrarily allocated).
Continuing system improvements	^c	The costs of hardware and software updates that occur after deployment of a system that improve a system's safety, reliability, maintainability, or performance characteristics to enable the system to meet its basic operational requirements throughout its life. (Costs for system improvement identified as part of the acquisition strategy or a preplanned product improvement program and included in the acquisition cost estimate are not included. Also, any improvements of sufficient dollar value that would qualify as distinct major defense acquisition programs are not included.)
Indirect support	Indirect support	Installation and personnel support costs that cannot be directly related to the units and personnel that operate and support the system being analyzed.

Source: GAO presentation of DOD guidance.

^aIn the 2007 cost element structure, contractor support costs are reported under other cost element areas.

^bThis description applies to the 1992 cost element structure.

^cIn the 1992 cost element structure, continuing system improvement costs were reported under the sustaining support cost element area.

The Services Have Developed Systems for Providing Visibility of Actual O&S Costs

Each of the services has developed a system for collecting, maintaining, and providing visibility over historical information on actual weapon system O&S costs. Collectively referred to as VAMOSOC systems, the Army's system is the Operating and Support Management Information System; the Navy's system is the Naval Visibility and Management of Operating and Support Cost system;¹⁶ and the Air Force's system is the Air Force Total Ownership Cost system. These systems were developed in response to long-standing concerns that the services lacked sufficient data on the actual costs of operating and supporting their weapon systems. For example, according to a Naval Audit Service report, in 1975 the Deputy Secretary of Defense directed the military departments to collect actual O&S costs of defense weapon systems. In 1987, the Senate Committee on Appropriations requested that each service establish a capability within 4 years to report accurate and verifiable O&S costs for major weapon systems.¹⁷ In 1992, DOD required that the O&S costs incurred by each defense program be maintained in a historical O&S data-collection system. Related guidance tasked the services with establishing historical O&S data-collection systems and maintaining a record of data that facilitates the development of a well-defined, standard presentation of O&S costs by major defense acquisition program.¹⁸

According to DOD's guidance, the services' VAMOSOC systems are supposed to be the authoritative source for the collection of reliable and consistent historical O&S cost data about major defense programs, and it is incumbent upon the services to make the data as accurate as possible. DOD's stated objectives for the systems include the provision of visibility of O&S costs so they may be managed to reduce and control program life-cycle costs and the improvement of the validity and credibility of O&S cost estimates by establishing a widely accepted database. According to the guidance, the O&S cost element structure provides a well-defined standard presentation format for the services' VAMOSOC systems.

¹⁶The Navy's VAMOSOC system collects O&S costs for both Navy and Marine Corps systems.

¹⁷S. Rep. No. 100-235, at 53 (Dec. 4, 1987).

¹⁸DOD 5000.4-M, *DOD Cost Analysis Guidance and Procedures* (December 1992).

**Prior GAO Reviews
Identified Factors
Negatively Affecting DOD's
Ability to Manage O&S
Costs**

Our work in the late 1990s and in 2003 identified several factors negatively affecting DOD's ability to manage O&S costs.¹⁹ First, DOD used immature technologies and components in designing its weapon systems, which contributed to reliability problems and acted as a barrier to using manufacturing techniques that typically help reduce a system's maintenance costs. In contrast, commercial companies ensure they understand their operating costs by analyzing data they have collected on equipment they are currently using. Second, DOD's acquisition processes did not consider O&S costs and readiness as key performance requirements²⁰ for new weapon systems and placed higher priority on technical performance features. Further, DOD continued to place higher priority on enhanced safety, readiness, or combat capability than on O&S cost management after system fielding. Third, DOD's division of responsibility among its requirements-setting, acquisition, and maintenance communities made it difficult to control O&S costs, since no one individual or office had responsibility and authority to manage all O&S cost elements throughout a weapon system's life cycle. Fourth, the services' VAMOSOC systems for accumulating data to analyze operations and support actions on fielded systems did not provide adequate or reliable information, thus making it difficult for DOD to understand total O&S costs.

We have also reported on the effect of DOD weapon system sustainment strategies on O&S costs. For example, we reported in 2008 that although DOD expected that the use of performance-based logistics arrangements would reduce O&S costs, it was unclear whether these arrangements were meeting this goal. The services were not consistent in their use of business case analyses to support decisions to enter into performance-based logistics arrangements. Also, DOD program offices that implemented these arrangements had not obtained detailed cost data from contractors and could not provide evidence of cost reductions attributable to the use of a performance-based logistics arrangement. Finally, we have reported on O&S cost issues associated with individual weapon systems, including the Marine Corps' V-22 aircraft in 2009 and the Navy's Littoral Combat Ship in 2010.

¹⁹See the Related GAO Products section at the end of this report.

²⁰Requirements for new weapon system capabilities are expressed as key performance parameters, which are attributes or characteristics of a system that are considered critical or essential to the development of an effective military capability and make a significant contribution to the characteristics of the future joint force.

Better Information and Guidance Could Help DOD to More Effectively Manage and Reduce O&S Costs of Major Weapons Systems

Life-Cycle O&S Cost Estimates for the Production Milestone Were Not Available for Five of the Seven Systems Reviewed

The services did not have the life-cycle O&S cost estimates that were prepared at the production milestone for most of the aviation weapon systems in our sample. Specifically, production milestone O&S cost estimates were available for two of the seven systems we reviewed—the Air Force’s F-22A and the Navy’s F/A-18E/F. We requested cost estimates from a variety of sources, including service and OSD offices that were identified as likely repositories of these estimates. However, service acquisition, program management, and cost analysis officials we contacted could not provide these estimates for the Army’s CH-47D, AH-64D, and UH-60L or the Air Force’s F-15E or B-1B. OSD offices we contacted, including the OSD Deputy Director for Cost Assessment and offices within the Under Secretary of Defense for Acquisition, Technology and Logistics, also could not provide the cost estimates for these five systems.

Without the production milestone cost estimates, DOD officials do not have important information necessary for analyzing the rate of O&S cost growth, identifying cost drivers, and developing plans for managing and controlling these costs. In addition, at a time when the nation faces fiscal challenges and defense budgets may become tighter, the lack of this key information hinders sound weapon-system program management and decision making in an area of high costs to the federal government. In a recent speech,²¹ the Secretary of Defense stated that given the nation’s difficult economic circumstances and parlous fiscal condition, DOD will need to reduce overhead costs and transfer those savings to force structure and modernization within the programmed budget. DOD officials we interviewed noted that the department has not placed emphasis on

²¹Remarks delivered by Secretary of Defense Robert M. Gates in Abilene, Kansas (May 8, 2010).

assessing and managing weapon system O&S costs compared with other priorities. Moreover, our prior work has shown that rather than limit the number and size of weapon system programs or adjust requirements, DOD's funding process attempts to accommodate programs. This creates an unhealthy competition for funds that encourages sponsors of weapon system programs to pursue overambitious capabilities and to underestimate costs.

DOD acquisition guidance has required the development of life-cycle cost estimates for acquisition milestone reviews since at least 1980. Based on the historical acquisition milestones for the five systems with missing estimates, the approximate dates that the production milestone life-cycle O&S cost estimates should have been prepared were 1980 for the Army's CH-47D, 1985 for the Air Force's F-15E, 1989 for the Army's UH-60L and the Air Force's B-1B,²² and 1995 for the Army's AH-64D. Additionally, DOD has been required to obtain independent cost assessments since the 1980s. We requested any independent estimates that had been prepared for the systems we reviewed from the OSD Cost Assessment and Program Evaluation office, but the office could not provide them.²³ The service estimates were prepared in 2000 for the F/A-18E/F and in 2005 for the F-22A. While DOD officials could not explain why life-cycle O&S cost estimates for the other five systems were not available, they said that likely reasons were loss due to office moves, computer failures, and purging of older files. Further, prior DOD and service guidance may not have addressed the retention of cost estimates. The two systems for which cost estimates were available had the most recent production milestones of the systems in our sample.

²²The Air Force's acquisition of the B-1B did not follow DOD's milestone process. Milestone reviews for the B-1B program were not conducted because the program was simultaneously engaged in full-scale development and production. Instead of the milestone process, a system of secretarial program reviews was used that involved the Air Force briefing the Secretary of Defense on the program status, focusing primarily on cost and schedule. We were unable to obtain any acquisition O&S cost estimates for the B-1B, including a cost estimate that the Air Force had planned to prepare in 1989.

²³According to OSD Cost Assessment and Program Evaluation officials, staffing levels did not allow them to begin developing independent life-cycle cost estimates until the early 1990's. Although they could not provide the estimate for the AH-64D, these officials stated they developed an independent cost estimate for a later upgrade to the program (Block 2), and are currently developing one for a new upgrade (Block 3). When we requested that this office provide initial and updated O&S cost estimates for the AH-64D during our review, we were not informed of the existence of the Block 2 cost estimate or provided this estimate.

Under GAO's guidance for cost-estimating best practices, issued in 2009, thorough documentation and retention of cost estimates are essential in order to analyze changes that can aid preparation of future cost estimates.²⁴ However, with the exception of the Army, current DOD and service acquisition and cost estimation guidance do not specifically address requirements for retaining O&S cost estimates and the support documentation used to develop the estimates. For example, although DOD's cost-estimation guidance emphasizes the need for formal, complete documentation of source data, methods, and results, neither it nor DOD's acquisition policy specifically addresses retention of cost estimate documentation.²⁵

- Naval Air Systems Command officials said they retained the production milestone O&S cost estimates for the F/A-18E/F because this was a good practice; however, they were not aware of any Navy guidance that required such retention. While the Navy's current acquisition and cost analysis instructions²⁶ state that records created under the instructions should be retained in accordance with the Navy's records management guidance,²⁷ the records management manual does not clearly identify any requirements for retaining acquisition cost estimates for aircraft.²⁸ In addition, we found that

²⁴GAO, *GAO Cost Estimating and Assessment Guide*, [GAO-09-3SP](#) (Washington, D.C.: March 2009).

²⁵For this analysis, we reviewed guidance in DOD Directive 5000.01, DOD Instruction 5000.02, DOD Directive 5000.04, DOD 5000.4-M, and OSD's *Operating and Support Cost Estimating Guide*.

²⁶Secretary of the Navy Instruction 5000.2D, *Implementation and Operation of the Defense Acquisition System and the Joint Capabilities Integration and Development System* (Oct. 16, 2008) and Secretary of the Navy Instruction 5223.2, *Department of the Navy Cost Analysis* (Dec. 16, 2008).

²⁷Secretary of the Navy Manual M-5210.1, *Records Management Manual* (November 2007 Revision).

²⁸The guidance broadly describes categories of records and does not explicitly include requirements for retaining acquisition cost estimates, other than for ships.

although the estimate for the F/A-18E/F was retained, some of the supporting documentation was incorrect or incomplete.²⁹

- The Air Force's acquisition and cost estimation guidance is also unclear with regard to retention of cost estimates. An Air Force acquisition instruction³⁰ states that the program manager is responsible for developing appropriate program documentation and for maintaining this documentation throughout the life cycle of the system, as well as maintaining a realistic cost estimate and ensuring it is well documented to firmly support budget requests. However, we did not find any references to retaining cost estimates specifically related to acquisition milestones in either this instruction or other Air Force acquisition and cost estimation guidance.³¹
- Only the Army's current acquisition regulation states that all documentation required by the milestone decision authority for each milestone review must be retained on file in the program office for the life of the program, although the regulation does not make specific reference to retaining the O&S cost estimate.³² The production milestones for the three Army systems we reviewed predate the Army's current regulation, which was issued in 2003.

²⁹For example, the flying hours contained in the Cost Analysis Requirements Description did not match the flying hours used to develop the cost estimate. The Cost Analysis Requirements Description is a complete description of the system whose costs are to be estimated; it is intended to define the program to a sufficient level of detail such that no confusion exists between the many parties who may be concerned with estimating the program's cost. Additionally, some data were not complete—there was not enough detail provided to substantiate the factors chosen, the regression formulas used, or the exact inflation factors that were employed.

³⁰Air Force Instruction 63-101, *Acquisition and Sustainment Life Cycle Management* (Apr. 17, 2009).

³¹Air Force Instruction 63-101; Air Force Instruction 63-1201, *Acquisition: Life Cycle Systems Engineering* (July 23, 2007); Air Force Instruction 65-508, *Financial Management: Cost Analysis Guidance and Procedures* (Oct. 1, 1997); Air Force Policy Directive 65-5, *Financial Management: Cost and Economics* (Aug. 5, 2008).

³²Army Regulation 70-1, *Army Acquisition Policy: Research, Development and Acquisition* (December 2003). This guidance is located in an appendix to the regulation.

Complete Data on Actual O&S Costs Were Not Collected in the Services' VAMOSOC Systems

The services' VAMOSOC systems did not collect complete data on actual O&S costs. The Air Force's and Navy's systems did not collect actual cost data for some cost elements that DOD guidance recommends be collected, and the Army's system was the most limited. Additionally, we found that data for some cost elements were not accurate. DOD guidance recommends—but does not require—that the cost element structure used for life-cycle O&S cost estimating also be used by the services to collect and present actual cost data. Such guidance, if followed, could enable comparisons between estimated and actual costs. Some O&S cost data that are not collected in the VAMOSOC systems may be found in other of the services' information systems or from other sources. However, these data may not be readily available for the purpose of analyzing weapon system O&S costs. Without complete data on actual O&S costs, DOD officials do not have important information necessary for analyzing the rate of O&S cost growth, identifying cost drivers, and developing plans for managing and controlling these costs.

