United States General Accounting Office

GAO

Report to Congressional Committees

March 2001

TACTICAL AIRCRAFT

F-22 Development and Testing Delays Indicate Need for Limit on Low-Rate Production

GAO-01-310

Contents

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Accountability * Integrity * Reliability

United States General Accounting Office
Washington, D.C. 20548

March 15, 2001

Congressional Committees

As you know, the Air Force is developing the F-22 aircraft—which is designed with advanced features to allow it to be less detectable to adversaries, capable of high speeds for long ranges, and able to provide the pilot with substantially improved awareness of the surrounding situation through the use of integrated aviation electronics (avionics). These features are expected to permit the F-22 to penetrate adversary airspace, operate with limited interference, and destroy targets in the air as well as on the ground. In view of past increases in cost estimates to complete development, the National Defense Authorization Act for Fiscal Year 1998[1] limited the cost of F-22 development to $20.443 billion, as adjusted under the act's provisions. The act requires us to annually assess whether the Air Force's engineering and manufacturing development program for the F-22 aircraft is meeting key goals. The act also requires us to assess whether we had access to sufficient information to make informed judgments on matters covered by our report.

The Air Force began F-22 engineering and manufacturing development in 1991, and it planned in December 2000 to complete ground and flight-testing in August 2002, to be followed by a year of operational tests and evaluation to demonstrate the aircraft's operational suitability and effectiveness. Completion of operational tests and evaluation will mark the end of F-22 development. Concurrent with these development activities, the Air Force plans to initiate low-rate production of F-22s, beginning with 10 aircraft in fiscal year 2001. This increases to 16 aircraft in fiscal year 2002.

In March 2000,[2] we reported that the Air Force had made progress in achieving its schedule goals and demonstrating expected F-22 performance. However, some tests and scheduled activities were delayed because of continuing problems delivering flight-test aircraft on time. We also reported that, according to the Air Force, if these problems persisted, as much as 37 to 50 percent of the total planned flight-test program would

[1] P.L. 105-85, Nov. 18, 1997.

[2] *F-22 Aircraft: Development Cost Goal Achievable If Major Problems Are Avoided* (GAO/NSIAD-00-68, Mar. 14, 2000).

not be completed as scheduled. Additionally, we reported that the Air Force had identified potential cost growth but had planned to mitigate this growth through offsetting cost reductions.

This report discusses (1) the extent to which the development program is meeting its schedule, cost, and performance goals, including whether the program is likely to be completed within the congressional cost limitation; (2) the status of F-22 modifications; (3) the development plan for fiscal year 2002; and (4) the Air Force's plan to increase the annual rate of initial production of F-22 aircraft before the development program is completed. This report was initially prepared based on the status and progress of the F-22 program through December 2000 and a draft was provided to DOD for comments in January 2001. The report, for the most part, identifies DOD's progress in meeting goals through December 2000, but also includes information about activities and events that occurred in January through early March 2001.

Results in Brief

The F-22 program did not meet its schedule goals for 2000, the cost to complete development as now planned may exceed the congressionally established limitation, and the program is not far enough along in flight-testing to confirm Department of Defense (DOD) estimates of weapon system performance. First, while progress was made toward achieving test requirements to evaluate the aircraft's capabilities, problems and delays were encountered with the assembly and delivery of flight-test aircraft. Test aircraft that were delivered were not ready for flight-testing and the operations of the flight-test program were not as efficient as planned. These delays prevented the Air Force from completing the flight-test hours planned for 2000, and, when coupled with delays from prior years, make it unlikely that the flight-test program, as now structured, can be completed by August 2002, as scheduled. It is also unlikely that operational test and evaluation can be completed by August 2003. Second, it appears unlikely that the development program can be completed as scheduled within the current $20.443 billion congressional cost limitation. Furthermore, contractor cost growth and potential extension of the flight-test program could generate additional costs that are not considered in current cost estimates. On January 19, 2001, the Director, Operational Test and Evaluation, advised the Secretary of the Air Force and the Congress that the Air Force had provided a plan to extend development tests by 4- to 6-months and that he had determined the 1.5-percent increase in the cost

