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TACTICAL AIRCRAFT

Air Force Still Needs Business Case to Support F/A-22 Quantities and Increased Capabilities



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Highlights of [GAO-05-304](#), a report to congressional committees

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Why GAO Did This Study

The Air Force is preparing a modernization plan that expands the capabilities of the F/A-22, which was first designed to serve as an air-to-air fighter aircraft with very limited ability to strike targets on the ground. The Air Force now intends to transform it by adding robust air-to-ground capabilities to attack enemy ground threats and by adding onboard intelligence data gathering capabilities. After the recent budget cut, DOD estimates F/A-22 cost at \$63.8 billion for 178 aircraft. It has been in development for more than 19 years, a decade longer than originally envisioned.

In the face of significant cost and schedule overruns, Congress mandates that GAO annually assess the F/A-22 program. In this report, GAO addresses (1) the Air Force's business case for the F/A-22 modernization plan and (2) the recently completed initial operational test and evaluation.

What GAO Recommends

GAO is reiterating and expanding upon a 2004 recommendation that DOD complete a new and comprehensive business case that reflects the current budget environment and justifies future investments and specific quantities needed to meet mission requirements. DOD concurred and expects to build a business case through such actions as the 2005 Quadrennial Defense Review and analysis required to support future modernization efforts as a separate program.

www.gao.gov/cgi-bin/getrpt?GAO-05-304.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Michael J. Sullivan at (202) 512-4841 or sullivanm@gao.gov.

What GAO Found

The Air Force has yet to produce a business case for the next-generation F/A-22. Much has changed in the years since the F/A-22 program began nearly 2 decades ago—adversarial threats against U.S. aircraft have evolved, and a plan to modernize the F/A-22 significantly different than the original aircraft is in progress. A DOD cost estimate in 2003 projected the Air Force's modernization plan to cost \$11.7 billion through 2018. A December 2004 budget decision reduced procurement funding and quantities but did not cut funding for modernization. The decision to terminate procurement after fiscal year 2008 places the current modernization plan in doubt as key ground attack and intelligence-gathering enhancements had been slated for aircraft now eliminated from the program. Without a new business case for adding a more robust ground attack capability and for new intelligence missions, the Air Force may be at a disadvantage when the time comes to justify the modernization plan in the face of future budget constraints. The following table shows the current plan for integrating new capabilities:

Planned Modernization Enhancements for the F/A-22 Program

	2007	2011	2013	2015
Examples of capabilities to be added	Air-to-air plus limited air-to-ground: Improved capability to launch Joint Direct Attack Munition at faster speeds; upgrade air-to-air capabilities	Air-to-ground: Add improved radar to seek and destroy advanced surface-to-air missile systems; integrate additional air-to-ground weapons	Additional air-to-ground: Increase capability to suppress or destroy full range of air defenses and improve speed and accuracy of targeting	Enhanced intelligence data gathering: Add integrated intelligence, surveillance, and reconnaissance capabilities.

Sources: Air Force and Office of Secretary of Defense (data); GAO (analysis and presentation).

DOD is set to conduct the 2005 Quadrennial Defense Review to weigh the merits of transformational priorities and investments to determine if the best choices are being made to meet military needs within available funding levels. This may further influence an F/A-22 business case.

The F/A-22 program recently underwent initial operational testing, but testing did not include the air-to-ground missions that the Air Force envisions for the aircraft. The Air Force does not expect to conduct testing of these capabilities until after a decision is made to enter full-rate production. Although a final test report was not available for our review, Air Force officials told us that the F/A-22 was extremely effective in performing its air-to-air missions. Evaluation results of capabilities needed to sustain combat operations and maintain aircraft were not as favorable. Additional testing will be required to assess corrective actions for deficiencies identified and to evaluate new ground attack and intelligence-gathering capabilities added by the modernization program.

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Abbreviations

CAIG	Cost Analysis Improvement Group
DOD	Department of Defense
IOT&E	Initial Operational Test and Evaluation
OSD	Office of the Secretary of Defense

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United States Government Accountability Office
Washington, DC 20548

March 15, 2005

Congressional Committees:

The F/A-22 aircraft program is acquiring the Air Force's next-generation, multi-mission fighter for about \$63.8 billion. The need for the F/A-22, its increasing costs, and the quantities required to perform its mission have been the subject of a continuing debate within the Department of Defense (DOD) and Congress. Supporters cite its advanced features—stealth, supercruise speed, maneuverability, and integrated avionics—as integral to the Air Force's Global Strike initiative¹ and for maintaining air superiority over potential future adversaries for years to come. Critics, however, argue that the Soviet threat it was originally designed to counter no longer exists and that its large budget could better be invested in enhancing current air assets and acquiring new and more transformational capabilities that will allow it to meet the evolving threat. The debate continues as a December 2004 budget decision by the Office of the Secretary of Defense (OSD) reduced F/A-22 funding and the number of aircraft to be acquired. Meanwhile, the upcoming 2005 Quadrennial Defense Review is girding up for a review of force structure, mission requirements, and modernization plans.

DOD has been pushing to transform its military operations and capabilities to acquire revolutionary weapon systems and meet evolving post-Cold War threats. Undertaking this transformational effort requires significant funding and competes with other DOD and national priorities. When DOD's weapon systems, such as the F/A-22, require more time and money than originally anticipated, the extra investment needed to solve problems takes funding away from other priorities, slows DOD's overall modernization effort, delays capabilities for the warfighter, and forces unplanned—and possibly unnecessary—trade-offs among DOD's many priorities. Our past work has shown that problems, such as cost overruns, arise when weapon programs do not have a sound business case² or

¹ Global Strike is one of six complementary concepts of operations laying out the Air Force's ability to rapidly plan and deliver limited-duration and extended attacks against targets.

² The business case is defined as demonstrated evidence that (1) the warfighter need exists and that it can best be met with the chosen concept and (2) the concept can be developed and produced within existing resources—including design knowledge, demonstrated technologies, adequate funding, and adequate time to deliver the product.

capture the knowledge needed to efficiently and effectively manage program risks. The end result is a reduction in quantities and ultimately in DOD's overall buying power.

The National Defense Authorization Act for Fiscal Year 1998 requires GAO to report annually on the F/A-22 development program and cost, schedule, and performance issues.³ The act also requires us to certify whether we had access to sufficient information to make informed judgments on the matters contained in this report. This report addresses (1) Air Force business case, plans, and funding for the F/A-22 modernization program and (2) the recently completed initial operational test and evaluation (IOT&E).

We performed our work from November 2004 to February 2005 in accordance with generally accepted government auditing standards. We analyzed modernization plans, funding, and impacts from recent budget changes. Our observations on operational testing are limited and largely based on summary comments and briefing materials provided by testing and program officials. We did not review Air Force and OSD reports on operational test results because the reports were not available to us at the time of our review. Notwithstanding, we believe DOD officials gave us access to sufficient information to make informed judgments on the matters in this report. Appendix I further discusses this report's scope and methodology.