Air Force's VAMOSOC System

While the Air Force's VAMOSOC system collected actual cost data on many of DOD's recommended cost elements, it did not collect data on some cost elements for the weapon systems we reviewed. For example, the Air Force's VAMOSOC system did not collect actual O&S costs for support equipment replacement, modifications, or interim contractor support. According to service officials, the F-22A, the F-15E, and the B-1B incurred support equipment replacement and O&S modification costs, and the F-22A incurred interim contractor support costs. Air Force officials responsible for the VAMOSOC system told us that actual cost data on these three cost elements are contained in another information system, the Air Force General Accounting and Finance System—Reengineered, but the data are not identifiable because procurement officials often do not apply the established accounting and budgeting structure when they entered into procurement contracts. Further, the Air Force lacks a standard structure for capturing contractor logistics support costs that could provide additional visibility over both procurement and O&S costs. For example, although program officials said the F-22A was supported under interim

contractor support in 2006 and 2007,³³ no F-22A interim support costs were included in the VAMOSOC system.

Further, according to officials, a recent change in the way the Air Force funds repair parts also introduced inaccuracies into that service's VAMOSOC system. Starting in fiscal year 2008, the Air Force centralized the funding of its flying operations at higher-level commands that support a number of aircraft and bases. For example, the Air Force Material Command now funds flying operations for most active units. Prior to that time, the Air Force provided funding for repair parts directly to lower-level organizational units that paid for each part when ordered. Under the new process, the higher-level commands provide funding for repair parts to the Air Force Working Capital Fund based on the anticipated number of flying hours and an estimated rate necessary to purchase repair parts per hour of use. Since repair parts funding is now based on such estimates, there have been differences between the amounts provided and the actual costs incurred. For example, officials indicated that in fiscal year 2008 overpayments of \$430 million were provided for repair parts, and in fiscal year 2009 the overpayment amount was \$188 million. Although the total overpayment amount can be identified, the Air Force cannot identify which specific programs overpaid, so the entire overpayment amount was recorded against the B-1B's O&S costs in the Air Force accounting system. VAMOSOC system officials were aware of this inaccuracy and removed the amount from the B-1B's O&S costs within the VAMOSOC system. However, because these officials said they do not have the information necessary to apply the appropriate amount of the refund to the appropriate programs, they placed the funds into an account not associated with a particular weapon system. Therefore, the actual O&S costs for repair parts reported by VAMOSOC system could be inaccurate for one or more weapon systems for at least the past 2 years.

Navy's VAMOSOC System

For the F/A-18E/F, the Navy's VAMOSOC system collected data on many of DOD's recommended cost elements but did not collect actual O&S costs for interim contractor support costs, civilian personnel, and indirect

³³Although the F-22A was supported by interim contractor support before fiscal year 2006, OSD cost-estimating guidance states that postoperational contractor support is an O&S cost. The F-22A reached initial operating capability in December 2005. According to program officials, subsequent interim contractor support costs were \$730.6 million in calendar year 2006 and \$632.1 in calendar year 2007. (We adjusted DOD data to reflect constant fiscal year 2010 dollars.) While not all of these costs may be O&S costs, none of the amounts were included in the Air Force's VAMOSOC system.

infrastructure costs by weapon system. Navy officials responsible for the VAMOSC system told us it did not collect interim contractor support costs because the Navy considers these to be procurement rather than O&S costs. According to Navy officials, the F/A-18E/F incurred interim contractor support costs prior to fiscal year 2003.³⁴ Navy officials are currently attempting to add direct civilian personnel costs from the Navy's Standard Accounting and Reporting System. However, since it is difficult to identify these costs by weapon system, aggregated civilian personnel costs are currently captured within a separate section of the VAMOSC system. In addition, Navy officials said indirect infrastructure costs are captured in the aggregate within a separate section of the VAMOSC system and are not reported within the O&S costs of each weapon system. According to Navy officials, these indirect infrastructure costs are not available by weapon system because of the time and resources that would be necessary to match real property records—indicating the use of the facility—to command installation records that contain the costs to operate the facility.

Further, we found that some of the cost elements in the Navy's VAMOSC systems were not accurate. For example, the Navy's VAMOSC system did not separately report F/A-18E/F costs for intermediate-level repair parts and materials and supplies. According to Navy officials, intermediate-level costs were included as unit-level repair parts and materials and supplies due to the way the Navy's accounting system captures these costs. Also, officials noted that support equipment maintenance costs were inaccurate because some of these costs were subsumed under other cost elements. Further, Navy officials said that the VAMOSC system reported costs for all F/A-18E/F modifications, including those that added capabilities and those that improved safety, reliability, maintainability, or the performance characteristics necessary to meet basic operational requirements. According to OSD guidance, modifications to add capabilities are considered a procurement cost and therefore should not be reported as an O&S cost in the VAMOSC system. According to Navy officials, they are

³⁴As noted previously in our discussion of the F-22A, OSD cost-estimating guidance states that postoperational contractor support is an O&S cost. According to budget data provided by Navy officials, interim contractor support costs could be as high as \$86.6 million in fiscal year 2000, \$75.3 million in fiscal year 2001, and \$73.3 million in fiscal year 2002 (in then year dollars). However, these amounts also include some funding for government activities. Further, additional amounts for interim contractor support were funded out of other budget line items but the amounts were unknown.

unable to separate the different types of modification costs in order to provide visibility for the O&S modification costs.

Army's VAMOSC System

Compared with the Navy's and Air Force's systems, the Army's VAMOSC system is the most limited in terms of actual O&S cost data collected. For the three types of Army aircraft we reviewed, the VAMOSC system consistently collected data for unit-level consumption cost elements: fuel, materials and supplies, repair parts, and training munitions. Costs for depot maintenance, while collected in the system, are not presented in the OSD-recommended cost element structure. The system does not include personnel cost data and instead provides a link to another database. In addition, Army officials said the VAMOSC system generally collected costs for only government-provided logistics support and currently contained costs for two weapon systems supported under contractor logistics support arrangements (the Stryker armored combat vehicle and UH-72A Light Utility Helicopter).³⁵ Further, Army officials said that the costs for materials and supplies and for repair parts were added to the VAMOSC system when the items were transferred to the unit instead of when they were actually used. Also, many of the costs were allocated based on demand, quantity, and price assumptions. That is, if more than one weapon system used a repair part, the costs for this part were allocated to each weapon system based on the number of aircraft. While this may be a reasonable allocation method, the VAMOSC system may not reflect the actual O&S costs for the weapon systems that used the part.

We reported on deficiencies of the Army's VAMOSC system in 2000.³⁶ Our prior work found that the Army did not have complete and reliable data on actual O&S costs of weapon systems. Specifically, the Army's VAMOSC system did not collect data on O&S cost elements such as contractor logistics support, supply depot support, and software support. Further, we reported that the VAMOSC system did not contain cost data on individual

³⁵While the use of contractor logistics support arrangements, including performance-based logistics arrangements, also affect the level of detail of costs reported in the Air Force and Navy VAMOSC systems, these systems generally include contractor logistics support costs in the aggregate. DOD relies heavily on these arrangements to support selected weapon systems. We have previously reported that detailed support cost data were often not available for DOD weapon systems supported by contractor logistics support and performance-based logistics arrangements. GAO, *Defense Logistics: Improved Data and Cost Analysis Needed to Evaluate the Cost-Effectiveness of Performance Based Logistics Arrangements*, [GAO-09-41](#) (Washington, D.C.: Dec. 19, 2008).

³⁶GAO, *Defense Acquisitions: Higher Priority Needed for Army Operating and Support Cost Reduction Efforts*, [GAO/NSIAD-00-197](#) (Washington, D.C.: Sept. 29, 2000).

maintenance events, such as removal and assessment of failed parts. We concluded that without complete O&S cost data, Army program managers could not assess cost drivers and trends in order to identify cost-reduction initiatives. Although we recommended that the Army improve its VAMOS system by collecting data on additional O&S cost elements, the Army has not made significant improvements. According to Army officials responsible for the VAMOS system, it was designed to collect information from other information systems. Therefore, it cannot collect data on other cost elements unless another information system captures these costs. According to Army officials, two information systems that the Army is developing—the General Fund Enterprise Business System and the Global Combat Support System—may enable the service to collect additional O&S cost data in the future.

Even with these planned information systems, it is unclear what additional O&S cost data will be collected, how quickly the Army will be able to incorporate the data into its VAMOS system, what resources may be needed, or what additional limitations the service may face in improving its VAMOS system. Army officials, for example, do not expect the General Fund Enterprise Business System to become fully operational until the end of fiscal year 2012, and full operation of the Global Combat Support System will occur later, in fiscal year 2015. Army officials also said while they have requested that additional O&S cost data be collected by weapon system, it is too early to tell whether these data will be collected.

The Services Generally Do Not Use Updated Life-Cycle Estimates to Assess O&S Cost Growth for Fielded Weapon Systems

Life-Cycle O&S Cost Estimates Were Not Periodically Updated after Fielding for Six of the Seven Systems Reviewed

For six of the seven systems selected for our review, the services did not periodically update life-cycle O&S cost estimates after the systems were fielded, even though most of the systems have been in DOD's inventory for over a decade. Only the program office for the F-22A had updated its production milestone cost estimate. According to Office of Management and Budget guidance on benefit-cost analysis,³⁷ agencies should have a plan for periodic, results-oriented evaluation of the effectiveness of federal programs. The guidance also notes that retrospective studies can be valuable in determining if any corrections need to be made to existing programs and to improve future estimates of other federal programs. In addition, cost-estimating best practices call for such estimates to be regularly updated.³⁸ The purpose of updating the cost estimates is to determine whether the preliminary information and assumptions remain relevant and accurate, record reasons for variances so that the accuracy of the estimate can be tracked, and archive cost and technical data for use in future estimates. Despite the benefit-cost analysis guidance and cost-estimating best practices, service officials for six of the seven aviation weapon systems we reviewed could not provide current, updated O&S cost estimates that incorporated actual historical costs or analysis of actual costs compared to the estimate prepared at the production milestone. While cost estimates were prepared for major modifications to some of the systems in our review, these estimates were limited in scope and did not incorporate actual cost data.

The Air Force's updated life-cycle O&S cost estimate for the F-22A illustrates the potential magnitude of changes in O&S costs that a weapon system may experience over its life cycle. When the F-22A program office updated the 2005 cost estimate in 2009, it found a 47-percent increase in life-cycle O&S costs.³⁹ The 2009 estimate of about \$59 billion to operate and support the F-22A is \$19 billion more than was estimated in 2005. The increase in life-cycle O&S costs occurred despite a 34-percent reduction in fleet size from 277 aircraft projected in the 2005 estimate to 184 aircraft projected in the 2009 estimate. The program office also compared the two estimates to identify areas of cost growth. According to the program office, the projected O&S cost growth was due to rising aircraft repair

³⁷Office of Management and Budget, Circular A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (Oct. 29, 1992).

³⁸[GAO-09-3SP](#).

³⁹Throughout this report, all percentage calculations are based on unrounded numbers.

costs, unrealized savings from using a performance-based logistics arrangement to support the aircraft, an increased number of maintenance personnel needed to maintain the F-22A's specialized stealth exterior, military pay raises that were greater than forecast, and personnel costs of Air National Guard and Air Force Reserve units assigned to F-22A units that were not included in the production milestone estimate.

A 2007 independent review by the Air Force Cost Analysis Agency also projected future O&S cost growth for the F-22A. According to Air Force Cost Analysis Agency officials, the review was initiated because cost data showed the F-22A's cost per flying hour was higher than projected in the 2007 President's Budget, prompting concerns that the future O&S costs of the aircraft were underestimated. Specifically, the fiscal year 2007 actual cost per flight hour was \$55,783, about 65 percent higher than the \$33,762 projected in the 2007 President's Budget.⁴⁰ The Air Force Cost Analysis Agency estimated that in 2015 (when the system would be fully mature), the F-22A's projected cost per flight hour would be \$48,236, or 113 percent higher than the \$22,665 cost per flight hour in 2015 that had been estimated in 2005.⁴¹ The estimated cost per flight hour increased

- \$8,174 because fixed O&S costs did not decrease in proportion to the reductions in the number of planned aircraft (277 to 183) and annual flight hours per aircraft (366 to 277);
- \$4,005 because the formula used in the 2005 estimate to calculate the cost to refurbish broken repair parts understated the potential costs;
- \$2,414 for engine depot maintenance costs due to higher-than-previously-projected engine cycles⁴² per flying hour;
- \$2,118 for higher costs for purchasing repair parts not in production or with diminishing manufacturing sources;
- \$2,008 because of unrealized economies of scale for repair parts due to smaller quantity purchases (based on reduced aircraft and flying hours);

⁴⁰We adjusted DOD data to reflect constant fiscal year 2010 dollars. Further, the Air Force Cost Analysis Agency used the cost data available in the Air Force VAMOS system at the time of their review. The fiscal year 2007 cost per flight hour currently reported in the Air Force's VAMOS system for the F-22A, in constant fiscal year 2010 dollars, is \$54,690.

⁴¹According to Air Force officials, the F-22A is currently expected to reach maturity in late 2010, when the fleet has reached 100,000 flight hours.

⁴²An "engine cycle" refers to one movement of the throttle from idle to full power and then back to idle.

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- \$1,670 for additional costs for munitions maintainers, training munitions, and fuel consumption associated with a new capability—an air-to-ground mission; and
 - \$1,641 for additional maintenance due to lower levels of weapon system reliability than projected in the production milestone O&S cost estimate.

The remaining \$3,542 cost per flight hour increase identified by the Air Force Cost Analysis Agency's review was due to changes in personnel requirements, a new requirement to remove and replace the stealth coating mid-way through the aircraft's life, labor rate increases, immature engine repair procedures, and the administrative cost of Air National Guard units assigned to active duty units or active duty units assigned to Air Force Reserve or Air National Guard units.

