United States Government Accountability Office

GAO

Report to Congressional Committees

April 2006

ELECTRONIC WARFARE

Option of Upgrading Additional EA-6Bs Could Reduce Risk in Development of EA-18G

GAO-06-446

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Option of Upgrading Additional EA-6Bs Could Reduce Risk in Development of EA-18G

GAO Accountability·Integrity·Reliability

Highlights

Highlights of GAO-06-446, a report to congressional committees

Why GAO Did This Study

The EA-6B has conducted airborne electronic attack for all services since 1996. In 2002, the Department of Defense (DOD) completed an analysis of alternatives for the EA-6B that concluded the inventory would be insufficient to meet the DOD's needs beyond 2009. Since then, the services have embarked on separate acquisition efforts to develop airborne electronic attack assets. In 2003, the Navy started development of the EA-18G aircraft to replace the EA-6B. This report was done under the Comptroller General's authority and assesses if (1) DOD's 2002 conclusion that the EA-6B inventory would be insufficient beyond 2009 remains valid for assessing the Navy's future needs, and (2) the acquisition approach used to develop the EA-18G is knowledge-based and might mitigate future risks.

What GAO Recommends

GAO recommends that DOD determine how many EA-6Bs with upgraded electronic suites are needed to deal with the existing and near-term capability gap, and consider procuring them. If DOD does this, it should cancel plans to end the electronic suite production line after 2006. If DOD outfits more EA-6Bs with upgraded electronic suites, it should restructure its EA-18G low-rate initial production plans so that procurement occurs after the aircraft demonstrates it is fully functional. DOD partially concurred with our recommendations.

www.gao.gov/cgi-bin/getrpt?GAO-06-446.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Allen Li, 202-512-4841, lia@gao.gov.

What GAO Found

EA-6B aircraft will be able to meet the Navy's suppression of enemy air defense needs through at least 2017 and the needs of the Marine Corps through 2025-- as long as sufficient numbers of the aircraft are outfitted with upgraded electronics suites. The conclusion that the EA-6B inventory would be insufficient past 2009 was not based on the Navy's requirement for 90 aircraft, but on an inventory requirement of 108 aircraft that would meet the needs of all services. The decision to move to a system of systems using multiple aircraft types means the Navy will no longer be required to support all of DOD's electronic attack requirements. However, insufficient quantities of upgraded jamming systems means that the majority of the EA-6B fleet is equipped with the older jamming system that is limited in its ability to conduct numerous critical functions. If the Navy is required to support all services, given the recent Air Force proposal to terminate its EB-52 standoff jammer program, additional EA-6Bs may require the Improved Capability (ICAP) III upgrade.

The risk of cost growth and schedule delays in the EA-18G program is increasing because the program is not following a knowledge-based approach to acquisition. None of its five critical technologies were fully mature as the system development phase began, and that is still the case today. Of particular concern is the ALQ-218 receiver, placed in the harsh wingtip environment on the EA-18G and not the more benign setting of the EA-6B's tail, for which it was developed. While the EA-18G's design appears stable, and almost all its design drawings are complete, that may change once the aircraft is flight-tested. Production of the EA-18G is also risky: One-third of the total buy will be procured as low-rate initial production aircraft based on limited demonstrated functionality.

EA-18G Mockup: F/A-18F Loaded with Jamming Pods

Source: Copyright 2001 the Boeing Company.

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Abbreviations

AEA	airborne electronic attack
AoA	analysis of alternatives
CCS	Communications Countermeasures Set
DOD	Department of Defense
FRP	full-rate production
J-UCAS	Joint Unmanned Combat Air System
LD/HD	low-density/high-demand
LRIP	low-rate initial production
OPEVAL	operational test and evaluation
SAM	surface-to-air missile
SOJ	Standoff Jammer
SoS	system of systems

GAO
Accountability * Integrity * Reliability

United States Government Accountability Office
Washington, DC 20548

April 26, 2006

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

The Honorable Duncan Hunter
Chairman
The Honorable Ike Skelton
Ranking Minority Member
Committee on Armed Services
House of Representatives

In conducting military operations, U.S. aircraft are often at great risk from enemy air defenses, such as surface-to-air missiles (SAM). The services use specialized aircraft to neutralize, destroy, or temporarily degrade enemy air defense systems through either electronic warfare or physical attack. These aircraft use electronic warfare jammers, which disrupt enemy radar and communications to temporarily suppress enemy air defenses. Other specialized aircraft use antiradiation missiles that home in on radars used by surface-to-air missiles or antiaircraft artillery systems to degrade or destroy them. Because specialized aircraft protect aircraft of all services in hostile airspace, the suppression mission necessarily crosses individual service lines.

Over the past decade, we have issued several reports calling attention to the possibility that our nation's ability to counter such defenses is being degraded. In 1996, for example, we reported that the Department of Defense (DOD) had decided to eliminate the F-4G and EF-111 suppression aircraft without first fielding comparable replacements.[1] Because no replacements were available, the Navy's EA-6B aircraft became DOD's only standoff radar jammer aircraft, providing suppression support for all services. In January 2001, we called attention to the acknowledged gap

[1] GAO, *Combat Air Power: Funding Priority for Suppression of Enemy Air Defenses May Be Too Low*, GAO/NSIAD-96-128, (Washington, D.C.: April 10, 1996).

between the services' suppression capabilities and their needs.[2] The gap was a consequence of the increasing modernization of enemy air defenses that had outpaced DOD's effort to improve its suppression capabilities. At that time, DOD stated that the analysis of alternatives (AoA) for airborne electronic attack (AEA) would provide a basis for its future strategy and lead to a balanced set of acquisition programs for the services. Urgency to complete such an analysis of alternatives was motivated by a projected shortfall of the EA-6B inventory, primarily caused by attrition, and the increasing cost of operating such aging aircraft. The study found that the EA-6B aircraft inventory was declining faster than had been projected and concluded that it would be insufficient to meet DOD's needs beyond 2009. In November 2002 we recommended that a comprehensive strategy was needed to remedy the situation.[3] Since then, the military services have embarked on separate acquisition efforts to develop a future AEA system of systems (SoS) for DOD. In 2003 the Navy started development of the EA-18G aircraft to replace the EA-6B as its contribution to the DOD AEA SoS.

We examined the analysis of alternatives and planned acquisition efforts to determine (1) whether the key conclusion that the projected inventory of EA-6Bs would be insufficient beyond 2009 for all services remains valid for projecting the Navy's future needs and (2) whether the acquisition management approach to developing the Navy's airborne electronic attack core component, the EA-18G, is knowledge-based and can help mitigate future risks. We conducted this work under the Comptroller General's authority and are addressing the report to you because of your committees' jurisdiction on these issues.