Results in Brief

The F/A-22 program has changed substantially since it started in 1986, and Air Force leaders have not developed a new business case for investing billions more dollars to modernize the aircraft that reflects this change. A December 2004 budget decision places much of the modernization program in doubt and renders the current plan obsolete. DOD cut more than \$10 billion from the procurement program, ending aircraft procurement after 2008. However, the decision did not cut budgeted funds planned for modernizing the F/A-22. In March 2003, OSD cost analysts had estimated the modernization may cost over \$11 billion to add more robust ground attack capabilities and much enhanced intelligence, surveillance,

³ P. L. 105-85 (Nov. 18, 1997), section 217(d). The act states that no report is required after Engineering and Manufacturing Development under the program has been completed. If the scheduled March 2005 full-rate production decision occurs, it means that the overall program has officially moved beyond the development phase into large-scale production. Accordingly, this would be the last GAO report under this mandate.

and reconnaissance capabilities to give the F/A-22 more utility and to take on new missions. Many of the advanced ground attack and intelligence-gathering modernization efforts were intended to be incorporated on aircraft procured after 2008, which have now been eliminated. Further, the budget decision and DOD studies to reappraise multi-service tactical air modernization programs and propose alternative investments call into question the F/A-22's expected role and contributions in combination with other DOD assets, the numbers of aircraft needed in each of its planned configurations, and the affordability and feasibility of modernization plans. If the modernization plan were canceled, what is left of the F/A-22 program is the original F-22, primarily a state-of-the-art fighter designed to counter large numbers of advanced Soviet fighter aircraft, a threat that never materialized. Nevertheless, the Air Force still has to decide how best to invest the remaining billions of dollars budgeted for the program, increasing the need for a new and executable business case unless the modernization program is also terminated.

Reports detailing the results from IOT&E were not available for our review, but Air Force test officials told us that testing showed the F/A-22 was "overwhelmingly effective" as an air superiority fighter and that its supporting systems were "potentially suitable." Some deficiencies and lack of maturity were identified in aircraft reliability and maintainability (including maintaining low observable characteristics) and in the integrated diagnostic systems used to identify and direct maintenance actions. Air Force officials believe these deficiencies are readily correctible and should meet the needs of the warfighter by the scheduled initial operational capability date in December 2005. They also believe that test results support making the full-rate production decision planned in late March 2005. Testing to demonstrate the limited air-to-ground attack capability included in the current design was not done during initial operational testing but is scheduled to be done during follow-on testing planned to start in July 2005. Air-to-ground attack capabilities are increasingly emphasized by the Air Force and future enhancements are planned for 80 percent of the modernized F/A-22s. More robust ground attack and intelligence gathering capabilities will be tested in the future as they are developed.

In March 2004,⁴ GAO recommended the Secretary of Defense complete a new business case that determines the need for the F/A-22 (air and ground

⁴ GAO, *Tactical Aircraft: Changing Conditions Drive Need for New F/A-22 Business Case*, [GAO-04-391](#) (Washington, D.C.: Mar. 15, 2004).

missions) and the quantities required and affordable. DOD did not prepare a new business case as recommended, stating routine acquisition and budget processes provide elements of the business case. We do not believe the routine processes provide sufficient analysis to justify future investments in the new capabilities added by the modernization program, especially given the continued uncertainties still surrounding these program issues. Therefore, we again recommend the Secretary of Defense direct appropriate studies and analyses be completed in order to prepare a new business case that justifies the new capabilities and affordable quantities. DOD concurred with the recommendation this time and said it will provide business case elements through the 2005 Quadrennial Defense Review, modernization program documentation required by policy, and in other ways.

Background

The F/A-22 is the Air Force's next-generation air superiority⁵ fighter aircraft and incorporates a low observable (stealth) and highly maneuverable airframe, advanced integrated avionics, and a new engine capable of sustained supersonic flight without the use of afterburners. It was originally designed to counter threats posed by the Soviet Union and was intended to replace the F-15 fighter in the air-to-air combat role. Over the years, the Air Force decided to add a more robust air-to-ground capability not previously envisioned but now considered necessary to increase the utility of the aircraft. In 2002, the F-22 aircraft was redesignated the F/A-22, with the "A" representing the expanded ground attack capabilities. Officials initiated a modernization program to develop and integrate these new capabilities.

The F-22 acquisition program started in 1986 with an intended development period of 9 years and an initial operational capability in March 1996. The Air Force's plan at that time was to procure 750 aircraft. In the years since, the original business case has been severely weakened as threats, missions, and requirements have changed. Further, the program milestones have slipped, the development period lengthened to more than 19 years, development costs more than doubled, and a modernization program was added. The initial operational capability date is now December 2005.

⁵ Air superiority is the degree of air dominance that allows the conduct of operations by land, sea, and air forces without prohibitive interference by the enemy.

Amidst concerns about escalating costs and schedule, Congress placed cost limitations on both development and production budgets in 1997,⁶ later removing the development cost cap.⁷ (The current production cost cap is \$37.3 billion.) Concomitantly, the planned procurement quantity has steadily decreased due to affordability concerns and changes in missions and combat requirements. Two major reviews of defense force structure and acquisition plans, the 1993 Bottom-Up Review and the 1997 Quadrennial Defense Review, both significantly reduced F/A-22 quantities. In addition, OSD's "buy to budget" acquisition strategy, which essentially placed a ceiling on the total program costs, has resulted in further cuts to quantity as development cost increased. In December 2004, OSD issued Program Budget Decision 753, which reduced F/A-22 funding by \$10.5 billion and cut 96 aircraft from the planned procurement quantity. The decision ends procurement in 2008, instead of 2011, and would reduce total procurement quantity to 178 aircraft.⁸

Figure 1 illustrates the downward trend in procurement quantity over the years juxtaposed with a rise in program acquisition unit costs,⁹ which has resulted in a significant loss in buying power. Program acquisition unit costs have increased largely due to (1) increased development and production costs; (2) decreased procurement quantities; and (3) increased costs to modernize and enhance capability. The current plan supporting the fiscal year 2006 defense budget request submitted in February 2005 is to acquire 178 aircraft for about \$63.8 billion.¹⁰ Appendix II illustrates other changes in cost, quantity, and schedule experienced by the program since its commencement.

⁶ P. L. 105-85 (Nov. 18, 1997), section 217.