limitation was necessary to ensure adequate testing.[3] Consequently, the Air Force plans to increase the cost limitation by 1.5 percent in the spring of 2001. However, the Director also stated that the delay in completing required testing might be longer than projected by the Air Force. While an internal Air Force cost study recognized that the estimated cost to complete development may increase by $126 million to $297 million, the Air Force had not sought an increase in the congressional limitation through March 6, 2001. Air Force officials maintain they are currently prioritizing work to allow for completion within the cost limitation but recognize that some development activities could be delayed. Accordingly, some test activities could also be delayed or dropped. Third, the Air Force continues to project that by the time the development program ends, the F-22 will meet or exceed its performance goals. However, testing to demonstrate performance is not far enough along to enable the Air Force to confirm its projections. One performance goal that may be difficult to meet is the average flight hours that can be achieved for an F-22 without requiring maintenance. With regard to the status of modifications or repairs, the Air Force solved problems identified earlier with a casting used to attach the wing to the aircraft body, and with unexpected stress in the aft (rear) fuselage of the aircraft. Manufacturing processes were changed and previously delivered aircraft were modified. Air Force officials said that they are continuing to address other problems.

The F-22 development plan includes $860.4 million in fiscal year 2002 funding, mainly for completing the remainder of the development flight-test program, finishing airframe structural testing and analysis, and beginning operational tests. The plan is consistent with completion of the development program at a cost that meets the congressional limitation. However, the plan does not address the need to extend the test program to accommodate delays in accomplishing tests that both the Air Force and Director, Operational Test and Evaluation have recognized, or the possibility of increasing the congressional cost limitation to allow for the costs associated with these delays.

The fiscal year 2001 Defense Appropriations Act provided funds for low-rate initial production of 10 F-22 aircraft and for advance procurement for 16 F-22s planned for procurement in fiscal year 2002. DOD plans to

[3] The National Defense Authorization Act for fiscal year 2001 provided for an increase to the cost limitation by up to 1.5 percent if the Director, Operational Test and Evaluation determined the increase was necessary to ensure adequate testing.

procure 24 aircraft in fiscal year 2003 and begin full-rate production of 36 aircraft a year in fiscal year 2004. In several reports over the last 6 years, we have concluded that DOD should minimize commitments to F-22 production until completion of operational test and evaluation. Flight-testing progress through December 2000, and an independent assessment by the Director, Operational Test and Evaluation, reinforce our prior conclusion. Limiting low-rate initial production to no more than 10 aircraft a year—the quantity approved in fiscal year 2001 appropriations and authorization acts—until completion of initial operational test and evaluation would minimize risks.

As discussed in the scope and methodology section of this report, the Air Force and contractors provided us access to sufficient information to make informed judgments on the matters covered by this report.

This report includes a recommendation that the Air Force provide the Congress with information and analysis in the form of a plan to complete testing. Furthermore, in view of the amount of testing that has yet to be completed, this report also includes a recommendation that initial production be limited until completion of operational testing. In regard to the first recommendation, DOD agreed there are concerns regarding completion of development testing within the period remaining for engineering and manufacturing development and that adjustments are needed in the F-22 program to ensure adequate development testing is completed prior to entry into operational test and evaluation. In regard to the second recommendation, DOD officials said they did not concur with the recommendation and stated it was premature to comment on any change in the rate of low-rate initial production, pending further progress in a defense program review directed by the President.

Background

The F-22 is an air superiority[4] aircraft with advanced features to make it less detectable to adversaries (stealth characteristics) and capable of high speeds for long ranges. It has integrated aviation electronics (avionics) to greatly improve pilots' awareness of the situation surrounding them. The objectives of the F-22 development program are to (1) design, fabricate, test, and deliver 9 F-22 flight-test aircraft, 2 nonflying structural test aircraft, 8 production representative test aircraft, and 37 flight-qualified

[4] 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.

engines; (2) design, fabricate, integrate, and test the avionics suite; and (3) design, develop, and test the support and training systems. The F-22 is being developed under contracts with Lockheed Martin Corporation (for the aircraft) and Pratt & Whitney Corporation (for the engine).

Following a history of increasing cost estimates to complete development of the F-22, the National Defense Authorization Act for Fiscal Year 1998[5] established a cost limitation of $18.688 billion for F-22 development and a limitation of $43.400 billion for production. The act instructed the Secretary of the Air Force to adjust the cost limitation for the amounts of increases or decreases in costs attributable to economic inflation after September 30, 1997, and for compliance with changes in federal, state, and local laws enacted after September 30, 1997. Congressional direction in fiscal year 2000 legislation shifted six production representative test aircraft to the development program and also caused the cost limitation to be adjusted. Since implementation, the cost limitation has been adjusted to its current amount of $20.443 billion.