To address these objectives, we reviewed the 2002 analysis of alternatives; pertinent DOD, service, and contractor documents addressing the status of the EA-6B inventory; plans for maintaining them; status of EA-6B suppression capabilities; testing conducted for the EA-6B Improved Capability (ICAP) III program; the AEA system of systems; gaps in the AEA; and potential solutions for AEA. We interviewed officials from the Office of the Secretary of Defense, Strategic Command (Offutt, Nebraska); Commander Electronic Attack Pacific Fleet (Whidbey Island); and officials

[2] GAO, *Electronic Warfare: Comprehensive Strategy Needed for Suppression of Enemy Air Defenses*, GAO-01-28 (Washington, D.C.: Jan. 2, 2001).

[3] GAO, *Electronic Warfare: Comprehensive Strategy Still Needed for Suppressing Enemy Air Defenses*, GAO-03-51, (Washington, D.C.: Nov. 25, 2002).

responsible for requirements and programs for the Air Force, Navy, and Marine Corps. We interviewed personnel responsible for ICAP III electronic warfare testing at the Office of the Director, Operational Test and Evaluation (Washington, D.C.); Commander of Operational Test and Evaluation Navy (Norfolk, Virginia); and VX-9 personnel responsible for ICAP III testing at China Lake, California. We discussed airborne electronic attack issues and EA-18G development and production with contractor personnel at Boeing Corporation in St. Louis, Missouri and El Segundo, California. We discussed software matters with officials at China Lake and Point Mugu, California. We met with pilots at Patuxent River Naval Air Station; China Lake, California; Whidbey Island Naval Air Station, Washington; Fallon Naval Air Station, Nevada; and Boeing Corporation to discuss pilot workload issues, the nature of the threat, ICAP III testing, and tactics developed for AEA. As with our past work on the EA-18G development effort conducted under our annual assessment of selected major defense acquisition programs, we focused our work to determining whether the program was following a knowledge-based acquisition approach. We met with Navy EA-18G program officials currently involved with the development effort to document the maturity status of the aircraft's critical technologies, and the status of its design effort and plans for producing the aircraft. We performed our review from May 2005 through March 2006 in accordance with generally accepted government auditing standards.

Results in Brief

The conclusion of the May 2002 AoA report that the EA-6B inventory would be insufficient past 2009 was not based on the Navy's requirement for 90 aircraft, but on an inventory requirement of 108 aircraft that would meet the needs of all services. The subsequent decision to move to a system of systems using multiple aircraft types means the Navy will no longer be required to support all of DOD's electronic attack requirements. As a result, EA-6B aircraft will be able to meet the Navy's suppression of enemy air defense needs through at least 2017 and the needs of the Marine Corps through 2025—as long as sufficient numbers of the aircraft are outfitted with ICAP III electronics suites. However, insufficient quantities of upgraded jamming systems means that the majority of the EA-6B fleet is equipped with the older ICAP II jamming system, which is limited in its ability to conduct numerous critical functions. If the Navy is required to support all services, given the recent Air Force proposal to terminate its EB-52 standoff jammer program, additional EA-6Bs may require the ICAP III upgrade.

While the EA-18G program is currently on cost and schedule, the risk of future cost growth and schedule delays in the program is increasing because the development effort is not fully following the knowledge-based approach inherent in best practices and DOD's acquisition guidance. A knowledge-based approach encourages managers to attain high levels of knowledge at key points to support investment decisions, ensuring, for example, that technologies are mature before starting development and that the design is stable before beginning manufacturing. The EA-18G entered system development without demonstrating that its five critical technologies had reached full maturity, and that is still the case today. Although three technologies are now very close to maturity, two have not been demonstrated as they will exist on the aircraft. While the EA-18G's design appears stable, the potential for costly design changes remains until all its technologies are mature. Driven by the expected decline in the EA-6B inventory, the program plans to make a decision to enter low-rate initial production in April 2007 to meet a required 2009 initial operational capability. DOD acknowledges that the EA-18G development schedule is aggressive. By adhering to this target, whose premise is no longer valid given the Navy's projected needs; the development schedule is unnecessarily compressed. Further, one-third of the aircraft will be purchased during low-rate initial production based on limited demonstrated functionality. This could result in the need to retrofit already produced EA-18G aircraft, a possibility that the Navy is already anticipating. Software mature enough to test whether the aircraft is fully functional will not be available until after the production decision. A fully functioning EA-18G aircraft, one that meets or exceeds the upgraded EA-6B ICAP III capability, will not complete operational testing until January 2009–3 months before the projected full-rate production decision.

This report recommends that the Secretary of Defense consider the option of procuring the necessary number of EA-6Bs equipped with ICAP III to deal with the existing and near-term capability gap. It also recommends that if DOD follows this course, the Secretary direct extension of ICAP III production for the EA-6B. It further recommends that if DOD acquires additional ICAP III capability, it restructure the EA-18G procurement so that it demonstrates the aircraft is fully functional before committing to a large low-rate initial production plan. In commenting on a draft of this report, DOD partially concurred with our recommendations. DOD agreed that refinement of Navy Electronic Attack inventory is needed, but believes that it was premature to make a decision on ICAP III production until ICAP III inventory requirements are determined. Determination of this and other AEA issues are expected on September 15, 2006 after completion of an AEA study directed by the Deputy Secretary of Defense.

Background

The four-seat EA-6B Prowler aircraft conducts missions for all services. The AEA mission is focused on protecting U.S. aircraft and ground forces by disabling enemy electronic capabilities. The EA-6B performs this mission with a complement of electronic receivers and jammers, referred to as its electronic suite, which are located on the aircraft structure and in external pods attached to its wings. A development effort is currently under way to replace the EA-6B with a two-seater electronic attack variant of the F/A-18F, designated the EA-18G Growler.