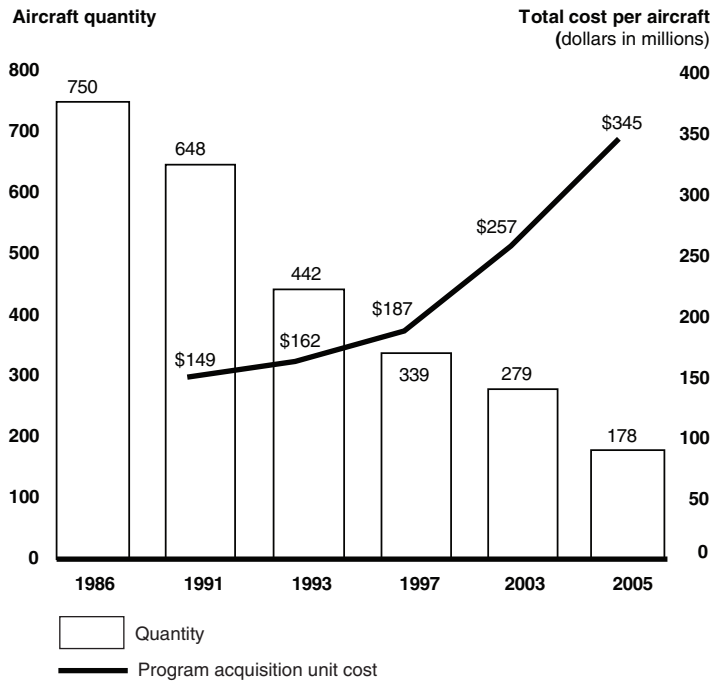
⁷ P. L. 107-107 (Dec. 28, 2001), section 213.

⁸ Program Budget Decision nominally reduced procurement quantity to 179 aircraft. Subsequently, the Air Force transferred one production aircraft to be dedicated to testing, further reducing procurement quantity to 178. It should also be noted that the recent crash of an F/A-22 has reduced planned operational aircraft to 177.

⁹ Program acquisition unit cost includes funding for development, procurement, related military construction, and initial modernization costs divided by total procurement quantity. It does not include later modernization costs and certain support costs.

¹⁰ The total amount consists of \$61.3 billion currently budgeted for the basic program and the initial stages of the modernization efforts; \$1.3 billion for future start-up costs of a separate acquisition program for the latter stages of modernization; and \$1.2 billion in related costs to retrofit aircraft with enhanced capabilities and activate depot maintenance activities.

Figure 1: Quantity and Program Acquisition Unit Cost of F/A-22s



Source: U.S. Air Force (data); GAO (presentation).

Our March 2004 report¹¹ discussed the significant changes in cost, quantity, capabilities, and mission since F-22 development began in 1986. We reported continued problems and delays in the development and testing schedules. We recommended that DOD complete a new business case that justifies the continued need for the F/A-22 and the quantities needed to carry out the air-to-air versus air-to-ground missions. The business case was to also consider alternatives within the constraints of future defense spending. Later in testimony,¹² we stated that there are competing priorities both internal and external to DOD's budget that require a sound and sustainable business case for DOD's acquisition programs based in clear priorities, comprehensive needs assessments, and a thorough analysis of available resources. DOD partially concurred with our report recommendation but did not prepare a new business case, stating that it

¹¹ GAO-04-391.

¹² GAO, *Tactical Aircraft: Status of the F/A-22 and Joint Strike Fighter Programs*, GAO-04-597T (Washington, D.C.: Mar. 25, 2004).

evaluates the F/A-22 business case elements as part of the routine acquisition and budget processes with the results reflected in the defense budget. We did not think these kinds of activities sufficiently analyzed and addressed the specific business case elements—analysis of need for original and new capabilities, assessment of alternatives, justification of needed quantities, and evidence that planned quantities were affordable.

F/A-22 Modernization Program Lacks Business Case and May Not Be Executable as Planned

The Air Force, in the face of significant changes to the F/A-22, has not prepared a new business case to justify the resources needed to add a much more robust ground attack capability and to assume new missions. The requirements for the F/A-22 have changed significantly since its original business case and the available resources are in flux—both are key components of a business case needed to support further investments. A December 2004 budget decision reduced procurement funding and quantities but did not cut funding for modernization. This has made the current modernization plan obsolete as key ground attack and intelligence gathering enhancements had been slated for aircraft that have now been eliminated from the F/A-22 procurement program. While its total cost is not clear at this time and program content is subject to change, in 2003 OSD cost analysts estimated the modernization program would cost about \$11.7 billion.

Modernization Program Makes Significant Changes to F/A-22 Requirements without a New Business Case

The Air Force embarked on the expensive and wide-ranging modernization program without a new business case to support investments of billions of dollars to develop and deliver new capabilities and missions. The modernized F/A-22 would differ so significantly from the original aircraft in capabilities and missions that it should have been developed in an entirely separate acquisition program. Instead, the Air Force opted to incorporate modernization efforts within the existing acquisition program.¹³ A business case should match requirements with resources—proven technologies, sufficient engineering capabilities, time, and funding—when undertaking a new product development. First, the user's needs must be accurately defined, alternative approaches to satisfying these needs properly analyzed, and quantities needed for the chosen

¹³ In November 2004, the acting Under Secretary of Defense for Acquisition, Technology and Logistics directed the Air Force to hold separate milestone reviews for the latter stages of the modernization program to be consistent with DOD acquisition policy. The Air Force now plans to manage these efforts as a separate acquisition program while continuing to manage the initial stages of modernization in the existing F/A-22 program.

system must be well understood. The developed product must be producible at a cost that matches the users' expectations and budgetary resources. Finally, the developer must have the resources to design and deliver the product with the features that the customer wants and to deliver it when it is needed. If the financial, material, and intellectual resources to develop the product are not available, a program incurs substantial risk in moving forward.

The original business case for the F/A-22 was made in 1986 to support acquiring large quantities of air superiority fighters to engage in conventional warfare and counter Cold War-era threats. These threats never materialized as expected. Because the program was in development for over 19 years, tactical fighter requirements, projected threats, and operational war plans changed. To enhance the utility of the F/A-22 for today and the future, the Air Force now plans to develop a robust air-to-ground attack capability to allow the aircraft to engage a greater variety of ground targets, such as surface-to-air missiles systems, that pose a significant threat to U.S. aircraft. It also plans to equip most of the F/A-22 fleet with improved capabilities to satisfy expanded warfighter requirements and to take on new missions, including intelligence data gathering and the suppression of enemy air defenses and interdiction.

The Air Force established a time-phased modernization program to develop and insert new capabilities required to implement the Air Force's Global Strike concept of operations. Table 1 shows how the Air Force intended to integrate new capabilities incrementally before the December 2004 budget decision reduced quantities by 96 aircraft. At the time of our review, officials were still determining the impacts of the budget decision on the modernization program content and quantities.

Table 1: Planned Modernization Enhancements for the F/A-22 Program

	Fiscal year when enhancements are expected to be incorporated			
	2007	2011 ^a	2013	2015
Capabilities increment	Global Strike Basic	Global Strike Enhanced	Global Strike Full	Enhanced Intelligence, Surveillance, and Reconnaissance
Configuration ^b	Block 20	Block 30	Block 40	Block 40
Quantity of F/A-22s	56	91	128	- ^c
Examples of enhancements to be added	Improve capability to launch Joint Direct Attack Munition at faster speeds and at longer distances; upgrade air-to-air capabilities	Enhance air-to-ground capability by adding improved radar capabilities to seek and destroy advanced surface-to-air missile systems; integrate additional air-to-ground weapons	Increase capability to suppress or destroy the full range of air defenses and improve speed and accuracy of targeting	Add capability for full intelligence, surveillance, and reconnaissance integration for increased target sets and lethality

Sources: Air Force and Office of Secretary of Defense.