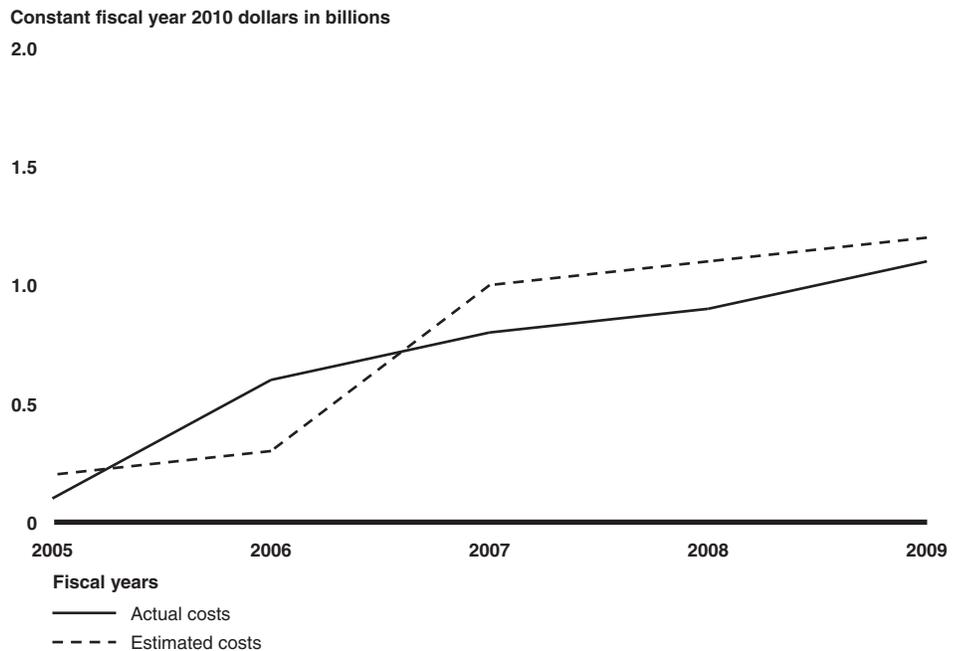
Program Changes over Time Complicate Comparisons of Estimated to Actual O&S Costs for Two Systems

For the two aviation systems where both estimated and actual O&S cost data were available, we found that although there were some areas of cost growth, direct comparisons between estimated and actual costs were complicated in part because of program changes that occurred after the estimates were developed at the production milestone. For example, the Air Force and Navy had fewer F-22A and F/A-18E/F aircraft, respectively, in their inventories and flew fewer hours than planned when the estimates were developed. In addition, a recent, OSD-sponsored study of the Air Force's C-17 aircraft identified various changes that can occur over a weapon system's life-cycle and lead to O&S cost growth. For the C-17, these changes included factors internal to the program, factors external to the program, and changes in accounting methods. (The findings from that study are summarized in app. II.)

Analysis of Estimated and Actual O&S Costs for the F-22A

Our analysis showed that actual O&S costs for the Air Force’s F-22A totaled \$3.6 billion from fiscal years 2005 to 2009, excluding amounts for interim contractor support. This amount compared to \$3.8 billion projected for these years in the 2005 production milestone O&S cost estimate. (Fig. 1 shows estimated and actual costs for each year.) However, the Air Force had 125 aircraft in its inventory in fiscal year 2009 rather than the 143 aircraft projected in the 2005 cost estimate. Also, the aircraft fleet actually flew 68,261 hours over this time period rather than the 134,618 hours projected in the 2005 cost estimate. On a per flight hour basis, the fiscal year 2009 actual O&S costs were \$51,829, or 88 percent higher than the \$27,559 forecast in 2005 after accounting for inflation.

Figure 1: Comparison of Estimated and Actual O&S Costs for the Air Force’s F-22A (Fiscal Years 2005-2009)



Source: GAO analysis of Air Force data.

Note: The information presented in this figure is subject to limitations in the data contained in the Air Force’s VAMOS system, as discussed earlier in this report.

The use of contractor logistics support for the F-22A further complicated comparisons of actual costs to the estimated costs developed in 2005. Although the F-22A has been supported under contractor logistics support arrangements since before 2005, the estimates included the costs for government-provided logistics support of the aircraft. For example, for

fiscal years 2005 through 2009, the O&S cost estimate projected that contractor logistics support would cost \$736 million. However, actual contractor logistics support costs for the F-22A were \$2.1 billion. For fiscal years 2005 through 2009, F-22A contractor logistics support costs were 60 percent of the total actual O&S costs reported in the Air Force's VAMOS system. Due to the use of this support arrangement, however, the Air Force's VAMOS system reports all of the amounts paid to the F-22A contractor under a single cost element instead of under multiple individual cost elements. In contrast, program officials confirmed that various contractor-provided cost elements—such as repair parts, materials and supplies, depot maintenance, and sustaining support—were included in the production milestone O&S cost estimate as separate items. Further, according to officials, prior to 2008 the program office did not obtain from the contractor cost reports that provide details of how the amounts paid to the contractor were spent in terms of DOD's recommended O&S cost elements by fiscal year.⁴³ Therefore, it is not possible to compare a significant amount of the actual O&S costs for the F-22A to the production milestone estimate at the cost element level.

Of the remaining F-22A O&S costs not covered by contractor logistics support, mission personnel costs constituted the largest proportion—approximately 22 percent—of the total actual O&S costs reported for fiscal years 2005 through 2009. Compared with the estimates developed in 2005, actual mission personnel costs were \$34 million (20 percent) higher for fiscal year 2008 and \$113 million (62 percent) higher for fiscal year 2009. The 2005 estimate provided for 1,335 maintenance personnel for each F-22A wing (which was projected to number 72 aircraft), but according to Air Force officials the current authorized personnel for an F-22A wing (now numbering 36 aircraft) is 1,051 maintenance personnel. While the number of aircraft per wing was reduced by half, the number of personnel was reduced by about 21 percent. According to officials, although the change in wing composition from three squadrons of 24 aircraft to two squadrons of 18 aircraft reduced personnel requirements, additional personnel who were not included in the 2005 estimate are now required to support the aircraft's added air-to-ground mission, an

⁴³According to program officials, during fiscal year 2008 the Air Force modified the F-22A support contract and began requiring the contractor to provide detailed cost reports to the program office by fiscal year for both the airframe and the engines. However, officials told us they did not yet have the finalized reports for fiscal year 2009 for use in our analysis. Air Force cost analysis officials confirmed the data were not in the database that contains these reports.

Analysis of Estimated and
Actual O&S Costs for the F/A-
18E/F

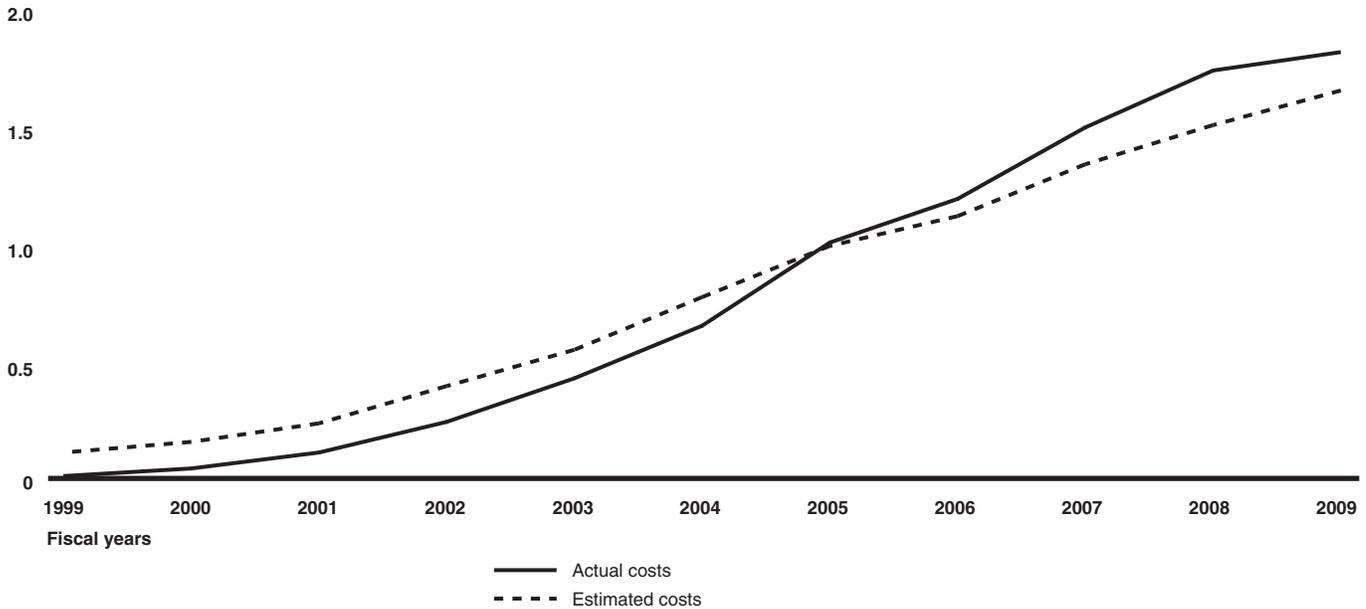
increased maintenance requirement for the aircraft's stealth exterior, and other maintenance requirements that were determined through a 2007 staffing study.⁴⁴ In addition, Air National Guard and Air Force Reserve units were not included in the 2005 estimate, so the personnel costs of these units resulted in higher actual costs. Finally, as noted in the F-22A program office's 2009 update to the life-cycle O&S cost estimate, military pay raises given to service members were greater than forecast in the production milestone estimate.

Our analysis for the Navy's F/A-18E/F showed that total actual O&S costs for fiscal years 1999 through 2009 were about \$8.7 billion. This amount compares to the \$8.8 billion projected for these years in the 1999 production milestone O&S cost estimate. However, program changes complicate direct comparisons between estimated and actual costs, as they do for the F-22A. For example, the Navy estimated that it would have 428 aircraft in fiscal year 2009, but the actual number of aircraft was 358, about 16 percent less. Similarly, the Navy estimated that the aircraft fleet as a whole would fly 780,628 hours from fiscal year 1999 through 2009, but the aircraft fleet actually flew 625,067 hours, or 20 percent less. On a per flight hour basis, the fiscal year 2009 O&S costs were \$15,346, 40 percent higher than the \$10,979 forecast in 1999. Although total actual costs were less than estimated for the 11-year period, actual annual costs for fiscal years 2005 through 2009 have exceeded the annual estimates by an average of 10 percent after accounting for inflation (see fig. 2).

⁴⁴According to the officials, the Air Force uses actual maintenance data to periodically reassess the personnel necessary to support an aircraft. In 2007, the Air Force performed such an assessment for the F-22A, resulting in an increase of maintenance personnel assigned to the F-22A.

Figure 2: Comparison of Estimated and Actual O&S Costs for the Navy's F/A-18E/F (Fiscal Years 1999-2009)

Constant fiscal year 2010 dollars in billions



Source: GAO analysis of Navy data.

Note: The information presented in this figure is subject to limitations in the data contained in the Navy's VAMOS system, as discussed earlier in this report.

With regard to individual cost elements, our comparison of actual O&S costs for fiscal years 1999 through 2009 to those projected in the 1999 estimate found that actual costs for fuel, modifications, depot maintenance, and intermediate maintenance were higher than originally estimated while training costs were much lower. (App. III presents a more detailed comparison of actual and estimated O&S costs for the F/A-18E/F.) In discussing findings from this comparison with cost analysts at the Naval Air Systems Command, they provided the following explanations for key changes we identified:

- Fuel costs were higher than estimated because the price of fuel has increased overall since the estimate was developed in 1999. Further, when the estimate was developed, it was assumed the F/A-18E/F aircraft's fuel consumption would be similar to that of the F/A-18C/D. However, this did not prove to be an accurate analogy, and the F/A-18E/F's fuel consumption has been higher than that of the earlier model aircraft. The analysts also said that some of the increased fuel costs for fiscal year 2005 through 2009 may also be attributed to

increased refueling activity of the F/A-18E/F after the retirement of the S-3B aircraft.⁴⁵

- Depot maintenance costs were higher than estimated, in part because the engine was repaired by a contractor under a performance-based logistics arrangement, but the estimate projected costs for government-provided support. The government repair estimate included a large initial investment of procurement funds—which are not considered O&S costs—for spare parts. The Navy subsequently changed the engine repair concept to a performance-based logistics arrangement with less expensive spare parts and reduced the initial investment by about 15 percent. However, as a result of the new arrangement, depot maintenance costs increased. Further, the 1999 estimate purposefully excluded some engine depot-maintenance costs in order to keep a consistent comparison with similar costs for the F/A-18A-D models. (These costs were instead included in the estimate as costs for repair parts.) However, after adjusting for these issues, actual engine depot maintenance costs in fiscal years 2007 and 2009 were higher by a total of approximately \$64 million, and Navy officials could not explain this variance. Additionally, the production milestone estimate developed in 1999 included costs for support equipment replacement, which are not captured in the Navy’s VAMOSC system.
- Actual costs for aviation repair parts were higher than estimated after removing the costs that should have been included as engine depot-maintenance costs from the estimate.
- Intermediate-level maintenance costs were higher than projected because the estimate did not include personnel costs for shore-based, intermediate-level maintenance.
- Modification costs were higher than projected because the Navy’s VAMOSC system collected costs for all procurement-funded modifications, including those that added capabilities, while the estimate only projected costs for flight-safety modifications.
- Training costs were lower than estimated because the Navy’s VAMOSC system did not include actual nonmaintenance training costs such as

⁴⁵According to Navy officials, when F/A-18E/F aircraft are assigned to tanking duty and obtain fuel both for aircraft consumption and delivery to other aircraft via their tanking system, the total cost of this fuel is charged to the tanking squadron and is reported in the Navy’s visibility system.

initial pilot and naval flight officer training and installation support costs. These costs were included in the cost estimate.