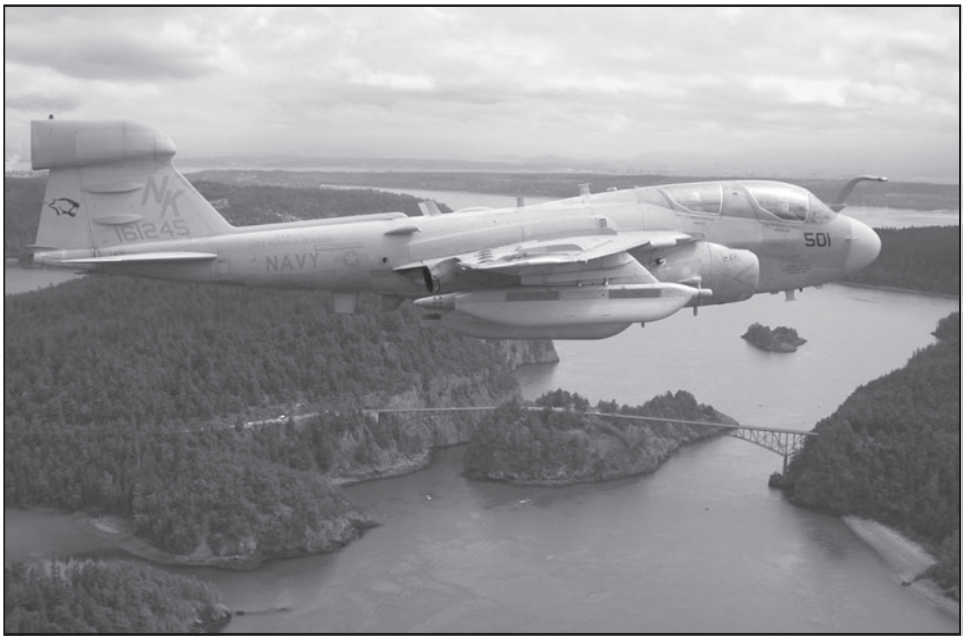
The EA-6B joined the Navy's fleet in January 1971. The EA-6Bs's initial deployment was in 1972 over the skies of Southeast Asia. Since the early 1990s, use of the EA-6B has steadily increased. In 1991 the aircraft was used in Operation Desert Storm and in support of Iraqi "no-fly" zones instituted after that war. In 1995, the EA-6B was selected to become the sole tactical radar support jammer for all services after the Air Force decided to retire its fleet of EF-111 aircraft. This decision resulted in increased use of the EA-6B. Since 1995 the Prowler force has provided AEA capability during numerous joint and allied operations against both traditional and nontraditional threats. It was used to provide support for Operation Allied Force in Kosovo and for peacekeeping operations over Bosnia-Herzegovina and Yugoslavia, and is currently being used against traditional and nontraditional target sets in support of ground forces. These capabilities continue to be demonstrated in the Global War on Terrorism, in which EA-6B operations in Afghanistan and Iraq protect coalition forces and disrupt critical communications links.

There have been several upgrades to the EA-6B's electronic suite since it was initially fielded to address increased threats faced by U.S. forces. The standard version, fielded in 1971, was quickly replaced in 1973 with the expanded capability EA-6B, which augmented the electronic countermeasure coverage of the aircraft. In 1977, the Improved Capability version entered service, and was followed by a more sophisticated ICAP II version, first deployed in 1984. The EA-6B/ICAP II featured updated receivers, displays, and software to cover a wider range of known surveillance and surface-to-air missile radars. As a result of heavy use and the limited inventory of the EA-6B, the Joint Chiefs of Staff directed that the inventory of EA-6Bs be managed as low-density/high-demand (LD/HD) assets. Low-density/high demand assets are force elements consisting of major platforms, weapon systems, or personnel that possess unique mission capabilities and are in continual high demand to support worldwide joint military operations. In 1998 an ICAP III upgrade was initiated to address capability gaps against threats from mobile surface-to-air missile systems. In addition, concerns surfaced about an anticipated

decline in the EA-6B inventory because of structural fatigue issues. As a result, an AEA analysis-of-alternative was started in 1999 to find a replacement for the EA-6B. At that time it was anticipated that the EA-6B would remain in the inventory until at least 2015.

Plans, as recently as December 2001, were to upgrade all 123 EA-6B aircraft in the inventory to the ICAP III configuration. The ICAP III provides rapid emitter detection, identification, geolocation, selective reactive jamming, and full azimuth coverage. Also, ICAP III-equipped EA-6Bs will have the ability to integrate multiple EA-6Bs to match any threat density, and to control other manned or unmanned assets. The upgrade is needed to address capability gaps in the ICAP II electronic suite presently installed in EA-6B aircraft. The EA-6B ICAP III production line is currently scheduled to shut down after the fiscal year 2006 buy.

Figure 1: EA-6B Improved Capability III



Source: U.S. Navy.

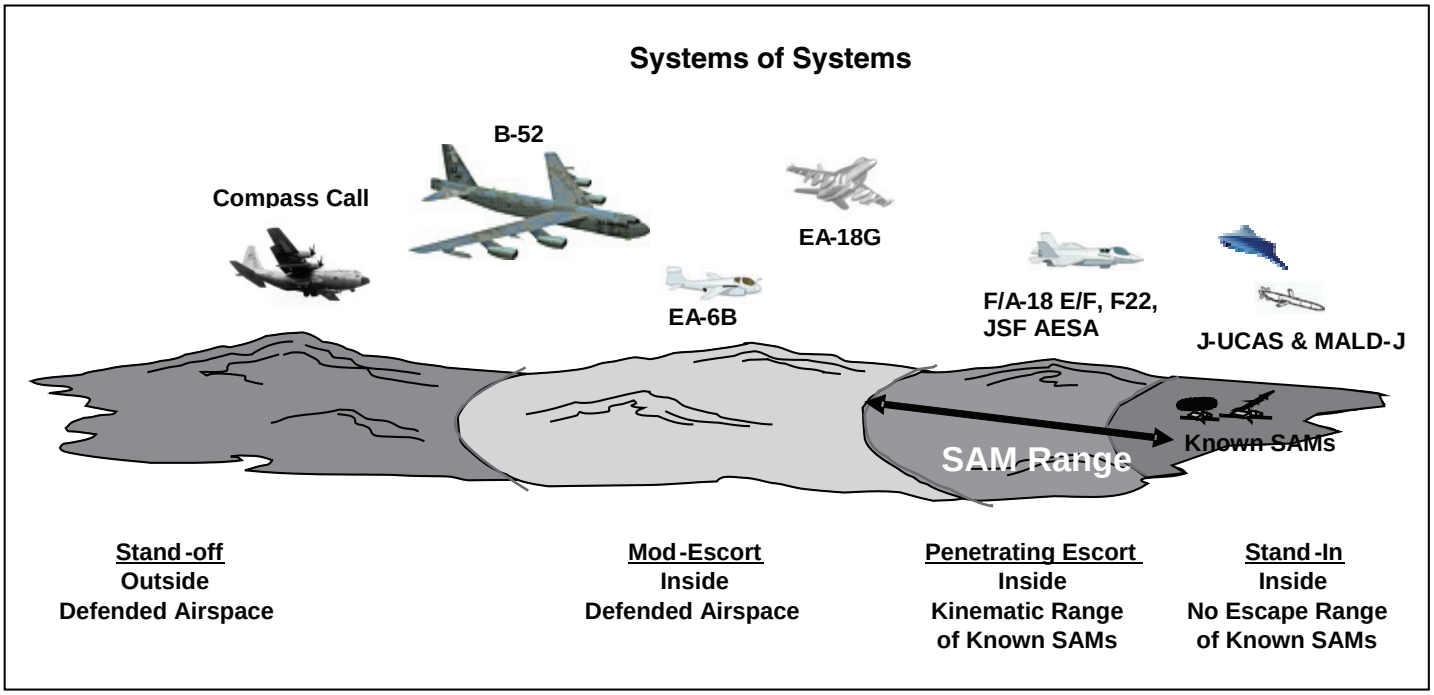
The AoA report, published in 2002, concluded that an EA-6B replacement would be needed in 2009 to meet the services needs. The AoA further concluded that two components are needed to provide a complete AEA solution that is able to meet DOD's collective needs. These two

components are a recoverable “core” component and an expendable “stand-in” component.