^aGlobal Strike Enhanced includes two increments of capability with the first increment incorporated in fiscal year 2009 and the second in 2011.

^bThe Air Force plans to have three configurations (called blocks) that include specific enhancements developed in the modernization program.

^cThis quantity included in Global Strike Full amount. Total 128 aircraft planned for block 40.

Initial development work on modernization enhancements started in 2003 and is planned to extend over a 12-year period with the first set of new capabilities inserted into the production line in fiscal year 2007. By the end of development in 2015, the Air Force plans to have three different configurations (or blocks) of F/A-22s, each with distinct operational capabilities. Based on the current modernization road map, the Global Strike Basic configuration (block 20) will include 56 F/A-22s built primarily to perform air-to-air missions but with limited air-to-ground capability. The Global Strike Enhanced configuration (block 30) includes 91 aircraft that will perform the bulk of air-to-ground and electronic attack missions using advanced radars to track targets and small diameter bombs to destroy them. Block 40 encompasses both the Global Strike Full and Enhanced Intelligence, Surveillance, and Reconnaissance increments. This configuration of 128 aircraft is expected to perform such missions as suppression of enemy air defenses and gathering up-to-date information on potential adversaries' locations, resources, and personnel to improve target identification and increase kill capabilities. According to program officials, these latter two increments are still conceptual in nature and subject to revision.

Budget Decisions and Unstable Resources Place the F/A-22 Modernization Program in Doubt

The modernization program as currently planned is much in doubt because of the recent budget cut and the likely prospects for more changes. The instability in F/A-22 resources and upcoming DOD-wide reviews of capabilities and requirements may result in further revisions and cutbacks, further impacting modernization plans. Budget and programmatic decisions also cause ripple effects on other resource plans tied to the modernization, which may open up budgeted funds for other uses.

In March 2003, OSD's Cost Analysis Improvement Group (CAIG)¹⁴ estimated that the Air Force would need \$11.7 billion for the planned modernization programs through fiscal year 2018. The CAIG estimate included costs for development, procurement, and retrofit of modernized aircraft. The Air Force's latest estimated cost for the modernization program is about \$5.4 billion through 2011. Future modernization costs beyond 2011 have not been definitized and are subject to change. The modernization program manager projected annual funding of \$700 million to \$750 million would be needed for the currently planned modernization program after 2011.

The December 2004 budget decision places much of the modernization program in doubt, particularly the latter stages. OSD substantially reduced the F/A-22 budget, which will require another strategy for the modernization program. It reduced F/A-22 funding by \$10.5 billion, stopped procurement of aircraft after 2008, and reduced the quantity by 96 aircraft. This and other events will reduce the Air Force's expected buy to no more than 178 aircraft. While the OSD funding decision changed the baseline F/A-22 program, it did not change the planned funding for the modernization program to add advanced ground attack and intelligence gathering capabilities between 2007 and 2015. However, many of these new and advanced capabilities had been planned for aircraft that will not be built as the budget eliminates F/A-22 aircraft that had been planned for production after 2008. Air Force officials told us they hope to reverse these changes, but officials acknowledge that a major restructuring is likely if the proposed funding cuts are sustained. If the budget cut is sustained, the modernization program as currently planned is largely obsolete and funding for these advanced capabilities to be incorporated after 2008 would be available for other uses. This could include up to

¹⁴ The OSD CAIG acts as the principal advisory body to the milestone decision authority on acquisition program costs.

\$1.2 billion now budgeted for the start-up of the latter modernization increments.

The Air Force's desire to upgrade the F/A-22's computer architecture and avionics processors in order to support the block 40 expanded capabilities¹⁵ may also be affected by the recent budget cut. Program officials do not expect the new architecture to be fully developed and ready for installation in the F/A-22 until fiscal year 2010. However, early indications show that the effort to upgrade the computer architecture—expected to cost between \$400 million and \$500 million—already is experiencing schedule problems and increased risks. As a result, the 2010 insertion date may not be achievable as planned for the F/A-22. Furthermore, DOD's proposed termination of procurement after 2008 raises questions about the need to proceed with the planned computer upgrade. The existing processors with some minor upgrades would support up to 155 aircraft and most Global Strike Enhanced capabilities.

Additionally, since our March 2004 report the program office has identified new requirements needed to implement the modernization program. The F/A-22 program office has concluded that the F/A-22 infrastructure, including government laboratories, such as software avionics integration labs, flying test beds, and test ranges need to be upgraded to ensure a successful modernization program. According to program officials, the existing facilities have major resource/capacity limitations and are inadequate to support needed software integration activities and system performance and operational testing for most planned enhancements. The program office has budgeted about \$1.8 billion through fiscal year 2009 for the infrastructure upgrades, including funds for engineering and maintenance personnel support. According to program officials, the current infrastructure limitations have caused some modernization efforts to be deferred to later blocks. If modernization plans are curtailed, some infrastructure improvements may not be needed.

Even if funding were restored to the F/A-22 program and the above-mentioned concerns were resolved, previous funding shortfalls and schedule slippages have already resulted in planned capabilities being deferred to later years. For example, block 20 enhancements required to conduct autonomous search and improve target recognition have been

¹⁵ GAO-04-391, p. 8 through 10, discusses Air Force needs, plans, and associated risks for a new computer architecture and avionics processor to support the modernization program.

deferred to block 30. Similarly, funding problems have caused the Air Force to scale back some efforts and delay development of block 30 electronic attack and small diameter bomb enhancements. In November 2004, the Defense Contract Management Agency reported that the contractor proposes to reduce the amount of planned tasks, defer development of software specifications, and incrementally develop a key communication component in order to meet an April 2005 system design review.

DOD officials stated that they believe the budget cut has some diseconomies that may result in procuring even fewer than 178 aircraft. They said that stopping aircraft production early affects production economies and efficiencies that were expected from a multiyear procurement contract and from production line efficiencies. The multiyear contract was to begin in fiscal year 2008, the year procurement is now curtailed by the budget decision. Now that opportunity is gone. Officials also said that cutting production quantities from the final years of the program eliminate projected savings in annual unit procurement costs. Typical of many DOD acquisitions, Air Force program officials had projected future budgets assuming that the marginal costs for buying F/A-22s would decrease with each passing year of production as a result of manufacturing efficiencies, productivity projects, and more economical buying quantities. This means that aircraft bought late in the production program usually cost less than those bought earlier in the program. For example, the average unit flyaway cost¹⁶ paid for F/A-22s was \$212 million per aircraft bought in 2002 and \$178 million in 2003. Before the budget decision, officials had projected average unit flyaway costs to decrease to \$127 million, \$111 million, and \$108 million in fiscal years 2007, 2008 and 2009, respectively. Now that the program has been truncated after 2008, the less expensive aircraft in 2009 and beyond will not be bought and unit costs are now projected at \$135 million in 2007 and \$149 million in 2008 (increase associated with close-out of production).