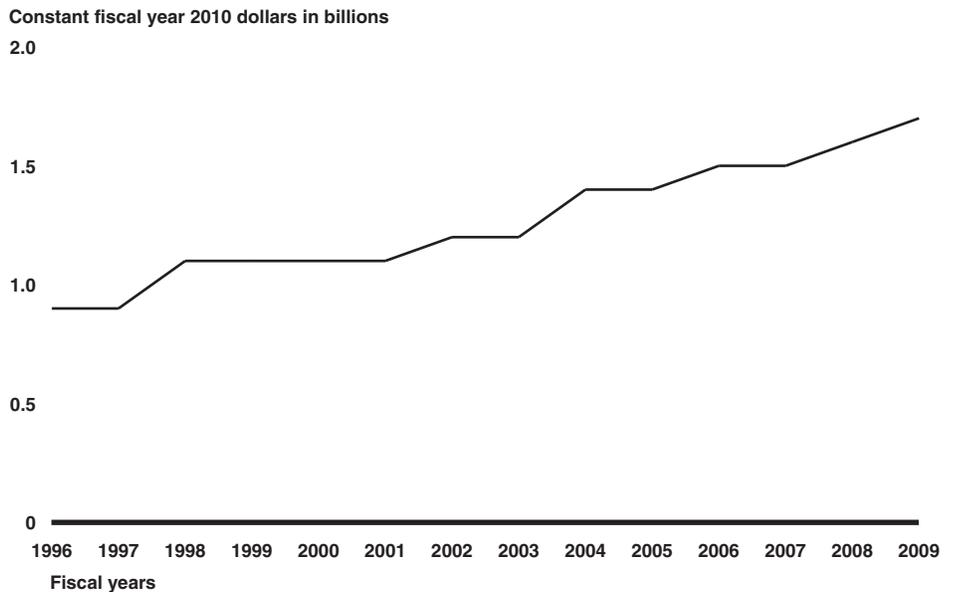
Actual O&S Costs Increased for Five Systems, but Extent of Planned Cost Growth Is Uncertain

Although we did not have production milestone estimates of life-cycle O&S costs for the Air Force's F-15E and B-1B or for the Army's AH-64D, CH-47D, and UH-60L, we reviewed changes in actual O&S costs for each system and found that costs increased over time for a variety of reasons. As noted earlier, some cost elements are not maintained in the services' VAMOSOC systems or are not accurate, and our analysis was subject to these limitations. Furthermore, we could not determine the extent to which the cost growth was planned since the services could not provide us with the O&S cost estimates developed for the production milestone. According to service cost analysis officials, actual O&S costs for these systems were likely higher than estimated because such estimates are typically based on peacetime usage rather than wartime usage assumptions. Further, service cost analysts said that since the late 1990's actual costs for repair parts have grown faster than the OSD inflation rates that are used to develop O&S cost estimates.

Actual O&S Costs for the F-15E for Fiscal Years 1996 through 2009

Total actual O&S costs for the Air Force's F-15E increased 82 percent from \$944 million in fiscal year 1996 to \$1.7 billion in fiscal year 2009 (see fig. 3). The number of F-15E aircraft increased 8 percent from 200 to 215 during this time period, and the number of flight hours increased 7 percent from 60,726 to 65,054. Per aircraft, O&S costs increased 69 percent from \$5 million to \$8 million over this period, and the cost per flight hour increased 70 percent from \$15,538 to \$26,408.

Figure 3: Actual F-15E O&S Costs for Fiscal Years 1996-2009



Source: GAO analysis of Air Force data.

Note: The information presented in this figure is subject to limitations in the data contained in the Air Force's VAMOS system, as discussed earlier in this report.

Our analysis found that personnel, fuel, repair parts, and depot maintenance accounted for about 95 percent of the overall increase in F-15E O&S costs from fiscal years 1996 to 2009. For example, actual personnel costs grew by \$73 million (19 percent) over the period. Most of the growth was due to wage increases rather than increases in the number of personnel. Also, fuel costs increased \$142 million (18 percent) during these years. According to program officials, this increase was mainly due to higher fuel prices rather than increased consumption. Cost for repair parts grew \$398 million (51 percent), and program officials attributed some of this growth to higher costs for materials used during depot repair, as well as higher prices paid for labor, storage, and handling. Further, officials said that several avionics systems on the F-15E have been replaced and the costs to repair some of the new components are higher. Depot maintenance costs increased \$124 million (16 percent) and program officials said this increase was due to increasing rates for depot work, noting that the Air Logistics Centers increased their rates because of

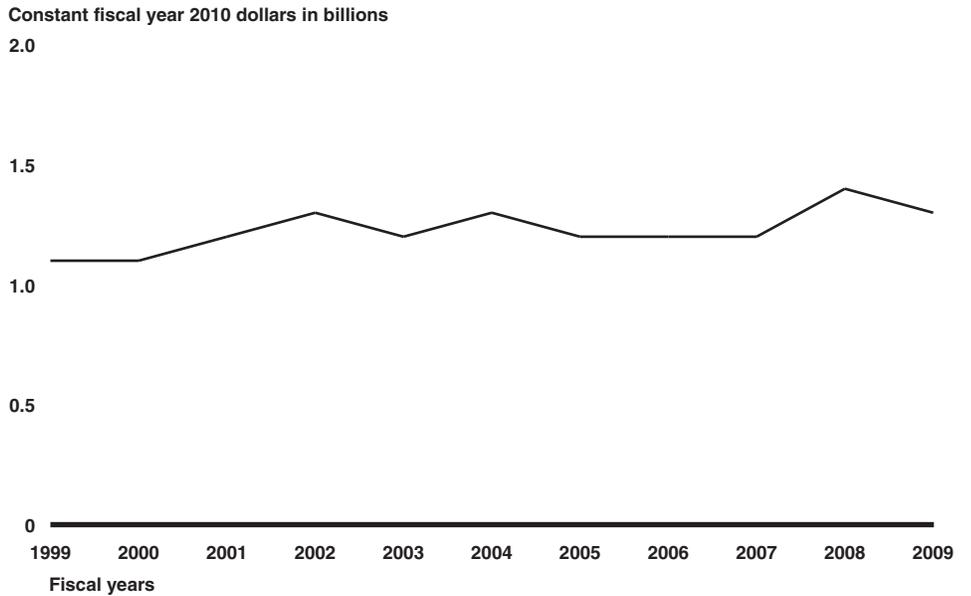
Actual O&S Costs for the B-1B
for Fiscal Years 1999 through
2009

higher material costs.⁴⁶ Also, officials said that as aircraft age the number of subsystems that require repair increases, which results in additional tasks being required during planned depot maintenance. For example, the F-15C/Ds that are expected to fly until 2025 will be completely rewired in planned depot maintenance because the original wiring is deteriorating. A similar program is planned in the future for the F-15Es and is expected to significantly increase the cost of planned depot maintenance for that aircraft.

Annual actual O&S costs for the Air Force's B-1B increased 21 percent from \$1.1 billion in fiscal year 1999 to \$1.3 billion in fiscal year 2009 (see fig. 4). This cost growth occurred despite a 29 percent reduction in the aircraft fleet from 93 to 66 during the same period. Per aircraft, O&S costs increased 71 percent from \$11 million to \$19 million, and the cost per flight hour increased 23 percent from \$46,224 to \$56,982.

⁴⁶In 2004, we reported that the per-hour price charged by the Air Force's Air Logistics Center for F-15E repair and maintenance increased 42 percent in 2003 and that the cost increases were due largely to higher material costs, which accounted for 67 percent of the increase. See GAO, *Air Force Depot Maintenance: Improved Pricing and Cost Reduction Practices Needed*, [GAO-04-498](#) (Washington, D.C.: June 17, 2004).

Figure 4: Actual B-1B O&S Costs for Fiscal Years 1999-2009



Source: GAO analysis of Air Force data.

Note: The information presented in this figure is subject to limitations in the data contained in the Air Force's VAMOS system, as discussed earlier in this report.

Our analysis showed that fuel, repair parts, and depot maintenance accounted for 97 percent of the overall increase in B-1B O&S costs from fiscal years 1999 through 2009. Fuel costs increased \$89.4 million (40 percent), which program officials attributed mainly to higher fuel costs and increased utilization of the aircraft in recent years. Program officials reported that in each of the last 3 full fiscal years (2007, 2008, and 2009), the hourly utilization rate per aircraft was 46 percent, 51 percent, and 54 percent higher, respectively, than in fiscal year 1999. According to the program office, the increased cost for repair parts, which grew \$51.9 million (23 percent), was due to the increased cost of materials consumed in the refurbishment of repair parts. Depot maintenance costs increased \$77.1 million (34 percent), and program officials said this increase was due to higher utilization of aircraft, increased labor and material costs,⁴⁷ and changes in cost accounting.

⁴⁷In our 2004 report, [GAO-04-498](#), we found the per hour price charged by the Air Logistics Centers for work performed on the B-1B increased 65 percent in 2003.

Actual O&S Costs for the AH-64D, CH-47D, and UH-60L for Fiscal Years 1998 through 2007

The Army's O&S data on unit-level consumption costs for the AH-64D, CH-47D, and UH-60L showed that all three experienced significant cost growth from fiscal years 1998 through 2007.⁴⁸ However, as table 2 shows, the size of the fleets and numbers of flying hours also increased, with the AH-64D experiencing the greatest growth. According to Army officials, fiscal year 1998 costs reflected peacetime training only, whereas data for fiscal year 2007 also includes costs for units deployed in Afghanistan and Iraq. O&S costs for deployed units constituted more than half of the total O&S dollars for these aircraft in fiscal year 2007.⁴⁹

Table 2: Changes in Army Helicopter Inventory, Flight Hours, and Unit-Level Consumption Costs between Fiscal Year 1998 and Fiscal Year 2007

Weapon system	Number of aircraft			Number of flying hours			Unit-level consumption costs (constant fiscal year 2010 dollars in millions) ^a		
	Fiscal year 1998	Fiscal year 2007	Percent increase	Fiscal year 1998	Fiscal year 2007	Percent increase	Fiscal year 1998	Fiscal year 2007	Percent increase
AH-64D	24 ^b	567	2,263%	994	158,030	15,798%	\$5	\$757	15,384%
CH-47D	415	446	7	58,311	99,743	71	189	488	159
UH-60L	453	605	34	79,126	180,446	128	103	498	382

Source: GAO analysis of Army data.

Notes: The information presented in this figure is subject to limitations in the data contained in the Army's VAMOSOC system, as discussed earlier in this report.

^aDue to the way the Army's VAMOSOC system collects and reports costs, these costs also include materials and supplies for intermediate-level maintenance.

^bThe Army began fielding the AH-64D in fiscal year 1998.

Measured by flight hour, Army unit-level consumption costs increased 51 percent per flight hour for the CH-47D and 111 percent per flight hour for the UH-60L, and decreased 3 percent per flight hour for the AH-64D, from fiscal year 1998 to 2007. As discussed earlier in the report, unit-level consumption costs reported in the Army's VAMOSOC system include fuel, materials and supplies, repair parts, and training munitions. As shown in table 3, fuel costs increased by more than 140 percent for all three

⁴⁸We used fiscal year 1998 data as our starting point because that was the first year that data for all three systems were available in the Army's VAMOSOC system. We ended our analysis in fiscal year 2007 because the Army had not yet transferred its fiscal year 2008 or 2009 data into the cost element structure recommended by DOD's guidance.

⁴⁹According to officials, wartime O&S costs were 60 percent of the total O&S costs reported in fiscal year 2007 for the AH-64D; 54 percent for the CH-47D; and 72 percent for the UH-60L.

systems, the costs of materials and supplies and repair parts also increased for each system, and the cost of training munitions decreased. The decreased cost of training munitions drove the overall decrease in unit-level consumption costs for the AH-64D, and a program official stated this was likely due to the significant amount of training conducted during the initial fielding of the AH-64D in 1998.

Table 3: Percent Change in Army Helicopter Unit-Level Consumption Costs per Flight Hour between Fiscal Year 1998 and Fiscal Year 2007

Weapon system	Increase or decrease in unit-level consumption cost element			
	Fuel	Materiel/supplies ^a	Repair parts	Training munitions
AH-64D	161%	67%	20%	-74%
CH-47D	142	68	35	-44
UH-60L	142	42	140	-54

Source: GAO analysis of Army data.

Notes: The information presented in this figure is subject to limitations in the data contained in the Army's VAMOS system, as discussed earlier in this report.

^aDue to way the Army's VAMOS system collects and reports costs, these costs also include materials and supplies for intermediate-level maintenance.

Updated Estimates of Life-Cycle O&S Costs and Documentation of Program Changes Are Generally Not Required after Weapon System Production Decisions

Even though periodic updates to life-cycle O&S cost estimates could quantify any cost growth in major weapon systems and help identify cost drivers, DOD acquisition and cost-estimating guidance do not require that O&S cost estimates be updated after a program has completed production. Service guidance that we reviewed does not consistently and clearly require the updating of O&S cost estimates after a program has completed production. Additionally, although our review showed program changes can have a large effect on actual O&S costs after cost estimates are developed at the production milestone, DOD and service acquisition guidance do not require program offices to maintain documentation of such changes for use in cost analysis.