The AEA AoA report identified 27 platform combinations that were capable of delivering jamming support. The study concluded that the final AEA solution must address both anticipated short-term platform shortfalls, as well as how best to implement the follow-on capability based on the menu of alternatives developed by the AoA. In addition, the study concluded that before a service can begin a formal acquisition program, the discussion should consider, among other things, whether one service will provide all DOD core component capability, and whether the AEA core component will reside on a single platform.

Subsequent to the AoA report, the Navy and the Air Force each decided to develop their own unique aircraft from the 27 platform combinations identified in the AoA to perform the core component of AEA, as shown in figure 2. The Navy opted to develop the EA-18G Growler, a derivative of the F/A-18F, as its core component. The Air Force decided to develop an electronic attack variant of the B-52, designated the EB-52 SOJ (Standoff Jammer), to function as its core component of the AoA solution and an unmanned combat air vehicle and an unmanned decoy as the expendable stand-in components of its AEA AoA solution. The Marine Corps opted to continue using the EA-6B with the ICAP III electronic suite in anticipation of an electronic variant of the Joint Strike Fighter (F-35) being developed as a replacement for its EA-6Bs. The combination of these service AEA solutions is shown below in the DOD AEA system of systems.

Figure 2: Service-Identified Airborne Electronic Attack System of Systems



Source: DOD.

Note: SAMs are surface-to-air missiles.

As a result of these changes the services have updated a memorandum of agreement that would allow Navy expeditionary EA-6B squadrons to be decommissioned between fiscal years 2009 and 2012, to be replaced by U.S. Air Force electronic attack capability. The Navy's aircraft would be dedicated to providing carrier-based AEA support to the Navy. The Navy determined that an inventory of 90 aircraft would be needed to support the Navy's core component requirement. In 2001 it was projected that an inventory of 108 EA-6Bs would be needed if the Navy were to continue to provide AEA mission support to all the services.

In February 2006, DOD proposed to terminate two major components of the system of systems: the B-52 Standoff Jammer system and the Joint Unmanned Combat Air System (J-UCAS). The goal of the B-52 SOJ program was to provide long-range jamming of sophisticated enemy air defense radars and communications networks, using high-powered jamming equipment. The Air Force believes that a standoff jamming capability is still required, and it is investigating the solution options,

platform numbers, and mix to deliver this capability. As part of the cancellation of the B-52 SOJ, the Air Force is investigating other solution options and platforms to provide the standoff capability, including examining how the B-52 SOJ cancellation affects Navy plans to retire the expeditionary squadrons of EA-6Bs. The goal of the J-UCAS program is to demonstrate the technical feasibility and operational value of a networked system of high-performance and weaponized unmanned air vehicles.

Changes in Operational Concept and Upgrades Extend Operational Viability of the EA-6B, but Quantities Are Insufficient to Meet Identified Requirements

The conclusion of the May 2002 AoA report that the EA-6B inventory would be insufficient past 2009 was not based on the Navy's requirement for 90 aircraft, but on an inventory requirement of 108 aircraft that would meet the needs of all services. The decision to move to a system of systems using multiple aircraft types means the Navy will no longer be required to support all of DOD's electronic attack requirements. As a result, EA-6B aircraft will be able to meet the Navy's suppression of enemy air defense needs through at least 2017 and the needs of the Marine Corps through 2025 as long as sufficient numbers of the aircraft are outfitted with ICAP III electronics suites. If the Navy is required to support all services, given the recent Air Force proposal to terminate the EB-52 standoff jammer program, additional EA-6Bs may require the ICAP III upgrade.

According to program officials, the EA-6B ICAP III electronic suite upgrade was determined to be operationally effective and suitable in 2005 and has proven to be significantly better than the ICAP II electronic suite that is currently in use on all but a few EA-6Bs. However, while the EA-6B inventory decline has been postponed, the planned number of aircraft that would receive the ICAP III electronic suite upgrade has been significantly reduced, leaving most EA-6Bs with a shortfall in electronic attack capability against some current and future threats. Production of the EA-6B ICAP III upgrade is scheduled to end after the 2006 buy.

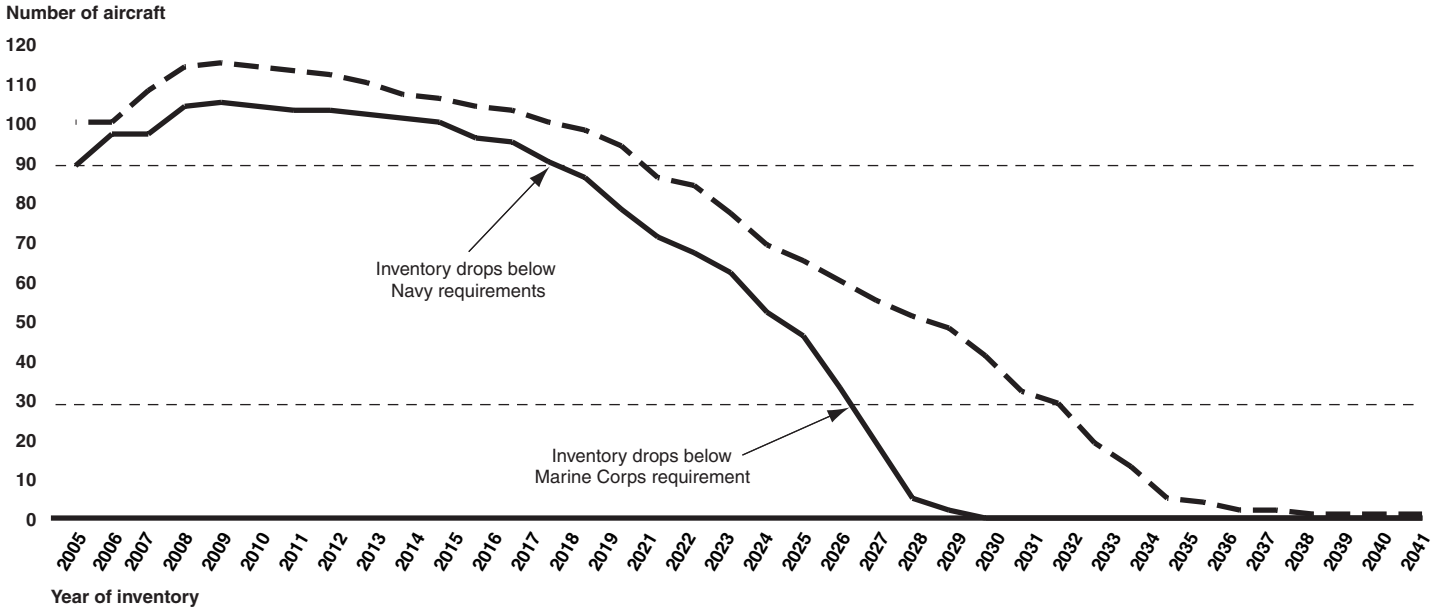
System of Systems Decision Reduces the Inventory Requirement for the Navy

Program officials said that DOD's 2002 decision to move to a system of systems concept has reduced the inventory requirement for the Navy from 108 aircraft to 90 aircraft. The Navy determined that an inventory of 90 aircraft would be needed to support Navy's core component requirement. An inventory of 108 EA-6Bs would be needed if the Navy were to continue to provide electronic attack mission support to all the services. The memorandum of agreement between the services, in which the EA-6B has been the sole provider of electronic attack since 1996, allows the Navy expeditionary squadrons to be decommissioned between fiscal year 2009

and 2012 and replaced by the U.S. Air Force's EB-52 standoff jammer. However, the Air Force has recently canceled the EB-52 jammer.