OSD has directed that the 2005 Quadrennial Defense Review include an assessment of joint air dominance in future warfare and the contributions provided by all tactical aircraft, including the F/A-22. An announced defense goal is to redirect investment from areas of conventional warfare,

¹⁶ Average unit flyaway cost includes the costs associated with procuring one aircraft, including the airframe, engines, avionics, other mission equipment, and certain nonrecurring production costs. It does not include “sunk” costs, such as development and test, and other costs to the whole system including logistical support and construction.

where the United States enjoys a strong combat advantage, toward more transformational capabilities needed to counter “irregular” threats, such as the insurgency in Iraq and ongoing war on terror. DOD is also conducting a set of joint capability reviews to ensure acquisition decisions are based on providing integrated capabilities rather than focused on individual weapon systems. The study results, although still months away, could further impact the future of the F/A-22 program including the modernization plan. The F/A-22 will have to compete for funding, priority, and mission assignments with operational systems, such as the F-15 and F/A-18, and future systems, such as the Joint Strike Fighter and the Joint Unmanned Combat Air Systems.

Air Force leadership and the Air Combat Command continue to support the multi-mission role for the F/A-22 and do not want to reduce or eliminate the new capabilities and missions. Therefore, if restructuring is required, program officials are considering other options to accommodate the program within reduced funding and fleet size. They are considering the possibility of moving forward with blocks 20 and 30 but curtailing block 40 because its enhancements are slated for those aircraft that have been cut by the budget decision (refer to table 1). Officials said that some of the enhancements planned for block 40 could be retrofitted into the block 20 and 30 aircraft. At the time of our review, Air Force officials were considering alternative strategies and plans for rephasing funds in order to execute the changes in the program enumerated above. It is paramount that these issues be settled before moving forward in the program.

Operational Testing Considered Successful by Air Force, but Ground Attack Role Has Not Yet Been Tested

Reports detailing the results from IOT&E were not available for our review, but Air Force test officials told us that testing showed the F/A-22 was “overwhelmingly effective” as an air superiority fighter and that its supporting systems were “potentially suitable.” Some deficiencies were noted, particularly in reliability and maintainability, but Air Force officials believe these deficiencies can be corrected in time to meet the warfighter’s needs by the scheduled initial operational capability date in December 2005. They also believe test results support making the full-rate production decision. Testing to demonstrate the limited air-to-ground attack capability was not accomplished but is scheduled to be done as part of the follow-on operational test planned to start in July 2005.

The F/A-22 initial operational test and evaluation was conducted by the Air Force Operational Test and Evaluation Center from April through December 2004 to support the full-rate production decision planned for March 2005. Its operational test plan was designed to assess the F/A-22’s

combat effectiveness and suitability in an operationally representative environment. The warfighter had established five critical operational issues for evaluation during operational testing to demonstrate effectiveness and suitability:

- **effectiveness**—demonstrate operational performance to effectively execute selected counter-air missions;
- **survivability**—assess ability to evade and survive against air-to-air and surface-to-air threats;
- **deployability**—evaluate the timely transportability and set up of F/A-22 personnel and equipment into a theater of operations;
- **sortie generation**—assess how well air crews can generate and launch sorties, including maintenance and supply support capabilities; and
- **ground attack**—demonstrate limited air-to-ground attack with the Joint Direct Attack Munition.

The first two issues assess combat effectiveness in completing selected counter air missions and in surviving against representative air and ground threats. The second two issues assess suitability of F/A-22 to support combat by transporting, deploying and sustaining forces and equipment. These four critical operational issues were addressed in IOT&E. The fifth critical operational issue—ground attack—was not addressed in IOT&E and will be assessed during follow-on operational test and evaluation, scheduled to start in July 2005. This follow-on testing is also planned to include demonstrations of corrective actions for some deficiencies identified during IOT&E and other testing needed to achieve initial operational capability in December 2005. Additional follow-on operational tests are planned in the future to test new, more robust attack capabilities and other enhancements added by the modernization program.

Combat effectiveness and survivability testing included extensive flight tests to evaluate air-to-air capabilities including (1) offensive counter-air missions against aggressor aircraft and (2) defensive counter-air missions to accompany and protect friendly strike and high value support aircraft from attack by aggressor aircraft. These tests incorporated ground and air threats resident at the Air Force's Nevada test range. Computer simulations and models were also used to evaluate performance against future threats and in other scenarios that cannot be replicated in open flight tests.

Test officials told us that the F/A-22 performed all the air-to-air missions very satisfactorily, demonstrating “overwhelming effectiveness” in their words. Officials also said that, in direct comparability tests with the F-15C,

the F/A-22 demonstrated a clear advantage often many more times the effectiveness of the F-15C. Testing did reveal some areas needing improvement, including avionics reliability, defensive systems, and other corrective actions that will need to be addressed in follow-on testing.

Test officials characterized F/A-22 suitability demonstrations for the aircraft and support systems as “potentially suitable.” The ability to transport and deploy F/A-22 personnel and equipment was adequately demonstrated and met the interim goal set by the warfighter regarding the number of airlift planes needed to transport forces and support equipment in the required amount of time.

Of the four critical operational issues assessed, sortie generation experienced the most problems. Officials rated the sortie generation area as unsatisfactory. Problems were noted in aircraft reliability and maintainability, including maintenance of the aircraft’s critical low observable characteristics. Problems were also noted in the maturity of integrated diagnostic systems, key assets expected to greatly improve and accelerate field maintenance activities for meeting sortie rates with constrained personnel. Officials believe these and other deficiencies can be corrected in time to meet the warfighter’s needs. For example, officials said the mission capability rate demonstrated during testing has continued to improve and is close to achieving the warfighter’s desired rate, not required until December 2005. However, the testing and implementation of most corrective actions will not occur until after the full-rate production decision.

Sortie generations and support activities also required the extensive involvement of contractor personnel for providing technical assistance, off-aircraft maintenance, and engineering, including trouble-shooting and use of special test equipment. Air Force officials said that extensive contractor involvement has long been planned for the F/A-22 system, particularly during initial fielding, and that reliance on contractor personnel and special test equipment should somewhat lessen as Air Force personnel gain experience.

Before full-rate production can start, the Office of the Director of Operational Test and Evaluation must still review test results and report to

Congress and defense leadership.¹⁷ In addition, the F/A-22 program must demonstrate it satisfies criteria established by the Defense Acquisition Board in November 2004. Among other things, that criteria includes delivering a fully-resourced plan for follow-on testing to correct deficiencies identified in IOT&E, achieving design stability of the avionics software, demonstrating mature manufacturing processes, and validating technical order data.