Federal law requires that a full life-cycle cost analysis for each major defense acquisition program be included in the programs' annual Selected

Acquisition Reports to Congress.⁵⁰ Requirements related to Selected Acquisition Reports, however, end when a weapon system has reached 90 percent of production.⁵¹ In addition, we found that for the systems we reviewed, the estimated O&S costs included in the Selected Acquisition Reports were sometimes not updated.⁵² For our sample, the estimated O&S costs included in the annual reports for the F-22A remained unchanged from 2005 through 2007, and the services did not have current updated life-cycle O&S cost estimates for the other six weapon systems we reviewed. Further, while life-cycle costs are required to be reported in the Selected Acquisition Reports, OSD officials noted that the calculation of the estimate may be inconsistent. For example, cost analysts at the Naval Air Systems Command maintain a cost-estimating model for the F/A-18E/F that is regularly updated and used to develop O&S cost estimates for the Selected Acquisition Reports and other analyses to improve cost effectiveness. However, the methodology used to develop the Navy's cost estimates for the Selected Acquisition Reports differs from the methodology used to develop life-cycle cost estimates for acquisition milestone decisions and includes significantly more infrastructure costs. According to the Naval Air System Command guidance, the estimates for the Selected Acquisition Reports are not comparable to the acquisition milestone life-cycle cost estimates without adjusting for the different ground rules and assumptions used. The estimates for the Selected Acquisition Reports also are not comparable to the costs reported in the Navy's VAMOS system.

DOD acquisition policy requires the services to provide life-cycle O&S cost estimates for decisions made during specific points in the acquisition process, including the production decision, but neither this policy nor

⁵⁰Selected Acquisition Reports, required under 10 U.S.C. § 2432, are the standard, comprehensive, summary status report of major defense acquisition programs periodically submitted to Congress. They contain key cost, schedule, and performance information. The requirement for submission of a Selected Acquisition Report may be waived under certain circumstances. DOD began providing Selected Acquisition Reports to Congress in the late 1960s.

⁵¹DOD is required to provide Selected Acquisition Reports to Congress on major weapon systems until 90 percent of the total quantity of items to be delivered under the program have been delivered or 90 percent of planned expenditures under the program have been made.

⁵²In some cases, DOD included life-cycle costs in its Selected Acquisition Reports; however, the life-cycle costs included in the reports to Congress were not detailed enough to enable us to assess the reasons for O&S cost growth.

DOD's cost-estimating guidance require O&S cost estimates for systems that have been fielded. In a December 2008 memorandum, DOD also required that several metrics, including an ownership cost metric,⁵³ be reported quarterly for all major weapon defense acquisition programs. However, this quarterly reporting policy does not currently apply to weapon systems that have completed production and are no longer reporting information in the Selected Acquisition Reports to Congress. Of the weapon systems we reviewed, program offices for the AH-64D, F-22A, and F/A-18E/F currently provide Selected Acquisition Reports to Congress.

The Army regulation and Navy instructions we reviewed do not address updating life-cycle O&S cost estimates for systems that have been fielded.⁵⁴ Although the Air Force has a directive requiring annual updates to program cost estimates, it does not specifically mention life-cycle O&S cost estimates. An Air Force directive issued in August 2008 includes the requirement that major acquisition program cost estimates be updated annually and used for acquisition purposes, such as milestone decisions, and other planning, programming, budgeting, and execution decisions.⁵⁵ The directive also states that it is applicable to organizations that manage both acquisition and sustainment programs. However, as mentioned earlier, service and OSD officials were unable to locate O&S cost estimates for the F-15E and the B-1B aircraft. According to Air Force cost analysis and policy officials, the requirement for annual cost estimate updates is applicable to programs no longer in acquisition, but they are still developing the Air Force instruction that will contain more specific guidance for implementing the 2008 directive. The officials expect that, once issued, the Air Force instruction will clarify the requirement to update O&S cost estimates annually.

In addition, changes in weapon system programs affected the assumptions used in production-milestone life-cycle O&S cost estimates, but DOD and service acquisition guidance that we reviewed do not explicitly require the services to maintain documentation of program changes affecting O&S

⁵³This metric is addressed further in our discussion of DOD initiatives to address O&S costs.

⁵⁴Army Regulation 70-1; Secretary of the Navy Instruction 5000.2D; Secretary of the Navy Instruction 5223.2.

⁵⁵Air Force Policy Directive 65-5.

costs. According to federal standards for internal control,⁵⁶ information should be recorded and communicated to management and others within the entity who need it and in a form and within a time frame that enables them to carry out their internal control and other responsibilities. Also, managers need to compare actual performance to planned or expected results and analyze significant differences.

DOD Has Departmentwide and Service-Specific Initiatives to Address Weapon System O&S Costs

Several Departmentwide Initiatives Address Weapon System O&S Costs

DOD has several departmentwide initiatives to address weapon system O&S costs. The DOD-wide Reduction in Total Ownership Costs–Special Interest Program, initiated in 2005, is aimed at reducing weapon system O&S costs by improving reliability and maintainability and reducing total ownership costs in weapon systems that are already fielded. Program funding totaled about \$25 million in fiscal year 2009. For its 15 funded projects, DOD forecasts total ownership cost savings for fiscal years 2006 through 2011 to be \$9.5 billion, with an average 60 to 1 return on investment.⁵⁷ For example, according to officials, the program is funding an effort to develop trend analysis software to diagnose and resolve problems with the F/A-18 aircraft.

Other departmentwide initiatives seek to better manage O&S costs of major weapon systems during the acquisition process. Some of these initiatives address factors we previously identified as negatively affecting DOD’s ability to manage O&S costs. In 2003, we reported that DOD did not consider O&S costs and readiness as key performance requirements for

⁵⁶GAO, *Standards for Internal Control in the Federal Government*, [GAO/AIMD-00-21.3.1](#) (Washington, D.C.: November 1999).

⁵⁷According to officials, projected savings are based on estimated return on investment developed prior to project funding.

new weapon systems and placed higher priority on technical performance features. In 2007, DOD began requiring the services to establish an ownership cost metric during the requirements determination and acquisition processes for weapon systems in order to ensure that O&S costs are considered early in decision making. According to current Joint Staff guidance,⁵⁸ the ownership cost metric and reliability metric are key system attributes of the sustainment (or materiel availability) key performance parameter.⁵⁹ While the ownership cost metric includes many of OSD's recommended O&S cost elements, such as energy (fuel, oil, petroleum, electricity, etc.), maintenance, sustaining support, and continuous system improvements, it does not include personnel and system-specific training costs. In 2008, OSD expanded the use of the ownership cost and materiel reliability metrics, along with the materiel availability key performance parameter, to all major defense acquisition programs that provide information to Congress in Selected Acquisition Reports. In a July 2008 memorandum intended to reinforce the use of the life-cycle metrics, OSD requested that these programs develop target goals for each metric within 60 days.⁶⁰ In a December 2008 memorandum, OSD asked the services to begin reporting against the target goals on a quarterly basis.⁶¹ According to OSD officials, they are working with the services to improve the accuracy and submission of the reported cost information.

We also previously noted that DOD used immature technologies in designing its weapon systems, which contributed to reliability problems and acted as a barrier to using manufacturing techniques that typically help reduce a system's maintenance costs. DOD has identified insufficient reliability designed in the system during acquisition as one of the key

⁵⁸Chairman of the Joint Chiefs of Staff, *Manual for the Operation of the Joint Capabilities Integration and Development System* (July 31, 2009).

⁵⁹As noted earlier, a key performance parameter is an attribute or characteristic of a system that is considered critical or essential to the development of an effective military capability that makes a significant contribution to the characteristics of the future joint force. A key system attribute is considered most critical or essential for an effective military capability but, since not selected as a key performance parameter, provides decision makers with an additional level of capability prioritization below the key performance parameter.

⁶⁰Under Secretary of Defense for Acquisition, Technology and Logistics, Memorandum for Secretaries of the Military Services, *Implementing a Life Cycle Management Framework* (July 31, 2008).

⁶¹Under Secretary of Defense for Acquisition, Technology and Logistics, Memorandum for Secretaries of the Military Departments, *Implementation of Life Cycle Sustainment Outcome Metrics Data Reporting* (Dec. 11, 2008).

reasons for increases in O&S costs. Based on the recommendation of the DOD Reliability Improvement Working Group, DOD's primary acquisition instruction was updated in 2008 to include guidance directing program managers to develop reliability, availability, and maintainability strategies that include reliability growth as an integral part of design and development. Further, the instruction states that reliability, availability, and maintainability shall be integrated within systems engineering processes; documented in system plans; and assessed during programmatic reviews.⁶²

DOD has also taken steps to improve the information available for cost estimating and monitoring of actual O&S costs. In 2008, we reported that for the performance-based logistics arrangements we reviewed, program offices often did not have detailed cost data that would provide insights regarding what the program office was spending for various aspects of the support program.⁶³ That same year, DOD's primary acquisition instruction was updated to include a requirement that sustainment contracts provide for detailed contractor cost reporting for certain major programs to improve future cost estimating and price analysis.⁶⁴ However, the instruction does not provide details as to the timing or content of such cost reporting. Officials in OSD Cost Assessment and Program Evaluation are currently drafting additional guidance to clarify the cost-reporting requirement.

Additionally, OSD Cost Assessment and Program Evaluation initiated an effort in 2008 to collect actual operational testing and evaluation information and make it available to cost analysts for use in developing weapon system cost estimates. According to OSD officials, actual test data could improve these estimates by providing cost analysts more accurate information. In support of the initiative, the services have collected over 150 test data reports from their operational testing agencies. Although cost analysis officials indicated that they have not yet used the test data in preparing cost estimates, there is a high level of interest in the information contained in the test reports as evidenced by the number of times the data have been accessed. Officials noted that research is ongoing, particularly

⁶²DOD Instruction 5000.02.

⁶³[GAO-09-41](#).

⁶⁴DOD Instruction 5000.02.

within the Army, to develop quantitative tools that link operational test results with O&S cost estimates.

The Services Have Initiatives to Help Them Better Manage Aviation System O&S Costs

The services also identified initiatives to help them better manage aviation system O&S costs. Although one Army command had an O&S cost-reduction program, none of the services had cost-reduction programs implemented servicewide. According to Army officials, the most direct aviation O&S cost-reduction initiative within that service is the Aviation and Missile Life Cycle Management Command's O&S Cost Reduction program. Under the program, the command investigates fielded aviation systems with high failure rates and high costs and attempts to reduce costs by funding projects aimed at reliability improvements, life-cycle extensions, and acquisition cost reductions. According to Army officials, the annual budget for this program is \$10 million to \$12 million per year, and most projects predict at least a 2.5 to 1 return on investment. Examples of funded projects include developing a fuel additive and reducing corrosion in CH-47 aircraft blades. Officials also noted that other Army initiatives during the last several years include a renewed emphasis on the importance of estimating total life-cycle costs during the weapon system acquisition process and the establishment of draft guidance for the inclusion of Operations and Maintenance funding projections within acquisition program affordability charts used during certain weapon system acquisition reviews.⁶⁵ In addition, the Army conducts annual weapon systems reviews at which program managers present current and emerging life-cycle weapon system funding requirements based on the latest Army or program office cost estimate developed for the system. Army officials said these initiatives can help the Army in better managing O&S costs.

While the Navy could not identify initiatives designed specifically to reduce O&S costs for its aviation systems, Navy officials said the Naval Aviation Enterprise, a working group of naval aviation stakeholders, was established in 2004 to meet multiple goals, including exchanging information to reduce O&S costs. Through cross-functional teams, subject-matter experts collaborate to resolve problems and improve operations. The Navy stated that, as a result of this initiative, it achieved O&S cost

⁶⁵These charts provide requirements and funding data for use in these reviews. Currently, the charts include this information only for Procurement; Research, Development, Test and Evaluation; and Military Construction appropriations.

savings of \$50 million from its flying-hour program in fiscal year 2005. Additionally, Navy officials cited the establishment of Fleet Readiness Centers as an initiative that could lead to O&S cost reduction in aviation systems. Created as part of the Base Realignment and Closure process in 2005, the Fleet Readiness Centers aim to improve maintenance efficiency and reduce costs by combining intermediate- and depot-level maintenance personnel. As a result, the Navy expects avoidance of unwarranted maintenance procedures, reduced turnaround times, an increase in completed repairs, and reduced maintenance costs. Although the Navy is expected to achieve cost savings from the Fleet Readiness Centers, we reported in 2007 that the projected savings are likely to be overstated.⁶⁶

The Air Force also lacks initiatives specifically designed to reduce O&S costs of aviation systems. Air Force officials noted, however, that improved management of O&S costs could result from its Expeditionary Logistics for the 21st Century program. The program is a logistics process-improvement effort that was started in 2005 under a larger program called Air Force Smart Operations for the 21st Century, which is the guiding program for all transformation efforts within the Air Force. Although one goal of the program is to reduce O&S costs by 10 percent, Air Force officials said program initiatives to date do not focus on specific weapon systems.

DOD's Recent Assessment Identified Problems and Recommended Actions to Improve Weapon System Product Support

A DOD Product Support Assessment Team led by the Office the Under Secretary of Defense for Acquisition, Technology and Logistics recently concluded a year-long study of weapon system product support, and in November 2009 issued a report with recommendations to improve weapon system life-cycle sustainment.⁶⁷ With regard to O&S costs, the report cited inadequate visibility of O&S costs as one of several problems that hinder weapon system life-cycle support management. According to the report, DOD does not have adequate visibility of O&S costs; lacks a process to systematically track and assess O&S costs; and lacks valid, measurable sustainment metrics to accurately assess how programmatic decisions will

⁶⁶GAO, *Military Base Closures: Projected Savings from Fleet Readiness Centers Likely Overstated and Actions Needed to Track Actual Savings and Overcome Certain Challenges*, [GAO-07-304](#) (Washington, D.C.: June 29, 2007).