For fiscal year 2000, the Air Force requested $1.6 billion for initial production of six F-22 aircraft. However, both authorization and appropriations acts for fiscal year 2000 established further congressional direction for the program. The authorization act[6] required that before the Secretary of the Air Force executes a contract for low-rate initial production of the F-22, the Secretary of Defense has to certify:

1. that the test plan in the engineering and manufacturing development phase of the program is adequate for determining the operational effectiveness and suitability of the F-22 aircraft and

2. that the engineering and manufacturing development phase, and the production phase for the F-22 program can each be executed within the congressionally mandated cost limitations.[7]

If the Secretary of Defense is unable to make either of these certifications then he is required to submit to the congressional defense committees a report that includes:

[5] P.L. 105-85, Nov. 18, 1997.

[6] P.L. 106-65, Oct. 5, 1999.

[7] The limitation on production cost does not specify a quantity of F-22 aircraft.

1. the reasons that either of the certifications cannot be made,

2. a revised acquisition plan approved by the Secretary of Defense if the Secretary desires to proceed with F-22 low-rate initial production, and

3. a revised cost estimate for the remainder of the engineering and manufacturing development phase and for the production phase of the program if the Secretary desires to proceed with low-rate initial production.

The appropriations act[8] for fiscal year 2000 did not approve initial production but approved acquisition of additional flight-test aircraft with research, development, test, and evaluation funding. The act restricted award of a fully funded contract for low-rate initial production until (1) the first flight of an F-22 aircraft incorporating an avionics system designated block 3.0, which brings the software into an integrated system; (2) the Secretary of Defense certifies to the congressional defense committees that all criteria for the award of low-rate initial production have been met (including first flight of the block 3.0 system); and (3) the Director, Operational Test and Evaluation, reports to the congressional defense committees on the adequacy of testing to measure and predict the performance of avionics systems, stealth characteristics, and weapon delivery systems. Through March 6, 2001, the Secretary of Defense had not completed the required certifications and the Director, Operational Test and Evaluation, had not submitted the required report.

The fiscal year 2001 authorization act[9] amended prior cost limitation provisions, permitting the Secretary of the Air Force to increase, by up to 1.5 percent, the limitation on the cost of engineering and manufacturing development, if the Director, Operational Test and Evaluation, after consultation with the Under Secretary of Defense for Acquisition, Technology, and Logistics, determines that the increase is necessary to ensure adequate testing. For fiscal year 2001, the Congress appropriated $2.1 billion for initial production of 10 aircraft. The fiscal year 2001 appropriations act[10] confirmed the prerequisites of the fiscal year 2000

[8] P.L. 106-79, Oct. 25, 1999.

[9] Floyd D. Spence National Defense Authorization Act for Fiscal Year 2001, P.L. 106-398, Oct. 30, 2000.

[10] P.L. 106-259, Aug. 9, 2000.

appropriations act. Before awarding a fully funded contract to begin low-rate production of 10 F-22 aircraft in fiscal year 2001, prerequisites included in the appropriations and authorization acts for fiscal years 2000 and 2001 must be fulfilled.

In December 2000, the Congress passed, and the President signed, legislation[11] that provided the Air Force authority to obligate up to $353 million of the fiscal year 2001 production appropriations if a full contract award for low-rate production is delayed beyond December 31, 2000, because of the program's inability to satisfy the prerequisites established by the Congress. The Air Force, as permitted by legislation, obligated the majority of these funds in February 2001 for F-22 contractors to proceed with advance procurement but without awarding a fully funded contract for low-rate initial production. On March 6, 2001, the Secretary of Defense requested the four defense committees to approve reprogramming of $674.5 million of fiscal year 2001 procurement funds to the advance procurement line to extend, through fiscal year 2001, the authority that had been provided in December 2000. At the same time, the Secretary indicated that the decision to award a contract to initiate low-rate production for 10 aircraft was deferred pending completion of a defense program review directed by the President.

Extent to Which the F-22 Development Program Is Meeting Schedule Goals

Through 2000, the Air Force had completed about 22 percent of its planned flight-testing hours for the F-22, and said it had fulfilled 9 of 11 DOD and congressional development and test criteria for awarding a low-rate production contract. The Air Force stated that all 11 criteria had been met by February 5, 2001.[12] However, the development program was behind in meeting key schedule goals. The Air Force acknowledges that the flight-test program is facing a potential 4- to 6-month extension because tests have been delayed and not enough time remains to complete all of the planned testing before the planned completion in August 2002. Furthermore, the program is running behind schedule in completing nonflying tests that assess the structural integrity of the F-22 airframe.