Conclusions

The Air Force, in the face of significant changes to the F/A-22, has not prepared a new business case to justify the resources needed to add a much more robust ground attack capability and to assume new missions. Over the 19 years that the program has been in development, the world threat environment has changed and the capabilities the Air Force once needed and planned for in the F-22 may not satisfy the warfighter's future needs. Additionally, cost growth over time and affordability concerns have driven down planned aircraft quantities from 750 to 178 aircraft. The Air Force is now planning a modernization program that will substantially change the role of the F/A-22. Because of budget cuts in the program that have eliminated F/A-22 procurement after 2008 the modernization program as planned is obsolete. Even if aircraft are restored to the procurement plan beyond 2008, this modernization is projected to occur over a 12-year period. Based on the program's current knowledge, there is significant risk that the planned modernization would not move ahead and deliver capability to the warfighter on schedule. The original plan to develop and deliver an initial capability for the F-22 was 9 years—it has taken nearly 20 years. Our body of work in best practices tells us one thing for certain, and that is that the chances of attaining successful outcomes are substantially increased when a business case is made that matches requirements and resources for developing a product. Right now both requirements and resources for the F/A-22 program are in a state of flux and it lacks a business case to move forward with billions of dollars in planned investments.

¹⁷ 10 U.S.C. section 2399 provides that a major defense acquisition program may not proceed beyond low-rate initial production until initial operational test and evaluation is completed and the congressional defense committees have received the report of testing results from the Director of Operational Test and Evaluation. This report is to contain an opinion about test adequacy and whether the test results confirm that the system actually tested is operationally effective and suitable for combat.

Over the immediate horizon, planned studies present OSD with opportunities to answer questions about need and affordability of the F/A-22. The 2005 Quadrennial Defense Review is expected to make a strategic assessment of available and planned tactical air capabilities to help determine where to target resources. Likewise, an ongoing series of joint capabilities reviews, to include the F/A-22, could help determine where the F/A-22 now fits in the force structure. These top-level studies would provide information needed for a specific F/A-22 business case that would place DOD leaders in a better position to decide on remaining F/A-22 investments in concert with other tactical aircraft and DOD needs. The F/A-22 full rate production decision is currently planned for March 2005, before the results of these studies are available and production is already at near full rate quantities.

Recommendations for Executive Action

Because of evolving threats against the United States; pending changes in U.S. defense plans; the lack of clarity regarding F/A-22 required capabilities, quantities, and resources; the recent budget decision; and upcoming reviews on joint air capabilities, we are reiterating and expanding upon the recommendation in our March 2004 report for a new and comprehensive business case to justify future investment in the F/A-22 program. We recommend the Secretary of Defense complete a new business case that determines the continued need for the F/A-22 and that specifically:

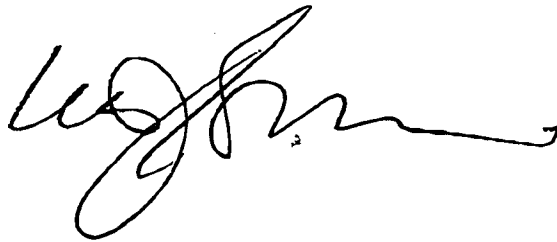
- (a) justifies the F/A-22's expanded air-to-ground capabilities based on an assessment of alternatives to include both operational assets and planned future weapon systems;
- (b) justifies the quantity of F/A-22 aircraft needed to satisfy requirements for air-to-air and air-to-ground missions;
- (c) provides evidence that the planned quantity and capabilities are affordable within current and projected budgets and the statutory funding limitation;
- (d) addresses impacts of the recent budget decision on the need for and cost of future developmental activities, long-term logistical support and basing decisions, and the ability to take advantage of cost reduction efforts, such as multiyear contracting and productivity improvement; and
- (e) justifies the need for investments for a new computer architecture and avionics processor, and F/A-22 infrastructure deficiencies.

Agency Comments and Our Evaluation

In written comments on a draft of this report, DOD concurred with our recommendation. They identified the following actions planned that would accomplish business case elements: (1) the 2005 Quadrennial Defense Review will address quantity of aircraft needed for air-to-air and air-to-ground missions; (2) Defense Acquisition Board reviews of the F/A-22 program will ensure that initial modernization efforts have validated requirements and are tested; and (3) the plan to break out the latter stages of modernization as a separate acquisition program will require the Air Force to develop requirements, perform an analysis to substantiate those requirements, and justify investments in new capabilities.

DOD also stated its concern that by only reporting total program acquisition unit cost (pp. 5 and 6 herein), the report does not provide a balanced picture. They asked us to also present information concerning the steady reduction in unit flyaway costs over the course of the program. Flyaway costs do not include “sunk” costs and fixed expenses for program start-up, development, test, construction, and support but focus on the procurement costs of buying additional systems, costs that generally decrease as a production program matures and manufacturing efficiency improves. In response, we provided additional information about flyway costs and potential diseconomies from truncating the procurement program (see p. 12). We also incorporated other technical comments from DOD where appropriate.

We are sending copies of this report to the Secretary of Defense; the Secretary of the Air Force; and the Director, Office of Management and Budget. Copies will also be made available to others on request. Please contact me or Michael J. Hazard at (202) 512-4841 if you or your staff has any questions concerning this report. Other contributors to this report were Robert Ackley, Michael W. Aiken, Lily J. Chin, Bruce D. Fairbairn, Steven M. Hunter, and Adam Vodraska.

A handwritten signature in black ink, appearing to read "Michael J. Sullivan". The signature is stylized with large, sweeping loops and a long horizontal tail.

Michael J. Sullivan
Director
Acquisition and Sourcing Management

List of Congressional Committees

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

The Honorable Ted Stevens
Chairman
The Honorable Daniel K. Inouye
Ranking Minority Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

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

The Honorable C. W. Bill Young
Chairman
The Honorable John P. Murtha
Ranking Minority Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Appendix I: Scope and Methodology

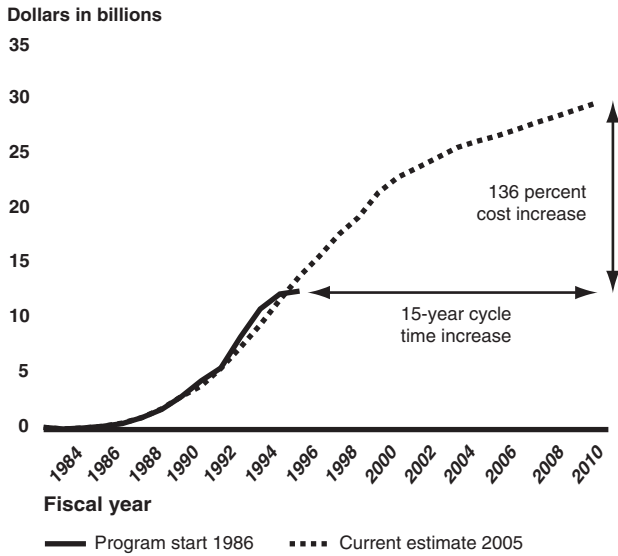
To determine the Air Force's F/A-22 modernization plans and funding requirements, we analyzed budget documents, cost reports, acquisition plans, and project listings to identify the purpose, scope, and cost of the modernization efforts. Officials from the Air Force and the Office of the Secretary of Defense (OSD) briefed us on program details, specific candidate projects, and program history. We compared current plans and project listings with previous time periods to determine changes in modernization projects and schedules. We also compared cost estimates prepared by the Air Force and OSD's cost analysts in order to identify key differences in assumptions used, cost factors applied, and time periods and to reconcile how these differences impacted final results.