As shown in figure 3, the EA-6B inventory levels are now expected to be sufficient to meet the Navy's requirement for 90 aircraft through at least 2017 and the Marine Corps requirement for 31 aircraft through 2025. Procurement and replacement of 114 wing center sections for the EA-6B, begun in 1998, have been made on 94 aircraft and are ongoing. A few aircraft have received more than one wing center replacement because of heavy use. As a result, program officials identified the fatigue life of the fuselage as the determining factor in projected inventory levels. The official estimated life analysis of the EA-6B was conducted between 1984 and 1988. The aircraft used in that analysis had 1,873 actual flight hours when the test began, and program management believes that factor was not considered in determining the current fuselage life limit. Program management has asked that updated fatigue life charts be developed based on this information. Program management predicts that this will result in an increase in fuselage life to 14,000 hours, as shown in the solid line in figure 3. In addition, according to program officials extended inventory life can be obtained by procuring 32 additional EA-6B wing center sections at an estimated cost of $170 million. This would result in an inventory of over 90 EA-6Bs through 2019. This projected inventory is represented by the dashed line in figure 3. However, according to program officials, Northrop Grumman Corporation will wrap up wing center section production late this summer, and any new wing center section production would have to be placed on order this year to avoid additional startup and production break costs.

Figure 3: Current EA-6B Inventory Decline Projection Showing Fatigue Effects and Operational Attrition



Source: U.S. Navy.

Note: Fatigue life is the number of cycles of stress and strain of a specific nature that a material will sustain before failure occurs.

Electronic Suite Upgrade Is More Capable, but Quantities Are Insufficient to Meet Requirements

While the inventory of EA-6Bs is now projected to meet the Navy's inventory needs through 2017, most of that inventory will be less able to address some current and future threats than recently anticipated. According to program documents, the ICAP II tactical jamming system, currently installed on most EA-6B aircraft, is limited in its ability to conduct numerous critical functions. Its receivers and integrated connectivity are limiting factors in the ICAP II's ability to detect, locate, and react to threat systems. Threat systems have become more sophisticated and incorporate advanced technology, severely limiting current ICAP II equipped EA-6Bs' receivers' ability to detect and identify threats. The ICAP III upgrade, at an estimated cost of $11.7 million per aircraft for the last four upgrades, provides selective reactive jamming capability; accurate emitter geolocation; full azimuth coverage; and a flexible command and control warfare core system that can integrate and coordinate multiple EA-6Bs to match any threat density, as well as the ability to integrate and control other manned or unmanned command and

control warfare assets. Program officials project that a lower unit cost could be achieved if higher quantities are procured.

Recent operational test and evaluation (OPEVAL) results for the EA-6B equipped with the ICAP III electronic suite have determined it to be operationally effective and suitable. Since these results, Navy operations and training units have flown and observed two EA-6B squadrons upgraded with ICAP III and found the upgrade to be significantly more capable than EA-6B aircraft equipped with the ICAP II electronic suite. According to Navy users who flew the EA-6B with ICAP III during a recent training detachment, the ICAP III system demonstrated a 30 percent increase in jamming effectiveness over the ICAP II. More data on the superior performance of ICAP III relative to the ICAP II system will become available as results from its first deployment, which just recently occurred, develop.

Although the ICAP III-equipped EA-6Bs have been found to be significantly more capable, the numbers of aircraft that are funded to receive the ICAP III upgrade has been reduced compared with earlier DOD intentions to fully upgrade all EA-6Bs. Currently 14 EA-6B aircraft have been funded to receive the ICAP III upgrade, because of funding reductions, development test results, and the decision in 2003 to replace the EA-6B with the EA-18G.

According to Navy and Marine Corps requirements officials, fitting only 14 EA-6Bs with ICAP III is not sufficient to allow for the transition to the EA-18G without leaving them with an airborne electronic attack capability shortfall against some current and future threats. They believe that between 21 (to meet the Navy requirement) and 31 (to meet the Marine Corps requirement) EA-6Bs should be fitted with ICAP III to address this shortfall. However, an analysis provided by the EA-6B program office concluded that 44 ICAP III aircraft would be needed to meet both Navy and Marine Corps requirements. We have not validated the number of aircraft Navy and Marine Corps officials identified as needed. Because of recent decisions affecting Air Force electronic attack near-term capabilities, additional EA-6Bs may be needed if the Navy is tasked to support the electronic attack requirements of all services beyond 2010. However, increasing the number of EA-6Bs with ICAP III will not be an option if ICAP III production ends in 2006 as currently planned.

EA-18G Program at Risk of Cost and Schedule Growth because It Is Not Following a Knowledge-Based Approach

The EA-18G development schedule is aggressive according to program officials and the DOD Director of Operational Test and Evaluation's 2005 annual report. While the program is currently on cost and schedule according to program officials, our analysis shows that the program is not fully following the knowledge-based approach inherent in best practices and DOD's acquisition guidance, thus increasing the risk of cost growth and schedule delays. In addition, we have found that most research and development cost growth is reported after a program has passed the critical design review--the acquisition phase the EA-18G recently entered. Over the last several years, we have undertaken a body of work examining weapon system acquisition in terms of lessons learned from best system development practices. Successful programs attain high levels of knowledge in three aspects of a new product or weapon: technology, design, and production. If a program is not attaining high levels of knowledge, it incurs increased risk of problems, with attendant cost growth and schedule delays. The EA-18G airborne electronic attack program entered system development with immature technologies, and some of these technologies are still not mature. Also, while most of the design drawings are complete, it is possible that redesign may be needed in the future as the technologies mature. In addition, the Navy plans to procure a large percentage of the total EA-18G aircraft during low-rate initial production based on limited knowledge of the aircraft's ability to perform the electronic attack mission. This could result in the need to retrofit already produced EA-18G aircraft, shown in mock-up form in figure 4, a possibility that the Navy is already anticipating.