[11] P.L. 106-554, Dec. 21, 2000.

[12] Our review of the F-22 program did not include a validation of the Air Force's statement that the criteria had been met.

Progress Made in 2000

During 2000, four test aircraft were assembled and first flight was achieved on two of these aircraft. The Air Force continued flight-testing with these aircraft and completed 325 flight-test hours during the year. The Air Force also began avionics flight-testing and the second phase of testing on the nonflying structural aircraft. Through December 2000, the Air Force said it fulfilled 9 of 11 criteria set by the Under Secretary of Defense for Acquisition, Technology, and Logistics, and the Congress for awarding a fully funded contract for the first lot of 10 production aircraft. The Air Force stated that all 11 criteria had been met by February 5, 2001. The criteria included completing the first flight of specific test aircraft, initiating certain types of tests such as high angle-of-attack testing, and completing other specific tests. (See app. I for a listing of the criteria.)

Air Force Did Not Meet Schedule Goals for Flight-Tests

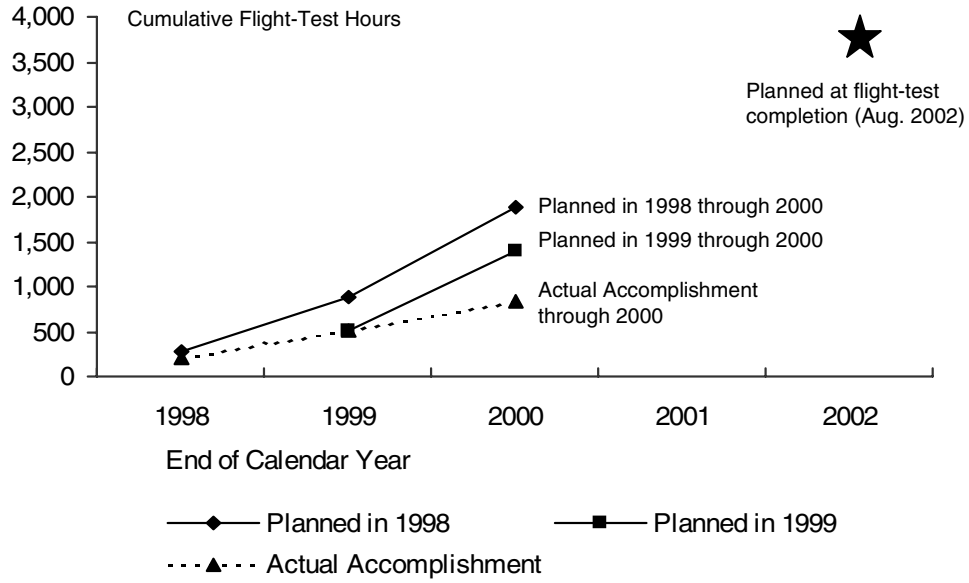
The Air Force did not meet its schedule goals in 2000 for flight-testing the F-22. The reasons included

- problems and delays with the assembly and delivery of flight-test aircraft,
- delivery of flight-test aircraft that were not ready for testing, and
- lower than planned efficiency in the flight-test program.

Figure 1 compares flight-test hours accomplished and the number of hours planned for 2000 in late 1998 and in late 1999. We calculated, based on planned introduction of new test aircraft into the flight-test program, that the Air Force, in late 1998, was planning[13] to accomplish about 1,900 flight-test hours by the end of 2000. At the end of 1999, the Air Force planned to accomplish about 1,400 hours. However, actual hours through December 2000 totaled about 831—well short of planned hours. About 78 percent of the total planned flight-test program hours remain to be completed to reach the goal of completing 3,757 hours by August 2002.

[13] Air Force officials advised us, however, that they had no documented plan indicating they intended to accomplish this amount of flight-test hours by the end of 2000.

Figure 1: Comparison of Actual and Planned Flight-Test Hours



Source: GAO analysis of Air Force data.

Late Introduction of Flight-Test Aircraft

Flight-test aircraft are assembled at Lockheed Martin's facility in Marietta, Georgia. After final assembly, the Air Force accepts the aircraft. Lockheed Martin flies the aircraft, corrects problems, and ultimately flies the aircraft to the Air Force Flight Test Center at Edwards Air Force Base, California. At the Flight Test Center, other corrections or changes may be made before the aircraft is used to carry out flight-testing plans aimed at demonstrating the F-22's capabilities.