To determine the results and implications of the initial operational test and evaluation on the F/A-22 program, we first reviewed test plans, laws and regulations governing operational tests, and management direction affecting the scope and schedule of testing. We then discussed summary results and program impacts, including schedule issues, with testing and evaluating officials from the Air Force and OSD. We also reviewed briefing materials used by testing officials to inform DOD management and congressional staffs on the results of initial operational test and evaluation (IOT&E). However, at the time of our review, the final reports on IOT&E results from the Air Force's Operational Test and Evaluation Center and the OSD Director of Operational Test and Evaluation were not issued nor were drafts made available to us. Accordingly, our analysis of actual results and data was somewhat constrained and our reporting limited to providing summary level observations on test scope, results, and corrective actions identified. Notwithstanding, DOD officials gave us access to sufficient information to make informed judgments on the matters covered in this report.

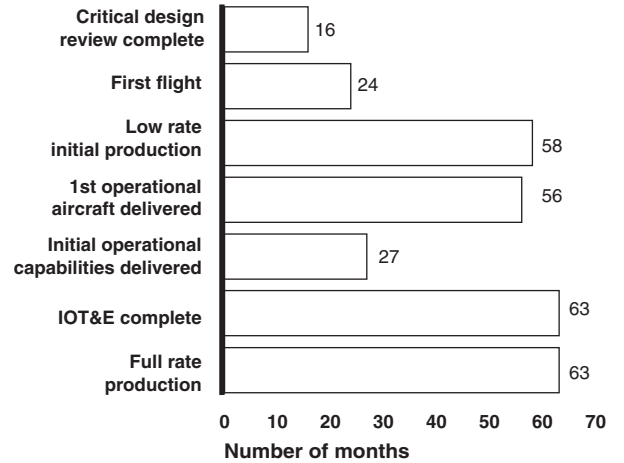
In performing our work, we obtained information and interviewed officials from the Office of the Secretary of Defense, Washington, D.C., including the offices of the Under Secretary of Defense for Acquisition, Technology and Logistics, the Director of Operational Test and Evaluation, the Program Analysis and Evaluation, and the Cost Analysis Improvement Group; Air Force Headquarters, Washington, D.C.; F/A-22 System Program Office, Wright-Patterson Air Force Base, Ohio; Air Combat Command, Langley Air Force Base, Virginia; Air Force Operational Test and Evaluation Center, Kirkland Air Force Base, New Mexico; and the Combined Flight Test Center, Edwards Air Force Base, California.. We performed our work from November 2004 through February 2005 in accordance with generally accepted government auditing standards.

Appendix II: F/A-22 Program Cost, Quantity, and Schedule Changes

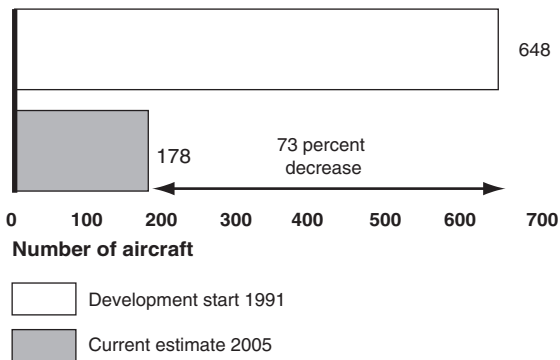
Development costs and cycle times have increased



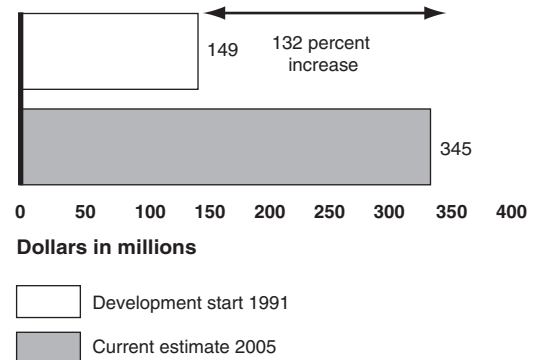
Events delayed since system development started in 1991



Procurement quantities have decreased



Program acquisition unit costs have increased



Source: GAO analysis of Air Force data.

Appendix III: Comments from the Department of Defense



ACQUISITION,
TECHNOLOGY
AND LOGISTICS

OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

MAR 09 2005

Mr. Michael J. Sullivan
Director, Acquisition and Sourcing Management
U.S. Government Accountability Office
441 G Street, NW
Washington, D.C. 20548

Dear Mr. Sullivan:

This is the Department of Defense's (DoD's) response to the Government Accountability Office's (GAO's) draft report, "TACTICAL AIRCRAFT: Air Force Still Needs Business Case to Support F/A-22 Quantities and Increased Capabilities," dated February 15, 2005 (GAO Code 120380/GAO-05-304).

The draft GAO report provides one recommendation in five parts. The Department of Defense concurs with the recommendation. A discussion of the ways in which the Department is addressing the recommendation is provided at Attachment 1. Additional comments and recommendations regarding the report are provided at Attachment 2. In particular, the Department is concerned that by only presenting total acquisition unit cost, the report does not provide a balanced picture of the cost to produce F/A-22 aircraft. We strongly recommend that the report also present information depicting the steady reduction in unit-flyaway costs over the course of the F/A-22 program.

Thank you for the opportunity to respond to this draft report.

Sincerely,

Glenn F. Lamartin
Director
Defense Systems

Attachments:
As stated



“TACTICAL AIRCRAFT: Air Force Still Needs Business Case to Support F/A-22 Quantities
and Increased Capabilities”

**DEPARTMENT OF DEFENSE COMMENTS
TO THE RECOMMENDATION**

RECOMMENDATION: GAO recommends the Secretary of Defense complete a new business case that determines the continued need for the F/A-22 and that specifically:

- (a) justifies the F/A-22's expanded air-to-ground capabilities based on an assessment of alternatives to include both operational assets and planned future weapon systems;
- (b) justifies the quantity of F/A-22 aircraft needed to satisfy requirements for air-to-air and air-to-ground missions;
- (c) provides evidence that the planned quantity and capabilities are affordable within current and projected budgets and the statutory funding limitation;
- (d) addresses impacts of the recent budget decision on the need for and cost of future developmental activities, long-term logistical support and basing decisions, and the ability to take advantage of cost reduction efforts, such as multiyear contracting and productivity improvement; and
- (e) justifies the need for investments for a new computer architecture and avionics processor, and F/A-22 infrastructure deficiencies.