⁶⁷DOD, *Weapon System Acquisition Reform Product Support Assessment* (November 2009). Product support is defined as the package of support functions required to maintain the readiness and operational capability of weapon systems, subsystems, software, and support systems.

affect life-cycle costs. Further, the report states that DOD cannot identify, manage, and mitigate major weapon system cost drivers. To address identified deficiencies in O&S cost management, the Product Support Assessment Team recommended (1) establishing an O&S affordability requirement, including linking O&S budgets to readiness, (2) developing and implementing an affordability process with all DOD stakeholders (such as the financial and program management communities), and (3) increasing the visibility of O&S costs and their drivers across the supply chain.

In addition to the deficiencies identified with regard to O&S cost management, the Product Support Assessment Team also found deficiencies in DOD's sustainment governance. Governance is defined by the Product Support Assessment Team as the consistent and cohesive oversight across the management, policies, processes, and decision making for sustainment to ensure that sustainment information is a critical component of weapon system acquisition and throughout the life cycle. The report noted that every programmatic decision made during the life cycle of a weapon system should be made with the knowledge of how that decision will affect the life-cycle support of that system. However, the report stated that this has been difficult within DOD due to the lack of perceived relative importance of long-term costs and lack of valid, measurable support metrics, especially cost projections. To address identified deficiencies in sustainment governance, the Product Support Assessment Team recommended (1) strengthening guidance so that sustainment factors are sufficiently addressed and governed at key life-cycle decision points, (2) issuing DOD policy to require the services to conduct independent logistics assessments⁶⁸ prior to acquisition milestones, and (3) creating a post-initial-operating-capability review that includes an assessment of known support issues and potential solutions. OSD has formed three Integrated Product Teams to further develop and lead the implementation of the Product Support Assessment Team recommendations over a 3-year period. While the report highlighted some of the limitations on assessing and managing O&S costs, the current recommendations do not identify specific actions or enforcement measures.

⁶⁸Independent logistics assessments are a compilation of information that the services recognize as important to their life-cycle product-support governance.

One of the first changes resulting from the Product Support Assessment Team recommendations was a new DOD effort in April 2010 to begin reviews of sustainment costs for all acquisition category ID weapon system programs⁶⁹ and address sustainment factors at milestone decision and other review points during the acquisition process. Under new DOD guidance, program managers for these programs are to use a sustainment chart to facilitate the reviews and provide information on support strategy, metrics, and costs in a standardized format.⁷⁰ Specifically, the chart should include the original O&S cost baseline, as reported in the initial Selected Acquisition Report for the system, as well as current program costs according to the most recent projections. Further, the current estimated total O&S costs for the life cycle of the system should also be included, along with the antecedent system's cost for comparison.

No Single Individual or Entity Is Empowered to Control O&S Costs

A related factor that has historically challenged DOD's ability to reduce weapon system O&S costs is that no single individual or entity within the department is empowered to control these costs. A variety of offices within the services and DOD are involved in the decision making that affects sustainment. Though DOD has designated the program manager as responsible for many aspects of weapon system life-cycle sustainment planning, many decisions and processes are outside of the program manager's control. Using aviation systems as an example, these decisions and processes include budget determination, funding processes, the number and pay of personnel assigned to support aircraft, the number of aircraft procured, the number of hours flown, the aircraft basing locations, and the rates charged by depot maintenance facilities. After the aircraft are produced, program managers have only a limited ability to directly affect O&S costs. Army aviation officials, for example, indicated that during the sustainment phase, program managers control only the budgets for program-related logistics and engineering support, retrofit modifications, and technical manuals, which account for only a small percentage of total O&S costs.

⁶⁹DOD acquisition category I programs are major defense acquisition programs or programs that have been designated as such by the milestone decision authority. An acquisition category ID weapon system is an acquisition category I program for which the milestone decision authority is the Under Secretary of Defense for Acquisition, Technology and Logistics.

⁷⁰Under Secretary of Defense for Acquisition, Technology and Logistics, Memorandum for Secretaries of the Military Departments, *Strengthened Sustainment Governance for Acquisition Program Reviews* (Apr. 5, 2010).

In addition, it is likely that multiple individuals will serve as the weapon system's program manager over its life-cycle. For example, the average tenure for a program manager is roughly 17 months, whereas the average life of a major weapon system often exceeds 20 years. This turnover results in program managers bearing responsibility for the decisions of their predecessors, making it difficult to hold the program manager accountable for growth in the system's O&S costs. Finally, a weapon system's long life-cycle also affects cost-reduction initiatives, as it may take many years for some of the initiatives to produce returns on investment.

Conclusions

In the absence of key information on O&S costs for its major weapon systems, DOD may not be well-equipped to analyze, manage, and reduce these costs. While the military services are required to develop life-cycle O&S cost estimates to support production decisions, DOD cannot fully benefit from these estimates if they are not retained. If cost-estimating best practices are followed, the estimates, among other things, can provide a benchmark for subsequent cost analysis of that system, enable the identification of major cost drivers, and aid in improving cost estimating for future systems. Similarly, in the absence of more complete historical data on a weapon system's actual O&S costs in their VAMOS systems, the services are not in a good position to track cost trends over time, compare these actual costs with previous estimates, and determine whether and why cost growth is occurring. While all the services' VAMOS systems have deficiencies, the Army's system has the greatest limitations. We reported on these limitations 10 years ago and recommended improvements, but the Army has not made significant improvements since then.

Moreover, without periodically updating life-cycle O&S cost estimates and documenting program changes affecting O&S costs after a system is fielded, DOD managers lack information necessary to compare actual performance to planned or expected results, as stated in federal standards for internal control. DOD has begun to recognize that greater management emphasis should be placed on better managing weapon system O&S costs, as indicated by several current and planned initiatives. The department furthermore has acknowledged deficiencies in O&S cost visibility and noted that every programmatic decision made during the entire life cycle of a DOD weapon system should be made with the knowledge of how that decision will affect the life-cycle sustainment of that system. Finally, citing the economic and fiscal challenges the nation faces along with the prospects for greatly reduced defense budgets, the Secretary of Defense

highlighted the need for DOD to take a more aggressive approach to reducing its spending and finding efficiencies where possible in order to better afford its force structure and weapon system modernization priorities. These competing budget priorities provide additional impetus for DOD to manage and reduce weapon system O&S costs.

Recommendations for Executive Action

To improve DOD's ability to manage and reduce O&S costs of weapon systems over their life cycle, we recommend that the Secretary of Defense direct the Under Secretary of Defense for Acquisition, Technology and Logistics and the Director of OSD Cost Assessment and Program Evaluation to take the following five actions:

- Revise DOD guidance to require the services to retain life-cycle O&S cost estimates and support documentation used to develop the cost estimates for major weapon systems. This requirement should apply to cost estimates developed by weapon system program offices and other service offices, including cost analysis organizations. Furthermore, this requirement should include cost estimates prepared during the acquisition process as well as those prepared after a system is fielded.
- Identify the cost elements needed to track and assess major weapon systems' actual O&S costs for effective cost analysis and program management, and require the services to collect and maintain these elements in their VAMOSOC systems. To the extent possible, data collected on actual O&S costs should be comparable to data presented in life-cycle cost estimates. To oversee compliance with this new requirement, DOD should require the services to identify any gaps where actual cost data are not being collected and maintained and to identify efforts, along with timelines and resources, for filling these gaps.
- Direct the Army to develop and implement a strategy for improving its VAMOSOC system. This strategy should include plans for incorporating additional cost elements from other information systems, time frames for expanding on existing cost elements, and resources required to improve the VAMOSOC system.
- Require the services to periodically update their life-cycle O&S cost estimates for major weapon systems throughout their life cycle. These updates should provide an assessment of cost growth since the prior estimate was developed and account for any significant cost and program changes.

-
- Develop guidance for documenting and retaining historical information on weapon system program changes to aid in effective analysis of O&S costs. DOD should determine, in conjunction with service acquisition and cost analysis officials, the types of information needed and the level of detail that should be retained.

We also recommend that the Secretary of Defense require that the Director of OSD Cost Assessment and Program Evaluation retain any independent life-cycle O&S cost estimates prepared by that office along with support documentation used to develop these cost estimates for major weapon systems.

Agency Comments and Our Evaluation

In its written comments on a draft of this report, DOD generally concurred with our recommendations, noting that the department is committed to strengthening its O&S data availability as well as its use of O&S estimates in the governance process for major defense acquisition programs. DOD also stated that it will take steps to update its policy to ensure that O&S cost estimates are retained, along with supporting documentation. Specifically, the department fully concurred with four recommendations and partially concurred with two. The department's written comments are reprinted in appendix IV. DOD also provided technical comments that we have incorporated into this report where applicable.

DOD concurred with our four recommendations to revise guidance to require the services to retain life-cycle O&S cost estimates and support documentation used to develop the cost estimates; develop guidance for documenting and retaining historical information on weapon system program changes to aid in effective analysis of O&S costs; require that the Director of the Cost Assessment and Program Evaluation retain any independent life-cycle O&S cost estimates prepared by that office, along with support documentation used to develop these cost estimates for major weapon systems; and revise DOD guidance to require the services to periodically update life-cycle O&S cost estimates for major weapon systems throughout their life cycle and assess program changes and cost growth. While DOD concurred with our recommendation to periodically update life-cycle O&S cost estimates for major weapon systems, the department noted that the Navy is concerned about the additional cost and personnel related to this requirement. We maintain that periodic estimates that quantify and assess changes in weapon systems O&S costs will assist with the identification of prospective areas for cost reduction and improve DOD's ability to estimate O&S costs in the future. Therefore, the resulting

benefits from periodic analysis of O&S costs will likely be greater than the incremental costs associated with the additional resources.

DOD partially concurred with our recommendation to identify the cost elements needed to track and assess major weapon systems' actual O&S costs for effective cost analysis and program management, require the services to collect and maintain these elements in their VAMOSOC systems, and require the services to identify elements where actual cost data are not being collected and maintained, along with efforts for filling these data gaps. However, the department noted that while DOD will coordinate internally to address this issue, the Director of the Cost Assessment and Program Evaluation office should be directed to take this action in lieu of the Under Secretary of Defense for Acquisition, Technology and Logistics. DOD's comments further noted that these two OSD offices would coordinate with one another to implement other recommendations we made. We have modified our recommendations to reflect that both the Under Secretary of Defense for Acquisition, Technology and Logistics and the Director of the Cost Assessment and Program Evaluation office will need to play key roles in implementing these recommendations.

DOD also partially concurred with our recommendation that the Army develop and implement a strategy for improving its VAMOSOC system. DOD stated that while the Army will develop such a strategy, the Army maintains that its military personnel costs are collected by a separate database, the Army Military-Civilian Cost System, and although the costs are not captured by weapon system fleet, the data are sufficient for O&S cost -estimating purposes. The Army also pointed out that it has made progress in collecting contractor logistics support cost data. Specifically, the Army stated that guidance issued in 2008 has led to cost-reporting requirements (that is, requirements that the contractor provide details regarding support costs by cost element) being included in new support contracts. Further, the Army noted that a future information system should be able to capture contractor support cost data. As we stated in our report, new Army systems may improve the availability of actual O&S cost data. However, these systems are still being developed. Even with these planned information systems, it is unclear what additional O&S cost data will be collected, how quickly the Army will be able to incorporate the data into its VAMOSOC system, what resources may be needed, or what additional limitations the service may face in improving its VAMOSOC system. We based our recommendation on DOD guidance regarding the VAMOSOC systems. As we state in our report, DOD required that the O&S costs incurred by each defense program be maintained in a historical O&S data-collection system and designated the services' VAMOSOC systems as

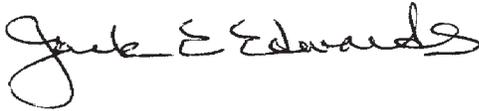
the authoritative source for these cost data. Therefore, we continue to believe the Army needs a strategy for improving the cost data available in its VAMOS system.

While generally concurring with our recommendations, DOD's response noted that there are over 150 major defense acquisition programs across the departments and agencies, ranging from missile defense systems to combat vehicles, with each program having unique challenges in data reporting. Although DOD agreed that our report was reasonable in its analysis of the seven programs reviewed, it emphasized that the problems encountered with our sample may not be found across the entire department. While we solicited DOD's and the services' inputs to try to avoid selecting weapon systems with known data limitations, we agree with DOD and our report clearly states that we selected a nonprobability sample for our review and, therefore, the results cannot be used to make inferences about all major weapon systems. DOD's response also noted that while our report recognizes the recent initiatives the department has established to track and prevent future O&S cost growth, the effects of these initiatives are generally not reflected in the systems we analyzed. According to DOD's comments, a review of at least one pre-major defense acquisition program would have allowed us to assess the potential long-term effect of these initiatives with respect to controlling O&S cost growth. While we agree that a review of the effectiveness of recent initiatives would be beneficial in the future, many of the initiatives were only implemented in the last several years and are likely too new to demonstrate improvements. Further, the scope of our work was limited to a comparison of the original O&S cost estimates developed for selected major weapon systems to the actual O&S costs incurred in order to assess the rate of cost growth. Therefore, we selected systems that had previously passed through DOD's acquisition process, achieved initial operating capability, and been fielded for at least several years. These systems were not affected by DOD's recent initiatives.