In early 2000, the Air Force anticipated that six aircraft would be available for flight-testing at the Flight Test Center by December 2000. However, only two flight-test aircraft actually were available. Contractor and Air Force officials told us that the test aircraft took longer to manufacture and assemble than planned because of design changes and modifications to the aircraft, parts shortages, and the need to complete certain assembly tasks out of sequence.

Table 1 shows the number of hours required to assemble the four aircraft that were completed during 2000, compared to the number of hours planned and the difference.

Table 1: Planned Versus Actual Assembly Hours for Recently Completed Aircraft

Aircraft	Planned assembly hours	Actual assembly hours	Difference
4003	269,360	272,799	+3,439
4004	230,588	265,731	+35,143
4005	207,345	229,387	+22,042
4006	205,821	220,889	+15,068

Source: Air Force.

Appendix II details the planned dates for introduction of new test aircraft into the flight-test program and shows that the introduction of some aircraft has been substantially delayed from the prior plans—as much as 15 months in one case.

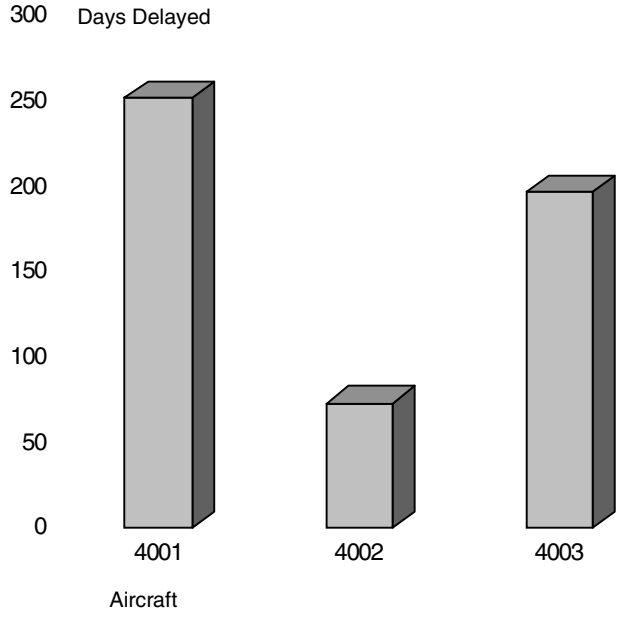
Some aircraft experienced additional delays at the contractor facility and the Flight Test Center after assembly was completed. For example, final assembly of aircraft 4004 was completed on January 26, 2000, and the aircraft was scheduled to make its first flight on May 3, 2000. However, a series of hardware and software-related problems caused that flight to be delayed until November 15, 2000.

In March 2000, we reported that these delays in meeting first flight dates meant the program had lost over 600 hours of flight-testing that would have been available had these aircraft been delivered on time. Because of continued late deliveries, the total hours lost through December 2000 was 1,062 hours.

Test Aircraft Introduced Into Flight-Test Program Not Ready for Testing

Even after delivery and being flown for the first time, test aircraft were not ready to accomplish flight-tests because they required more modifications and repairs, which caused additional delays. Delays ranged from 73 to 252 days for aircraft 4001, 4002, and 4003 (see fig. 2).

Figure 2: Flight-Test Aircraft Delays From First Flight Dates to Start of Flight-Testing at the Flight Test Center



Source: GAO analysis of Air Force data.