Figure 4: EA-18G Mock-up: F/A-18F Loaded with ALQ-99 Jamming Pods

Source: Copyright 2001 the Boeing Company.

EA-18G Program Has Entered the Acquisition Phase Where Most Cost Growth is Reported

According to program officials, the EA-18G program is currently on cost and schedule. While it held its critical design review in April 2005, it is now in the phase where most research and development cost growth is recognized and reported. We recently reviewed the development cost experience of 29 programs that have completed their product development cycle--the time between the start of development and the start of production.[4] We found a significant portion of the recognized total development cost increases of these programs took place after they were approximately halfway into their product development cycle. These increases typically occurred after the time of the design review of the programs. The programs experienced a cumulative increase in development costs of 28.3 percent throughout their product development. Approximately 8.5 percent of the total development cost growth occurred

[4] The 29 programs include ATIRCM/CMWS, AEHF, AESA Radar, AIM-9X/Air to Air Missile, ATACMS BAT, B-1B CMUP, Bradley Fighting Vehicle A3 Upgrade, CH-47F, CEC, EELV, F/A-18E/F, F-22A, GMLRS Tactical Rocket, JASSM, JDAM, JPATS, JSOW, Longbow Hellfire, M1A2 Abrams, MCS, MM III GRP, MIDS-LVT, NAS, SDB, Strategic Sealift, Stryker Family of Vehicles, Tactical Tomahawk, Tomahawk TBIP, and V-22. The average design review is based on 21 of the 29 programs that either reported a critical design review date in the annual Selected Acquisition Reports or was provided to us by program officials.

up until the time of the average critical design review. The remaining 19.7 percent occurred after the average critical design review.[5]

Potential for Cost Growth and Redesign Because of Technological Immaturity

Our work shows that the demonstration of technology maturity by the start of system development phase is a key indicator of achieving a match between program resources (knowledge, time, and money) and customer requirements. We recently reported that the cost effect of proceeding into product development without mature technologies can be dramatic.[6] Research, development, and test and evaluation costs for programs that started development with mature technologies increased by an average of 4.8 percent, while those that began with immature technologies increased by an average 34.9 percent.

In December 2003, after a truncated concept exploration phase, the EA-18G was approved to enter system development, in order to achieve a 2009 initial operational capability date directed by the Chief of Naval Operations. Prior to entering system development, the program office assessed the readiness of the EA-18G's technologies and concluded that the system was not developing or advancing any new technologies and that only proven systems with minor modifications using mature technologies would be utilized. In addition, program officials stated that the EA-18G development benefited from the maturity of the F-18F platform and the airborne electronic attack suite currently flown on the EA-6B.

Our assessment of the technology maturity of the EA-18G, however, differs from that offered by program officials. Over the last few years, we have reported on the system's progress in our annual assessment of selected major defense acquisition programs. We have reported that at the start of system development[7] none of the program's five critical technologies were fully mature, and as recently as our March 2005 report this had not

[5] GAO, *Defense Acquisitions: Assessments of Selected Major Weapon Programs* GAO-06-391 (Washington, D.C., March 2006).

[6] GAO-06-391.

[7] Milestone B-the stage of system development focused on reducing integration and manufacturing risk; ensuring operational suitability and reducing the logistics footprint; implementing human systems integration; designing for producibility; ensuring affordability and protection of critical program information; demonstrating system integration, interoperability, safety, and utility.

changed.[8] While they are similar to the mature technologies found on the EA-6B and the F/A-18F, integrating those technologies on the EA-18G involves form and fit challenges. Three of the critical technologies--the ALQ-99 jamming pods, the F/A-18F aircraft, and the tactical terminal system--are approaching full maturity; two other technologies—the communications countermeasure set and the ALQ-218 receiver--are less mature.

The Communications Countermeasures Set (CCS) provides communications detection and processing to the EA-18G. Among other things, it is used to degrade the effectiveness of the communications components that make up enemy integrated air defense systems. The existing set used on legacy EA-6Bs is out of production, and a replacement system is needed for use in the EA-18G. The new one is to be composed of new components, and it will function in a new environment. We believe that putting the CCS into the space constraints of the EA-18G platform may be a challenge and thus should be considered a technology risk to the program.

The EA-6Bs fitted with ICAP III have a new technologically mature receiver, the ALQ-218, which is housed in the large space on the aircraft's vertical tail. The ALQ-218 receiver for the EA-18G, however, is being split and redesigned so it can be integrated into the aircraft's smaller wingtip pods. The wingtip environment is also known to be harsh, with noise and vibration that are known to be particularly severe and can degrade the reliability of receiver components. Isolators will be used in an attempt to lower the vibration levels. Since the ALQ-218 antenna elements will be subject to flexing of the wing that could reduce system performance, accelerometers will be placed in the wingtip pods to measure relative movement between the wingtips so that accurate threat locations can be made. In addition, many subcomponents also include new and modified parts, so the receiver's performance and delivery schedule are being tracked as risks to the program. Furthermore, the unique ALQ-218 wingtip covers, or radomes, have recently surfaced as potentially problematic. There are technical risks with the radome's electrical characteristics and environmental specifications--especially its ability to withstand hail strike requirements. The radome is being tracked as a high risk to the program because it may not meet a performance requirement. Flight tests on the

[8] GAO, *Defense Acquisitions: Assessments of Selected Major Weapon Programs*, GAO-05-301, (Washington, D.C.: March 31, 2005).

EA-18G to measure the impact of noise and vibration on completed components will not start until February 2007. The performance of the ALQ-218 radome will not be known until flight tests that demonstrate its capability are conducted later this year. The maturity of the full ALQ-218 will not be fully known until the EA-18G aircraft completes flight tests with these components during developmental testing scheduled to start in April 2008.

The design of the EA-18G appears stable because almost all of its design drawings are complete. However, the order in which knowledge is built throughout product development is important to delivering products on time and within costs. Our past work has shown that knowledge gaps have a cumulative effect. For example, design stability cannot be attained if key technologies are not mature. Until all the EA-18G critical technologies demonstrate maturity, the potential for design changes remains. While the program held its system-level critical design review in April 2005, flight tests will be needed to verify the loads and environment used for some of these designs and determine the maturity of the critical technologies.