We are sending copies of this report to interested congressional committees; the Secretary of Defense; the Secretaries of the Army, the Navy, and the Air Force; the Under Secretary of Defense for Acquisition, Technology and Logistics; and the Director, Office of Management and Budget. In addition, the report will be available at no charge on the GAO Web site at <http://www.gao.gov/>.

If you or your staff have any questions concerning this report, please contact me on (202) 512-8246 or edwardsj@gao.gov. Contact points for our

Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors are listed in appendix V.

A handwritten signature in black ink that reads "Jack E. Edwards". The signature is written in a cursive style with a large, looping initial "J".

Jack E. Edwards
Director, Defense Capabilities and Management

List of Committees

The Honorable Carl Levin
Chairman
The Honorable John McCain
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Daniel K. Inouye
Chairman
The Honorable Thad Cochran
Ranking Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable Ike Skelton
Chairman
The Honorable Howard P. McKeon
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Norman D. Dicks
Chairman
The Honorable C.W. Bill Young
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Appendix I: Scope and Methodology

To conduct our review of growth in operating and support (O&S) costs for major weapon systems, we collected and analyzed data on seven major aviation systems: the Navy's F/A-18E/F; the Air Force's F-22A, B-1B, and F-15E; and the Army's AH-64D, CH-47D, and UH-60L. We focused on aviation systems to enable comparisons of cost growth, where possible, across the selected systems. For example, some factors driving cost growth in an aviation system may be more applicable to other types of aircraft than to maritime or land systems. We selected aviation systems that had reached initial operating capability after 1980 and had incurred several years of actual O&S costs, indicating a level of maturity in the program. The newest system in our sample—the F-22A—has been fielded for about 4 years, and the oldest system—the CH-47D—has been fielded about 17 years. We limited our selection to aviation systems that had relatively large fleets, avoiding low-density systems for which cost data may have been anomalous. We also selected the systems to reflect varied characteristics in terms of military service, mission, and support strategy. However, we did not include a Marine Corps aviation system in our sample because the Naval Air Systems Command manages and supports all Marine Corps aircraft. We also did not select systems with known limitations of available data on actual O&S costs. For example, we have previously reported that some systems supported under performance-based logistics arrangements may not have detailed cost data available because the Department of Defense (DOD) has not required the contractor to provide these data. In considering which systems to select for our review, we also obtained input from DOD and service officials. The results from this nonprobability sample cannot be used to make inferences about all aviation systems or about all major weapon systems because the sample may not reflect all characteristics of the population.

The following is an overview of each system selected for our review:

- The F/A-18E/F Super Hornet is an all-weather attack aircraft as well as a fighter. It performs a variety of missions including air superiority, fighter escort, reconnaissance, aerial refueling, close air support, air defense suppression, and day/night precision strike. The F/A-18E/F entered full rate production in January 2000 and established initial operational capability in September 2001. As of the end of fiscal year 2009, the Navy had 358 F/A-18E/F aircraft.
- The F-22A Raptor is the Air Force's newest fighter aircraft and performs both air-to-air and air-to-ground missions. Officials stated that the program received approval to enter into full rate production in

April 2005 and established initial operating capability in December 2005. Currently, the Air Force plans to buy 187 F-22A aircraft.

- The F-15E Strike Eagle is a dual-role fighter designed to perform air-to-air and air-to-ground missions. Officials indicated that the program received approval to enter into full rate production in early 1986 and established initial operating capability in September 1989. As of the end of fiscal year 2009, the Air Force had 223 F-15E aircraft.
- The B-1B Lancer is a multimission long-range bomber designed to deliver massive quantities (74,000 pounds) of precision and nonprecision weapons. The Air Force received the first B-1B in April 1985 and established initial operating capability in September 1986. As of the end of fiscal year 2009, the Air Force had 66 B-1B aircraft.
- The AH-64D Apache Longbow is the Army's heavy division/corps attack helicopter. It is designed to conduct rear, close, and shaping missions, as well as distributed operations and precision strikes. In addition, the AH-64D is designed to provide armed reconnaissance during day or night, in obscured battlefields, and in adverse weather conditions. The original Apache entered Army service in 1984, and the AH-64D followed in 1998. As of the end of fiscal year 2009, the Army had 535 AH-64D aircraft.
- The UH-60L Black Hawk is a twin-engine helicopter that is used in the performance of the air assault, air cavalry, and aeromedical evacuation missions. The UH-60L is an update to the original UH-60A, which entered Army service in 1979. As of the end of fiscal year 2009, the Army had 564 UH-60L aircraft.
- The CH-47D Chinook is a twin-engine, tandem-rotor transport helicopter that carries troops, supplies, ammunition, and other battle-related cargo. Between 1982 and 1994, the Army upgraded all early models—the CH-47A, B, and C models—to the CH-47D, which features composite rotor blades, an improved electrical system, modularized hydraulics, triple cargo hooks, and more powerful engines. As of the end of fiscal year 2009, the Army had 325 CH-47D aircraft.

To determine the extent to which (1) life-cycle O&S cost estimates developed during acquisition and data on actual O&S costs are available for program management and decision making and (2) DOD uses life-cycle O&S cost estimates for major weapon systems after they are fielded to quantify cost growth and identify its causes, we identified available cost estimates, compared the estimates with actual cost data, and obtained

additional information on how O&S costs are tracked, assessed, managed, and controlled. We requested documentation from the services and the Office of the Secretary of Defense (OSD) on life-cycle O&S cost estimates that the services prepared during acquisition to support the decision to proceed with production of the aircraft in our sample. We also requested documentation of O&S cost estimates that OSD may have independently prepared for this milestone decision. We focused on the production milestone because, while life-cycle cost estimates may be developed during earlier stages of the acquisition process, DOD cost-estimating guidance states that cost estimates for the production milestone should be based on the current design characteristics of the weapon system, the latest deployment schedule, and the latest operation and maintenance concept. In addition, we requested documentation from the services for any current updates to life-cycle O&S cost estimates that may have been developed after the systems were fielded. We also obtained information from weapon system program offices on their practices for retaining information regarding program changes affecting O&S costs. To identify requirements for conducting, updating, and retaining cost estimates, we reviewed Office of Management and Budget guidance, DOD and service acquisition and cost estimation guidance, and federal guidance on cost-estimating best practices.

For actual historical data on weapon system O&S costs, we obtained access to the services' Visibility and Management of Operating and Support Costs (VAMOSOC) systems that have been designated as the authoritative sources of these data. We worked with service cost analysis officials to understand how data in these systems are organized and how to query them for data on our selected aviation systems. To assess the reliability of the data, we surveyed cost analysis officials. For example, we obtained information on specific cost elements that were collected, data sources, and efforts to improve the completeness and accuracy of collected data. We also reviewed DOD and service guidance on the VAMOSOC systems and cost element structure, and we reviewed prior GAO and DOD assessments of the availability of actual O&S cost data for DOD weapon systems. We identified limitations in the data and discuss these in our report. Taking these limitations into account, we determined that the available data were sufficiently reliable to compare estimated to actual costs for the F-22A and F/A-18E/F, the two systems in our sample for which we were able to obtain the production milestone life-cycle O&S cost estimate, and also to present an analysis of changes in actual costs over time for the other five systems.

In comparing estimated to actual costs for the F-22A and the F/A-18E/F, we analyzed differences that occurred each year, determined which cost elements experienced the greatest changes over time, and reviewed how actual program conditions compared to the assumptions used to develop the production milestone cost estimate. In addition, we met with cost analysis experts from the Center for Naval Analyses and the Institute for Defense Analyses and obtained the results of an Institute for Defense Analysis study on O&S costs for the Air Force's C-17 aircraft that had been prepared at the request of the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics. For the five weapon systems in our sample where production milestone life-cycle O&S cost estimates were unavailable, we obtained and analyzed data on actual O&S costs from the services' VAMOSC systems. This analysis was subject to the limitations in the data that we identified for each of the services' VAMOSC systems, as discussed in the report. We met with officials responsible for each selected weapon system to discuss issues related to the management of the program and cost trends. In our analysis of O&S costs, we have adjusted DOD data to reflect constant fiscal year 2010 dollars, unless otherwise noted.¹ Throughout this report, all percentage calculations are based on unrounded numbers.

To identify efforts taken by DOD to reduce O&S costs, we interviewed cognizant OSD and service officials involved in weapon system acquisition, logistics, and program management. For specific initiatives, we obtained documents that described their objectives, time frames, and other information. In addition, we obtained and reviewed pertinent guidance on performance management and internal control practices in the federal government. We also reviewed a report issued in November 2009 by the DOD Product Support Assessment Team. Finally, we also consulted prior O&S studies performed by DOD, the services' audit entities, and GAO.

During our review, we conducted work at the DOD and service offices as shown in table 4 (located in the Washington, D.C., area unless indicated otherwise).

¹Constant dollars measure the value of purchased goods and services at price levels that are the same as those in the base or reference year. Constant dollars do not contain any adjustments for inflationary changes that have occurred or are forecast to occur outside the base year. Therefore, the changes in these dollar amounts will not be due to inflation.

Table 4: Organizations Contacted to Obtain Information on Major Weapon System Operating and Support Costs

Office of the Secretary of Defense	
	Office of the Assistant Deputy Under Secretary of Defense (Materiel Readiness)
	Office of the Director, Defense Research and Engineering, Systems Engineering
	Office of the Director, Acquisition Resources and Analysis, Acquisition Management
	Office of the Director, Cost Assessment and Program Evaluation
Joint Staff, Joint Chiefs of Staff	
Air Force	Directorate of Resource Integration, Weapon Systems Readiness Division, Deputy Chief of Staff for Logistics, Installations and Mission Support
	Directorate of Transformation, Transformation Management Division, Deputy Chief of Staff for Logistics, Installations and Mission Support
	Air Force Fleet Viability Board, Deputy Chief of Staff for Logistics, Installations and Mission Support, Wright-Patterson Air Force Base, Ohio
	Directorate of Studies, Analyses, Assessments and Lessons Learned
	Directorate for Acquisition Integration, Assistant Secretary of the Air Force for Acquisition
	Air Force Cost Analysis Agency
	Air Combat Command, Langley Air Force Base, Virginia
	Air Force Materiel Command, Wright-Patterson Air Force Base, Ohio
	Aeronautical Systems Center, Wright-Patterson Air Force Base, Ohio
	F-15 Development Program Office (912th Aeronautical Systems Group), Wright-Patterson Air Force Base, Ohio
	B-1 Development Program Office (812th Aeronautical Systems Group), Wright-Patterson Air Force Base, Ohio
	F-22 System Program Office (478th Aeronautical Systems Group), Wright-Patterson Air Force Base, Ohio
	Oklahoma City Air Logistics Center, Tinker Air Force Base, Oklahoma
	Warner-Robins Air Logistics Center, Robins Air Force Base, Georgia
Army	Deputy Chief of Staff for Logistics
	Office of the Deputy Assistant Secretary of the Army for Acquisition Policy and Logistics
	Program Executive Office-Aviation, Redstone Arsenal, Alabama
	Apache Helicopters Project Manager's Office, Redstone Arsenal, Alabama
	Cargo Helicopters Project Manager's Office, Redstone Arsenal, Alabama
	Utility Helicopters Project Manager's Office, Redstone Arsenal, Alabama
	Office of the Deputy Assistant Secretary of the Army for Cost and Economics
	Army Materiel Command Headquarters
	Army Aviation and Missile Life Cycle Management Command, Redstone Arsenal, Alabama
	Aviation and Missile Research Development and Engineering Center, Redstone Arsenal, Alabama

Appendix I: Scope and Methodology

Navy	Deputy Chief of Naval Operations (Fleet Readiness and Logistics)
	Deputy Chief of Naval Operations (Integration of Capabilities and Resources)
	Assistant Secretary of the Navy (Research, Development, and Acquisition)
	Naval Center for Cost Analysis
	Naval Air Systems Command, F/A-18 Program Office, Naval Air Station Patuxent River, Maryland
	Naval Air Systems Command, Cost Department, Naval Air Station Patuxent River, Maryland
Other organizations	
	Center for Naval Analyses
	Institute for Defense Analyses

Source: GAO.

We conducted this performance audit from June 2009 through July 2010 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Results of OSD-Sponsored Analysis of C-17 Aircraft

This appendix provides further information on an Office of the Secretary of Defense–sponsored study of operating and support (O&S) cost growth for the Air Force’s C-17 aircraft. The Institute for Defense Analyses (IDA) conducted the study for the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics. According to an IDA analyst, the study began in 2007 and was completed in April 2009. We did not evaluate the study’s methodology, results, or conclusions.

The intent of the study was to demonstrate various analytic methods for monitoring major weapon system reliability, maintainability, availability, and O&S costs against baseline targets throughout the life cycle. IDA obtained O&S cost estimates developed by the Air Force during the acquisition of the C-17,¹ compared them to actual fiscal year 2009 O&S costs (estimated using DOD’s recommended cost element structure), and developed an updated life-cycle cost estimate using actual O&S cost data.² In its report, IDA showed that the C-17’s estimated life-cycle O&S costs increased from \$91.6 billion to \$118.1 billion (29 percent) from 1985 through 2009.³ The estimated cost growth occurred despite a decrease in the total aircraft inventory from a projected 210 down to an actual total of 190.⁴ Further, the study reported that the C-17’s cost per flight hour increased 43 percent from an estimated \$13,989 in 1985 to an estimated \$19,995 in 2009. According to the study, major cost drivers were fuel consumption, materials and supplies, repair parts, airframe overhaul, engine overhaul, and sustaining engineering/program management.