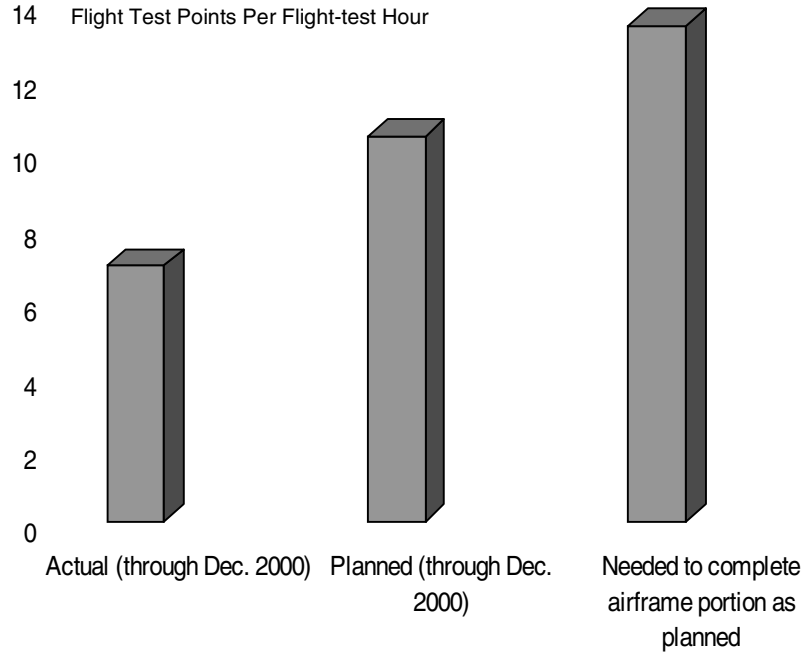
The delays these aircraft experienced can be attributed to planned, but yet unfinished, work. Over 2,500 labor hours of planned but unfinished work had to be completed on aircraft 4003 prior to beginning flight tests at the Flight Test Center. Aircraft 4003's entry into the flight-test program was also delayed by several modifications and repairs, such as those addressing problems with large titanium castings that attach the wing to the aircraft's body, structural inadequacies in the aft (rear) fuselage, and bonding of composite materials in the horizontal tail section. These problems as well as cracking problems with the clear section[14] of the aircraft canopy interrupted the flight-test program. If similar delays occur after the first flight dates of the remaining test aircraft, it will be even more difficult for the Air Force to complete the flight-test program as planned.

[14] The Air Force refers to this clear section as the transparency.

Flight-Test Program Not as Efficient as Planned

Even after test aircraft began to complete flight-test hours, the flight-testing hours and the overall flight-test program were not as efficient as planned. A gauge of the efficiency of flight-tests is the average number of test points (specific test objectives) achieved in each flight-test hour. Through December 2000, the Air Force planned to accomplish an average of about 10.4 test points per flight-test hour. However, it achieved about 30 percent less, or an average of 6.9 test points per flight-test hour. To complete the airframe portion of the flight-test program[15] as planned, according to our calculations the Air Force would have to almost double its accomplishment rate, to an average of about 13.4 test points per flight-test hour. Figure 3 shows actual, planned, and needed flight-test point accomplishment rates.

Figure 3: Comparison of Actual, Planned, and Needed Airframe Flight-Test Point Accomplishment Rates



Source: GAO analysis of Air Force data.

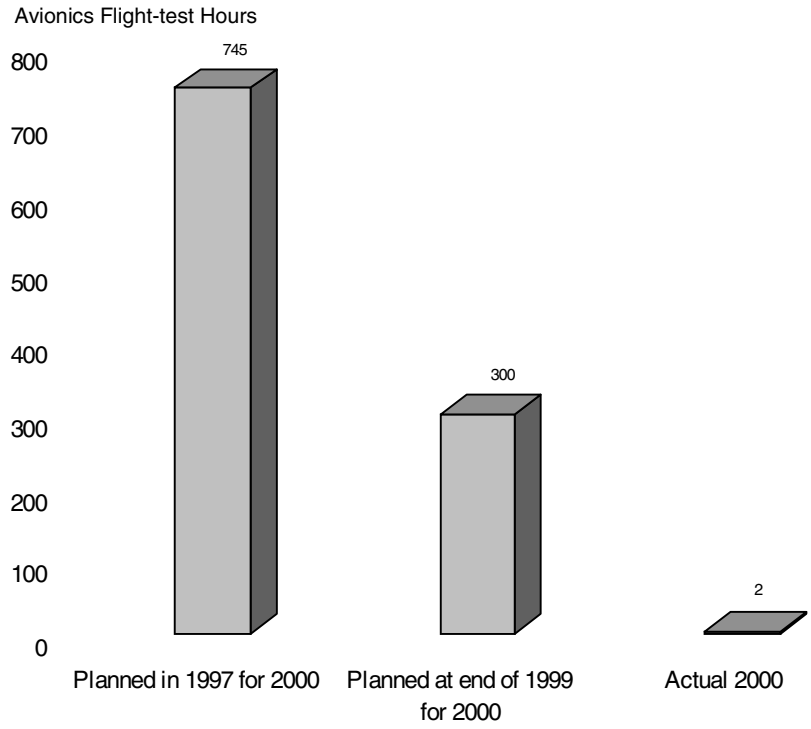
[15] The airframe portion of the flight-test program is the first portion and consists of about 20,000 test points and 1,800 flight-test hours. The second portion is avionics flight-testing and consists of about 1,970 flight-test hours.