Production Decision Based on Limited Demonstrated Functionality, and Initial Capability Provided Will Be Less than That of EA-6B ICAP III

The EA-18G production decision scheduled for April 2007 will be based on limited demonstrated functionality. The initial capability demonstrated in support of the production decision will be less than that of the ICAP III on the EA-6B. Four EA-18G aircraft will be built to conduct operational tests during the system development and demonstration test phase. The Navy plans to procure an additional one-third, or 30, of the EA-18G aircraft during low-rate initial production (LRIP), at an estimated cost of $2,297.1 million for the two low-rate initial production lots in fiscal year 2007 and fiscal year 2008. This low-rate initial production quantity is significantly higher than the recommended DOD acquisition target of 10 percent. The program does not plan to demonstrate through flight tests a fully functional production representative prototype until testing in April and May of 2008. In addition, program plans call for procuring 56 EA-18G full-rate production (FRP) aircraft to achieve the procurement objective of 90 aircraft. As a result, full funding for 56 of the 90 EA-18G aircraft and 34 of the 56 airborne electronic attack suites will be committed prior to the completion of operational testing and evaluation.[9] This creates a risk, acknowledged by the program office, that redesign and retrofitting may be

[9] The EA-18G is composed of the aircraft and an airborne electronic attack suite.

needed, since it will not be known how effective and suitable the EA-18G will be or what changes are required until after those tests are completed.

The EA-18G requirements are to meet, and in some cases exceed, those of the EA-6B ICAP III, adding an air-to-air intercept capability and the ability to communicate while jamming. However, according to program documents the first operational test, scheduled to be completed in February 2007, 2 months before the low-rate initial production decision, will demonstrate a much more limited capability, primarily the ability to radiate a simple, single-source jamming assignment and the ability to receive, identify, and display limited simple emitters. Test results demonstrating full ICAP III equivalent capabilities will not be available until the operational evaluation scheduled to be completed in January 2009, 3 months before the projected full-rate production decision, when the third and final software release will be available for testing.

The test plan is driven by software development, and the EA-18G software will be available for testing in three releases, or builds. Software is on the critical path to program completion and will provide the functionality that is available for testing before each production decision. While the program officials responsible for managing the software appear to be tracking all major cost, schedule, and quality markers, software development is still considered a moderate risk. Problems or delays in the initial software releases could affect the start of the operational evaluation. Even before that, the current software development schedule will not allow the program to demonstrate that the EA-18G system can fully function until after the program office has committed to producing all 30 of the low-rate initial production aircraft. Under the current schedule, operational testing of the final software release needed to demonstrate the desired functionality of EA-18G aircraft will not be completed until January 2009 – 3 months before the projected full-rate production decision.

Conclusions

Should the Air Force decisions to terminate its EB-52 jammer and Joint-Unmanned Combat Air System programs stand, the airborne electronic attack framework that arose after the 2002 analysis of alternatives will not materialize as planned. These decisions and the emergence of irregular threats place an added burden on the Navy's EA-6B and EA-18G airborne electronic attack assets and may result in an even larger gap in DOD's capability.

A reduction in plans to upgrade Navy EA-6B with ICAP III electronic suites creates a transition shortfall in capability until the EA-18G becomes

operational. Potential delays in the EA-18G development and testing effort would only aggravate this shortfall. The EA-18G development schedule is based on a premise--EA-6B inventory will not be sufficient beyond 2009--that is no longer valid for assessing the Navy's future needs. The inventory of EA-6B aircraft is now projected to be sufficient to meet Navy and Marine Corps needs for another decade or longer. In addition, the compressed and aggressive schedule, a direction given to the program office, does not allow decision makers to benefit from the demonstration of knowledge at critical junctures, a proven mitigator of risk.

The availability of EA-6B aircraft allows DOD to consider an alternative to its current strategy. After determining how it will fulfill the warfighter's needs and address capability shortfalls, DOD could outfit additional EA-6B aircraft with upgraded ICAP III electronic suites. This option is made possible by the successful integration of the ICAP III electronic suite with the EA-6B aircraft and structural improvements. However, this would necessitate not closing production of these electronic suites in 2006, as presently planned.

Recommendations for Executive Action

To mitigate the effects accruing from the shortfall in upgraded EA-6B aircraft, the risk of delay in the development of the EA-18G, and the proposed cancellation of the EB-52 jammer and the Joint-Unmanned Combat Air System, we recommend that the Secretary of Defense take the following two actions:

- Determine the number of EA-6Bs equipped with ICAP III electronic suites necessary to deal with the existing and near-term capability gaps.
- Consider procuring this necessary number of ICAP III upgrades. If DOD implements the option, we recommend that the department
  - continue the EA-6B ICAP III production line after the fiscal year 2006 buy, and
  - restructure its EA-18G low-rate initial production plans so that procurement of the aircraft occurs after the aircraft has demonstrated full functionality.

Agency Comments and Our Evaluation

DOD provided us with written comments on a draft of this report. The comments appear in appendix II.

DOD partially concurred with our recommendation that the Secretary of Defense determine the necessary number of EA-6Bs equipped with ICAP

III electronic suites to deal with the existing and near-term capability gap. DOD agreed that the Navy's airborne electronic attack inventory needs review and has directed a study of department wide airborne electronic attack forces to be issued on September 15, 2006. However, it is unclear from DOD's response if the department's review will specifically identify, as we recommended, the necessary number of ICAP III-equipped EA-6Bs needed to address the existing and near-term capability gap. In light of the end of planned ICAP III production this year, DOD needs to identify this specific number, as it is a necessary prerequisite to our second recommendation.

DOD also partially concurred with our recommendation that the Secretary of Defense consider procuring the determined number of ICAP III upgrades and that if DOD takes this option, the department (1) continue ICAP III production and (2) restructure the EA-18G low-rate initial production plans so that the procurement of the aircraft occurs after the aircraft has demonstrated full functionality. Regarding the first part of our recommendation, DOD agreed that it should consider procuring the required ICAP III upgrades, as determined by the ongoing airborne electronic attack review, but stated that it is premature to make a decision until the ICAP III inventory levels are determined. We agree that such determination is a prerequisite and have so stated in our first recommendation. However, that determination needs to be completed before the ICAP III production line ends in fiscal year 2006. With regard to the second part of our recommendation, DOD stated that the current EA-18G low-rate initial production plan provides the best balance of risk and cost to expeditiously meet warfighters' needs. We remain concerned that producing EA-18G aircraft before testing demonstrates that the design is mature unnecessarily increases the likelihood of design changes that will lead to cost growth, schedule delays, and performance problems. In the past, Congress has raised concerns about the costly outcomes of highly concurrent development and production efforts that are not "flying before buying." Starting production before flight tests demonstrate the full ICAP III equivalent capability works as intended places the $2,297.1 million low-rate initial production investment at significant risk. The procurement of additional ICAP-III-equipped EA-6Bs would allow the time to properly test the EA-18G before making a production decision and reduce the risk of costly retrofitting of the initially produced EA-18Gs. Therefore, we continue to believe that our recommendation should be implemented.

We are sending copies of this report to interested congressional committees; the Secretary of Defense; the Secretaries of the Air Force, and Navy; the Commandant of the Marine Corps; and the Director, Office of

Management and Budget. We will provide copies to others on request. This report will also be available at no charge on GAO's Web site at http://www.gao.gov.

Should you or any of your staff have any questions on matters discussed in this report, please contact me on (202) 512-4841. Contact points for our offices of Congressional Relations and Public Affairs may be found on the last page of this report. Principal contributors to this report were David Best Assistant Director, Jerry Clark, Robert Ackley, Michael Aiken, Judy Lasley, Chris Miller, and Robert Swierczek.