According to IDA’s report, the C-17 program experienced changes during and after acquisition that affected the comparison of the updated O&S cost estimates—developed using actual O&S costs—to the originally estimated O&S costs. The report grouped the factors that caused O&S cost growth

¹The study included the 1985 milestone II estimate, the 1989 milestone low-rate production estimate, and the 1995 milestone IIIB estimate for the C-17.

²According to the IDA analyst, since the C-17 has been supported by a contractor under a performance-based logistics arrangement, actual historical O&S costs were not available in OSD’s recommended cost element structure. As part of the study, the amounts of the various cost elements were estimated using the C-17 support contract, budget data, and other available data in order to update the O&S cost estimate.

³Amounts in constant fiscal year 2009 dollars. The estimates assume a 30-year service life.

⁴Although the IDA analysis was based on a total of 190 aircraft, Air Force officials stated that the current C-17 program of record as of June 2010 is 223 aircraft.

into three categories: internal program factors, external program factors, and accounting factors.

- According to an IDA analyst involved with the study, variances due to internal program factors are defined as those that were influenced by the aircraft's program managers. Such factors identified in the study included system design, reliability, and maintenance support concepts. For example, the report noted that the C-17 transitioned from planned government-provided support to contractor logistics support, and this change greatly complicated the analysis and became a major aspect of the study. IDA attributed cost increases for sustaining engineering/program management, contractor field service representatives, contractor training support, and engine depot-maintenance costs to this change in support concept. Further, the C-17's airframe weight increased during development, which led to increased fuel consumption and higher fuel costs.⁵ Finally, system modifications increased in scope, which led to additional cost increases.
- Changes in costs due to external program factors are defined as those that were generally beyond the control of program managers, according to the IDA analyst. These factors included changes to system quantities or delivery schedules, basing and deployment plan changes, and higher system-operating tempos due to contingencies. For example, the change from 210 to 190 aircraft reduced total costs; a change to the mix of active and reserve units from 73 percent active to 90 percent active increased costs; and personnel costs increased due to growth in incentive pay, housing, and medical care costs.
- Finally, according to the IDA analyst, variances from accounting factors are defined as those that resulted from differences in the way costs were categorized over time. Accounting factor changes that affected C-17 O&S costs included a change in the scope of DOD's indirect costs; changes in personnel accounting; and changes to the timing of the weapon system's phase-in, steady state, and phase-out periods.

On the basis of its C-17 analysis, IDA concluded that any mechanism to track and assess weapon system O&S costs against baseline estimates

⁵According to IDA's study, the C-17's current aircraft operating weight is 6 percent higher than that used in the Air Force's 1985 milestone II estimate.

would require a systematic and institutional methodology that does not currently exist within DOD. According to the report, the methodological approach that was used in the study was ad hoc, labor intensive, and dependent on analyst judgment. The study suggested that, in the absence a more systematic, institutional methodology, DOD could instead track major O&S cost drivers—such as reliability, fuel consumption, maintenance manning per aircraft, and dollars per airframe overhaul. However, the exact metrics DOD used would depend on how the department plans to use the data in managing the O&S costs of its weapon systems and how the data would be used in decision making.

Appendix III: Analysis of Changes between Estimated and Actual O&S Costs for the Navy's F/A-18E/F

This appendix provides a detailed breakdown, by cost element, of total estimated and actual operating and support (O&S) costs for the Navy's F/A-18E/F for the period of fiscal years 1999 through 2009 (see table 5). The estimated costs were obtained from the Navy's O&S life-cycle cost estimates prepared for the 1999 production milestone. Data on actual O&S costs were obtained from the Navy's Visibility and Management of Operating and Support Costs (VAMOSC) system.

Table 5: Comparison of Navy F/A-18E/F Total Estimated and Actual O&S Costs for Fiscal Years 1999-2009

Constant fiscal year 2010 dollars in millions

Cost element	Total estimated O&S costs, fiscal years 1999-2009	Percent of total estimated costs	Total actual O&S costs, fiscal years 1999-2009	Percent of total actual costs	Change in total O&S costs	Percent change
Manpower	\$2,235	25%	\$2,031	23%	\$-204	-9%
Unit-level operations	3,573	41 ^a	4,259	48 ^a	685	19
Fuel	792	9	2,188	25	1,395	176
Materials and supplies	760	9	555	6	-205	-27
Repair parts	1,639	19	1,363	16	-276	-17
Training expendable stores	382	4	153	2	-229	-60
Intermediate maintenance	86	1	452	5	366	428
Depot maintenance	280	3	723	8	443	159
Contractor support	0	0	79	1	79	^b
Sustaining support	2,638	30 ^a	1,139	13 ^a	-1,499	-57
Sustaining engineering	128	2	14	^c	-114	-89
Modifications	742	8	946	11	204	27
Software maintenance	71	1	40	1	-30	-43
Simulator operations	62	1	17	^c	-44	-72
Training	1,635	19	45	1	-1,591	-97
Other	0	0	77	1	77	^b
Indirect support	0	0	36	^c	36	^b
Total	\$8,811	100%	\$8,719	100%^d	-\$92	-1%

Source: GAO analysis of DOD data.

^aThe percentages for the cost subelements listed under the unit-level operations cost element and the sustaining support cost element are shown separately and are also rolled up into the overall percentages for these two cost elements.

^bSince these costs were not included in the production milestone estimate, a percentage increase or decrease could not be calculated.

^cPercentage is less than 1 percent.

^dMay not add to 100 due to rounding.

Appendix IV: Comments from the Department of Defense



LOGISTICS AND
MATERIEL READINESS

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
3500 DEFENSE PENTAGON
WASHINGTON, DC 20301-3500

June 29, 2010

Mr. Jack E. Edwards
Director, Defense Capabilities and Management
U.S. Government Accountability Office
441 G Street, N.W.
Washington, DC 20548

Dear Mr. Edwards,

This is the Department of Defense (DoD) response to the GAO draft report, GAO-10-717, "DEFENSE MANAGEMENT: DoD Needs Better Information and Guidance to More Effectively Manage and Reduce Operating and Support Costs of Major Defense Systems," dated May 21, 2010 (GAO Code 351370).

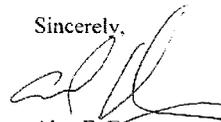
The Department generally concurs with the recommendations presented in the report on more effectively managing and reducing O&S costs for Major Defense Acquisition Programs (MDAPs). There are over 150 MDAPs across the departments and agencies, ranging from missile defense systems to combat vehicles, with each MDAP having unique challenges in data reporting. The report is reasonable in its analysis of the seven programs reviewed, but it does not necessarily follow that problems encountered with that sample are to be found across the entire Department. The Department requests that this point be highlighted in GAO's report.

While the GAO report also indicates that the Department has made significant changes, these changes are generally not reflected in the systems analyzed. Recent changes focus on tracking and preventing future cost growth. GAO missed an opportunity to review pre-MDAPs to assess the potential effectiveness of these initiatives. For instance, for the Joint Lightweight Tactical Vehicle program, reliability and maintainability are being emphasized in the design and engineering phase of the program, with the goal of reducing future maintenance cost and optimizing vehicle readiness, consequently reducing long-term operating and support (O&S) costs. A review of at least one pre-MDAP would have shed light on the long-term impact recent initiatives should have on controlling O&S cost growth.

Further, the Department will take steps to update policy to ensure that O&S cost estimates are retained along with supporting documentation. The Department is committed to strengthening its O&S data availability, as well as its use of O&S estimates in the governance process for MDAPs at each major Milestone.

Detailed DoD comments on the draft GAO recommendations are provided in the attachment. The DoD appreciates the opportunity to comment on the draft report.

Sincerely,



Alan F. Estevez
Principal Deputy

Attachment
As stated

GAO DRAFT REPORT – DATED MAY 21, 2010
GAO CODE 351370/GAO-10-717

**"DEFENSE MANAGEMENT: DoD Needs Better Information and Guidance to
More Effectively Manage and Reduce Operating and Support Costs of Major
Defense Systems"**

**DEPARTMENT OF DEFENSE COMMENTS
TO THE RECOMMENDATIONS**

RECOMMENDATION 1: The GAO recommends that the Secretary of Defense direct the Under Secretary of Defense (Acquisition, Technology and Logistics) (USD(AT&L)) to revise DoD guidance to require the Services to retain life-cycle operating and support (O&S) cost estimates and support documentation used to develop the cost estimates for major weapon systems. This requirement should apply to cost estimates developed by weapon system program offices and other Service offices, including cost analysis organizations. Furthermore, this requirement should include cost estimates prepared during the acquisition process as well as those prepared after a system is fielded.

DOD RESPONSE: Concur. This effort will require coordination between USD(AT&L) and the Director of the Cost Assessment and Program Evaluation.

RECOMMENDATION 2: The GAO recommends that the Secretary of Defense direct the Under Secretary of Defense (Acquisition, Technology and Logistics) (USD(AT&L)) to identify the cost elements needed to track and assess major weapon systems' actual operating and support (O&S) costs for effective cost analysis and program management, and require the Services to collect and maintain these elements in their visibility and management of operating and support cost (VAMOSOC) systems. To the extent possible, data collected on actual O&S costs should be comparable to data presented in life-cycle cost estimates. To oversee compliance with this new requirement, DoD should require the Services to identify any gaps where actual cost data are not being collected and maintained and to identify efforts, along with timelines and resources, for filling these gaps.

DOD RESPONSE: Partially Concur. The Department agrees with the intent of the GAO recommendation; however the Department recommends that the Director of the Cost Assessment and Program Evaluation, Office of the Secretary of Defense be directed to take this action in lieu of USD(AT&L). This effort will require coordination between USD(AT&L) and the Director of the Cost Assessment and Program Evaluation.

RECOMMENDATION 3: The GAO recommends that the Secretary of Defense direct the Under Secretary of Defense (Acquisition, Technology and Logistics) to direct the

Army to develop and implement a strategy for improving its Visibility and Management of Operating and Support Cost (VAMOSOC) System. This strategy should include plans for incorporating additional cost elements from other information systems, time frames for expanding on existing cost elements, and resources required to improve the VAMOSOC system.

DOD RESPONSE: Partially Concur. The Army will develop and implement a strategy to improve its' VAMOSOC system, consistent with the comments below:

The magnitude of Army weapon systems (over 1 million) makes it very difficult to capture every O&S cost element by system. The growth in weapon system operating and support (O&S) costs is primarily related to OPTEMPO costs, which the Army tracks in its VAMOSOC system.

In regards to Military Personnel (MILPERS) costs, these costs are not captured by fleet in the Army. The Deputy Assistant Secretary of the Army for Cost and Economics (DASA(CE)) maintains the Army Military-Civilian Cost System (AMCOS) that provides MILPERS costs for accurate cost estimating purposes. Since manpower requirements for individual systems are known, AMCOS has provided what is required for the military personnel cost portion of system O&S cost estimating.

With respect to Contractor Logistic Support (CLS), the Army has provided guidance on the reporting of contractor logistic support costs. Army Regulation 700-142 (dated 26 March 2008) paragraph 2-15(b)(4)(f) now requires the PM to coordinate with DASA(CE) and Deputy Chief of Staff, G3/5/7, Training Directorate (DAMO-TR), to determine if the system being fielded warrants a demand-based cost factor developed by DASA(CE) in order to generate out-year operations and maintenance funding for support. The PM must then provide updated cost data to the DASA(CE) during the life of the system. This has resulted in program managers adding CLS reporting requirements into the CLS contracts. Significant progress has been made in capturing CLS costs for Operating and Support Management Information System (OSMIS) – in addition to Stryker and Light Utility Helicopter (LUH), Mine Resistant Ambush Protected (MRAP) and Unmanned Aerial Systems (UAS) that are currently reporting data to the Army VAMOSOC system, new CLS contracts include the requirement to report data. CLS reporting by weapon system was designed into the Army's financial new system - CLS reporting by weapon system was designed into General Fund Enterprise Business System.

RECOMMENDATION 4: The GAO recommends that the Secretary of Defense direct the Under Secretary of Defense (Acquisition, Technology and Logistics) (USD(AT&L)) to require the Services to periodically update their life-cycle operating and support (O&S) cost estimates for major weapon systems throughout their life cycle. These updates

should provide an assessment of cost growth since the prior estimate was developed and account for any significant cost and program changes.

DOD RESPONSE: Concur. The Department of Navy views with concern that this valid and necessary requirement that will require additional resources in terms of cost and personnel across the cost estimating and data provider organizations. This effort will require coordination between USD(AT&L) and the Director of the Cost Assessment and Program Evaluation.

RECOMMENDATION 5: The GAO recommends that the Secretary of Defense direct the Under Secretary of Defense (Acquisition, Technology and Logistics) (USD(AT&L)) to develop guidance for documenting and retaining historical information on weapon system program changes to aid in effective analysis of operating and support costs. DoD should determine, in conjunction with Service acquisition and cost analysis officials, the types of information needed and the level of detail that should be retained.

DOD RESPONSE: Concur. This effort will require coordination between USD(AT&L) and the Director of the Cost Assessment and Program Evaluation.

RECOMMENDATION 6: The GAO recommends that the Secretary of Defense require that the Director of OSD Cost Assessment and Program Evaluation retain any independent life-cycle operating and support (O&S) cost estimates prepared by that office along with support documentation used to develop these cost estimates for major weapon systems.

DOD RESPONSE: Concur.

Appendix V: GAO Contact and Staff Acknowledgments

GAO Contact

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Staff Acknowledgments

In addition to the contact name above, the following staff members made key contributions to this report: Tom Gosling, Assistant Director; Tracy Burney; Sandra Enser; Kevin Keith; James Lackey; Charles Perdue; Richard Powelson, Janine Prybyla; Jennifer Spence; and Alyssa Weir.

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