Progress Is Less Than Planned in Avionics Flight-Testing

An integrated avionics system is a major feature of the F-22, permitting the pilot to have substantially better control of information regarding the surrounding situation. Tests of individual components and the integrated package are done on the ground in specially designed facilities, followed by tests in a Boeing 757 flying test bed. Ultimately, the fully integrated package (known as block 3.0) is to be installed in an F-22 test aircraft and flown to determine if it meets requirements and if it functions properly. The avionics tests in F-22 flight-test aircraft are scheduled to take about 1,900 flight-test hours, about two-thirds of the total remaining flight-test hours.

Avionics is being developed in blocks (segments), with completion of each block being dependent on completion of prior blocks. During 2000, several early blocks completed ground testing and were ready to be installed on flight-test aircraft. However, because of the delayed delivery of test aircraft designated for avionics flight-testing, delays occurred in flight-testing avionics. As a result, only 2 of 300 avionics flight-test hours planned were flown through December 2000 (see fig. 4). Only 1 hour of avionics flight-testing was flown with block 3 avionics through January 5, 2001. In addition, in attempting to meet its schedule of flight-testing avionics block 3 in an F-22 before the end of 2000, the Air Force deferred into mid-2001 and later some block 3 functions and capabilities, such as software that will allow F-22s to transfer necessary mission data between aircraft.

Figure 4: Planned Versus Actual Avionics Flight-Test Hour Accomplishment for 2000



Source: GAO analysis of Air Force data.

A total of 1,970 avionics flight-test hours are scheduled to be flown by the end of development flight-testing planned for August 2002. An independent assessment sanctioned by the Air Force recently estimated that a minimum of 7-12 additional months after the planned completion of flight-testing will be required to complete avionics testing.

The Air Force was able to accomplish airborne avionics testing on the flying test bed, providing information to testers and helping correct many problems with the hardware and software. However, while avionics testing on a flying test bed is productive testing, it is not the equivalent of avionics testing in an actual F-22 test aircraft for two main reasons. First, because the flying test bed is a large Boeing 757 passenger aircraft and not a more agile F-22, avionics performance cannot be tested in a dynamic flight environment where the aircraft is maneuvering at speeds and angles more characteristic of a smaller fighter aircraft. A DOD testing official advised us that avionics performance can change when operated under the more

demanding conditions of a fighter aircraft. Second, the flying test bed does not contain the full complement of avionics sensors that are planned to be on an F-22, and in some cases, the position of sensors on the test bed are not representative of how they are to be positioned on an F-22.

Flight-Testing Delays Increase F-22 Risks

The Air Force, in monthly assessments of the program from July through December 2000, determined that completing F-22 development on schedule was the program's highest risk and that cost was also a concern. Also, a review of the flight-test program in late 2000 concluded that extending the test program schedule 4- to 6-months may be needed to complete tests. Extending the test program schedule will likely increase costs. Further, DOD's Director, Operational Test and Evaluation, indicated the development test program will likely need to be extended a year or more. Based on this possibility, the Director has indicated that operational testing that is to follow development testing cannot be started as scheduled without clearly unacceptable risks and may need to be delayed almost a year. The Director also indicated there was some justification to delay low-rate production in view of these delays.

Completion of Testing of Nonflying Ground Test Aircraft Continues to be Delayed

The F-22 test plan requires two major tests (static and fatigue) of the structural integrity of the F-22's airframe. These tests are important to reduce the risk of structural problems emerging during production or during aircraft operations. Fatigue testing, which measures the aircraft's durability over its expected life, was initiated on December 21, 2000. Static testing is undertaken to ensure the aircraft will withstand stresses expected to be encountered throughout the aircraft's flight regime. The aircraft structure is tested to determine if it can withstand stresses up to 150 percent of its design limits.

After progressing through all but one test, static testing was interrupted in November 2000, about 6 percent short of the testing goal, because the test hardware, not the aircraft, failed. Testing resumed and was essentially completed in December 2000. Because of a delayed start, the expected completion for fatigue testing is now almost 2 years later than planned in 1997. The previous and currently planned completion dates for these tests are shown in table 2.

Table 2: Delays in Planned Completion of Static and Fatigue Structural Integrity Tests

	Planned completion date				
Test	**1997 plan**	**Mar. 1999 plan**	**Dec. 1999 plan**	**Dec. 2000 plan**	**Total delay (months)**
Static	Oct. 1999	Feb. 2000	Nov. 2000	Dec. 2000[a]	14
Fatigue	Dec. 1999	Sept. 2000	Feb. 2001	Nov. 2001	23

[a] Completed Dec. 21, 2000.