RESPONSE: The Department of Defense (DoD) concurs with the GAO's recommendation. Actions are currently underway, or planned, to accomplish those items addressed in the recommendation.

As noted in the report, the PB06 budget deliberations require that the 2005 Quadrennial Defense Review (QDR) include an assessment of joint air dominance in future warfare and the contributions provided by all tactical aircraft, including the F/A-22. Accordingly, the QDR will address the quantity of F/A-22 aircraft needed to satisfy requirements for air-to-air and air-to-ground missions. In support of the QDR, DoD is performing an aircraft capabilities study. The objective of this study is to evaluate the capabilities that planned U.S. air superiority and strike forces will bring to bear in meeting future potential threats, and to assess options that may be developed to reduce selected risks. Options may include alternative force structures, aircraft and system upgrades, and enhancements to the F/A-22's air-to-air and air-to-ground capabilities. A product of the QDR will be an assessment of the affordability of

“TACTICAL AIRCRAFT: Air Force Still Needs Business Case to Support F/A-22 Quantities
and Increased Capabilities”

alternative tactical aviation force structures, including procurement quantities and development of enhanced capabilities.

Moreover, in its oversight of the development and acquisition of modernization Increment 4, the Department will conduct an analysis that is consistent with the GAO’s definition of a business case, as defined in the report. As noted in the GAO’s draft report, the Acting Under Secretary of Defense (Acquisition, Technology and Logistics) “directed the Air Force to break out the latter stages of the modernization efforts and manage it as a separate acquisition program.” This refers specifically to Increment 4, which the Air Force has not defined, but which may include a new computer architecture and avionics processor. The Air Force is required by DoD and Joint Chiefs of Staff regulations to develop requirements and perform an analysis to substantiate those requirements, and to justify investments in the new capabilities proposed. The analysis must show that the concept can be developed and produced within existing resources. The decision to proceed will also be based on an assessment of cost, schedule and technical risk. The risk assessment will address the adequacy of design knowledge. If the development requires advanced technologies, those technologies must be demonstrated to a sufficient level of maturity to permit development to proceed with acceptable cost, schedule, and technical risk.

Although the Department has decided to manage Increments 2 and 3 as part of the existing F/A-22 program, those spirals will be subject to separate Defense Acquisition Board (DAB) reviews. These DAB reviews will ensure that each capability increment has validated requirements and is subject to operational test and evaluation.

The Department recognizes that President’s Budget for Fiscal Year 2006 (PB-06) will have an impact on decisions regarding logistical support and basing, and on the viability of cost-reduction initiatives. The Air Force currently is evaluating these impacts. Because the PB-06 curtails production in Fiscal Year 2008, it effectively forecloses the multi-year procurement of F/A-22 aircraft.

Attachment 1

Related GAO Products

Defense Acquisitions: Assessments of Major Weapon Programs. [GAO-04-248](#). Washington, D.C.: March 31, 2004.

Tactical Aircraft: Status of the F/A-22 and Joint Strike Fighter Programs. [GAO-04-597T](#). Washington, D.C.: March 25, 2004.

Tactical Aircraft: Changing Conditions Drive Need for New F/A-22 Business Case. [GAO-04-391](#). Washington, D.C.: March 15, 2004.

Best Practices: Better Acquisition Outcomes Are Possible If DOD Can Apply Lessons from F/A-22 Program. [GAO-03-645T](#). Washington, D.C.: April 11, 2003.

Tactical Aircraft: Status of the F/A-22 Program. [GAO-03-603T](#). Washington, D.C.: April 2, 2003.

Tactical Aircraft: DOD Should Reconsider Decision to Increase F/A-22 Production Rates While Development Risks Continue. [GAO-03-431](#). Washington, D.C.: March 14, 2003.

Tactical Aircraft: F-22 Delays Indicate Initial Production Rates Should Be Lower to Reduce Risks. [GAO-02-298](#). Washington, D.C.: March 5, 2002.

Tactical Aircraft: Continuing Difficulty Keeping F-22 Production Costs Within the Congressional Limitation. [GAO-01-782](#). Washington, D.C.: July 16, 2001.

Tactical Aircraft: F-22 Development and Testing Delays Indicate Need for Limit on Low-Rate Production. [GAO-01-310](#). Washington, D.C.: March 15, 2001.

Defense Acquisitions: Recent F-22 Production Cost Estimates Exceeded Congressional Limitation. [GAO/NSIAD-00-178](#). Washington, D.C.: August 15, 2000.

Defense Acquisitions: Use of Cost Reduction Plans in Estimating F-22 Total Production Costs. [GAO/T-NSIAD-00-200](#). Washington, D.C.: June 15, 2000.

F-22 Aircraft: Development Cost Goal Achievable If Major Problems Are Avoided. [GAO/NSIAD-00-68](#). Washington, D.C.: March 14, 2000.

Defense Acquisitions: Progress in Meeting F-22 Cost and Schedule Goals. [GAO/T-NSIAD-00-58](#). Washington, D.C.: December 7, 1999.

Fiscal Year 2000 Budget: DOD's Production and RDT&E Programs. [GAO/NSIAD-99-233R](#). Washington, D.C.: September 23, 1999.

Budget Issues: Budgetary Implications of Selected GAO Work for Fiscal Year 2000. [GAO/OCG-99-26](#). Washington, D.C.: April 16, 1999.

Defense Acquisitions: Progress of the F-22 and F/A-18E/F Engineering and Manufacturing Development Programs. [GAO/T-NSIAD-99-113](#). Washington, D.C.: March 17, 1999.

F-22 Aircraft: Issues in Achieving Engineering and Manufacturing Development Goals. [GAO/NSIAD-99-55](#). Washington, D.C.: March 15, 1999.

F-22 Aircraft: Progress of the Engineering and Manufacturing Development Program. [GAO/T-NSIAD-98-137](#). Washington, D.C.: March 25, 1998.

F-22 Aircraft: Progress in Achieving Engineering and Manufacturing Development Goals. [GAO/NSIAD-98-67](#). Washington, D.C.: March 10, 1998.

Tactical Aircraft: Restructuring of the Air Force F-22 Fighter Program. [GAO/NSIAD-97-156](#). Washington, D.C.: June 4, 1997.

Defense Aircraft Investments: Major Program Commitments Based on Optimistic Budget Projections. [GAO/T-NSIAD-97-103](#). Washington, D.C.: March 5, 1997.

F-22 Restructuring. [GAO/NSIAD-97-100R](#). Washington, D.C.: February 28, 1997.

Tactical Aircraft: Concurrency in Development and Production of F-22 Aircraft Should Be Reduced. [GAO/NSIAD-95-59](#). Washington, D.C.: April 19, 1995.

Tactical Aircraft: F-15 Replacement Issues. [GAO/T-NSIAD-94-176](#). Washington, D.C.: May 5, 1994.

Tactical Aircraft: F-15 Replacement Is Premature as Currently Planned. [GAO/NSIAD-94-118](#). Washington, D.C.: March 25, 1994.

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