Allen Li
Director, Acquisition and Sourcing Management

Appendix I: Scope and Methodology

To determine if the key conclusion reached in the Department of Defense's (DOD) May 2002 airborne electronic attack (AEA) analysis of alternatives (AoA)--the projected inventory of EA-6Bs would be insufficient beyond 2009--is still valid, we interviewed officials in the Office of the Secretary of Defense; the Strategic Command (Offutt, Nebraska); the Commander Electronic Attack, Pacific Fleet (Whidbey Island); and officials responsible for Air Force, Navy, and Marine Corps AEA requirements. We interviewed personnel responsible for Improved Capability (ICAP) III electronic warfare testing at the Office of the Director, Operational Test and Evaluation (Washington, D.C.); Commander of Operational Test and Evaluation Navy (Norfolk, Virginia); and VX-9 personnel responsible for ICAP III testing at China Lake, California. In addition to the reviewing 2002 AEA AoA, we reviewed pertinent DOD, service, and contractor documents addressing the status of the EA-6Bs inventory, plans for maintaining the status of EA-6B suppression capabilities, testing conducted for the EA-6B ICAP III program, the AEA system of systems, gaps in the AEA, and potential solutions for AEA.

To determine whether the acquisition management approach to the Navy's airborne electronic attack core component, the EA-18G, is knowledge-based and can help forestall future risks, we reviewed pertinent DOD, service, and contractor documents addressing the status of the EA-18G development effort. We discussed airborne electronic attack issues and EA-18G development and production with contractor personnel at Boeing Corporation in St. Louis, Missouri and El Segundo, California. We discussed software matters with officials at China Lake and Point Mugu, California. We met with pilots at Patuxent River Naval Air Station, China Lake, Whidbey Island Naval Air Station, Fallon Naval Air Station, and Boeing Corporation to discuss pilot workload issues given the transition to the two-seat EA-18G from the four-seat EA-6B. As with our past work on the EA-18G development effort conducted under our annual assessment of selected major defense acquisition programs, we focused our work to determining whether the program was following a knowledge-based acquisition approach. We met with Navy EA-18G program officials currently involved with the development effort to document the maturity status of the aircraft's critical technologies, the status of its design effort, and plans for producing the aircraft.

We performed our review from May 2005 through March 2006 in accordance with generally accepted government auditing standards.

Appendix II: Comments from the Department of Defense

OFFICE OF THE UNDER SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

ACQUISITION
TECHNOLOGY
AND LOGISTICS

APR 19 2006

Mr. Allen Li
Director, Acquisition and Sourcing Management
U.S. Government Accountability Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Li:

This is the Department of Defense's (DoD's) response to the Government Accountability Office Draft Report, "ELECTRONIC WARFARE: Option of Upgrading Additional EA-6Bs Could Reduce Risk in Development of EA-18G," dated March 16, 2006 (GAO Code 120440/GAO-06-446). The DoD partially concurs with the two recommendations in the draft report. Details of the partial concurrences are contained in the enclosure.

We appreciate the opportunity to comment on the draft report.

Sincerely,

Mark D. Schaeffer
Acting Director
Defense Systems

Enclosure:
As stated

GAO DRAFT REPORT - DATED MARCH 16, 2006
GAO CODE 120440/GAO-06-446

"ELECTRONIC WARFARE: OPTION OF UPGRADING ADDITIONAL EA-6Bs COULD REDUCE RISK IN DEVELOPMENT OF EA-18G"

DEPARTMENT OF DEFENSE COMMENTS TO THE RECOMMENDATIONS

RECOMMENDATION 1: The GAO recommended that the Secretary of Defense determine the necessary number of EA-6Bs equipped with Improved Capability (ICAP) III electronic suites to deal with the existing and near-term capability gap. (p. 19/GAO Draft Report)

DOD RESPONSE: Partially Concur. The Department agrees that refinement of Navy Electronic Attack aircraft inventory is needed. The Deputy Secretary of Defense directed a review of Airborne Electronic Attack plans, programs, and required capabilities on December 16, 2005. The final report is due September 15, 2006. This AEA review will identify the AEA forces that the Department should maintain to meet joint needs across the range of military operations.

RECOMMENDATION 2: The GAO recommended that the Secretary of Defense consider procuring the determined number of ICAP III upgrades. If DOD takes this option, the GAO recommends that the department:

a. continue the EA-6B ICAP III production line after the fiscal year 2006 buy and

b. restructure its EA-18G low-rate initial production plans so that procurement of the aircraft occurs after the aircraft has demonstrated full functionality.

DOD RESPONSE: Partially Concur. The Department agrees that it should consider procuring required ICAP III upgrades as determined by the ongoing AEA review. However, it is premature to make a decision on ICAP III production until ICAP III inventory requirements are determined. The Department is confident that the EA-18G Low Rate Initial Production (LRIP) plan provides the best balance of risk and cost to expeditiously meet warfighter needs.

Related GAO Products

Defense Acquisitions: Assessments of Selected Major Weapon Programs. GAO-06-391. Washington, D.C.: March 31, 2006.

Military Readiness: DOD Needs to Identify and Address Gaps and Potential Risks in Program Strategies and Funding Priorities for Selected Equipment. GAO-06-141. Washington, D.C.: October 25, 2005.

Defense Acquisitions: Assessments of Selected Major Weapon Programs. GAO-05-301. Washington, D.C.: March 31, 2005.

Defense Acquisitions: DOD's Revised Policy Emphasizes Best Practices, But More Controls Are Needed. GAO-04-53. Washington, D.C.: November 10, 2003.

Defense Acquisitions: Stronger Management Practices Are Needed to Improve DOD's Software-Intensive Weapon Acquisitions. GAO-04-393. Washington, D.C.: March 1, 2004.

Electronic Warfare: Comprehensive Strategy Still Needed for Suppressing Enemy Air Defenses. GAO-03-51. Washington, D.C.: November 25, 2002.

Electronic Warfare: Comprehensive Strategy Needed for Suppressing Enemy Air Defenses. GAO-01-28. Washington, D.C.: January 3, 2001.

Contingency Operations: Providing Critical Capabilities Poses Challenges. GAO/NSIAD-00-164. Washington, D.C.: July 6, 2000.

Combat Air Power: Joint Assessment of Air Superiority Can Be Improved. GAO/NSIAD-97-77. Washington, D.C.: February 26, 1997.

Combat Air Power: Funding Priority for Suppression of Enemy Air Defenses May Be Too Low. GAO/NSIAD-96-128. Washington, D.C.: April 10, 1996.

Combat Air Power: Joint Mission Assessments Needed Before Making Program and Budget Decisions. GAO/NSIAD-96-177. Washington, D.C.: September 20, 1996.

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