Source: GAO analysis of Air Force data.

Air Force officials, in commenting on a draft of this report, stated that, even though the F-22 fatigue testing was delayed compared to the plan, they expect to complete the first of four test series 11 months after beginning low-rate initial production. They said that was similar to schedules of fatigue testing completion in the F-16 and F/A-18E/F programs. However, delays in the completion of fatigue testing affects when any structural changes required can be recognized. Late recognition of any structural problems affects when solutions can be incorporated into F-22 production. DOD's Director, Operational Test and Evaluation, has expressed concern over the delays in completion of fatigue testing and the incorporation of any necessary solutions into production.

Extent to Which the F-22 Program Is Meeting Cost Goals

It appears unlikely that the F-22 development program can be completed as scheduled, and also include delivery of development and production representative test aircraft, as well as all the testing now planned, within the $20.443 billion cost limitation. Contractor costs have continued to increase above budgets and measures identified to offset those increases had not all been initiated through December 2000. If contractor costs continue to increase above budgets, measures to offset cost increases are not all initiated and achieved, and the Air Force extends the flight-test program, cost is likely to increase above the congressional cost limitation. A recent internal Air Force review concluded that development cost will likely be about $126 million to $297 million above such a limitation. If the Secretary of the Air Force increases the cost limitation by 1.5 percent, or about $307 million, to ensure adequate testing—as permitted subsequent to a determination by the Director, Operational Test and Evaluation—the Air Force's estimate would be within the limitation. Notwithstanding such an increase, the Director has also stated that the test program may need to be

extended further than planned by the Air Force. Such an extension is likely to increase development program costs further.

Development Cost Growth Is Not Fully Offset by Cost Reductions

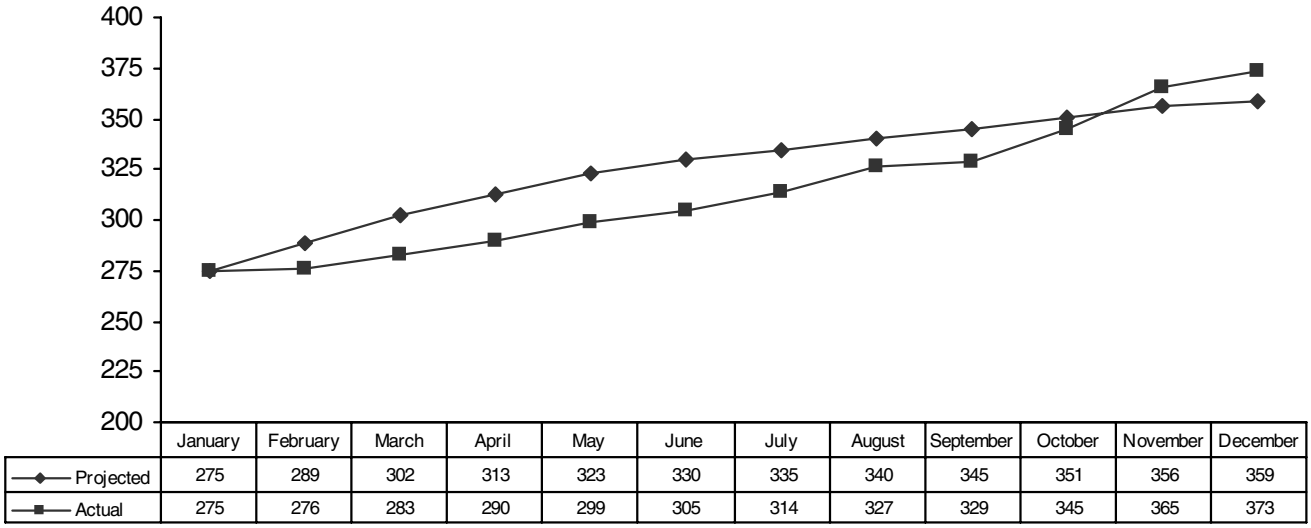
The Air Force has anticipated growth in development costs for the F-22 every year since the Congress established a cost limitation, and it has identified a number of offsets to mitigate this growth, including reducing testing infrastructures. In March 1999, we reported that the potential cost growth through the end of development was estimated at $667 million above a cost baseline established in 1998; in March 2000, it was estimated to be $757 million. As of December 2000, the Air Force and its contractors estimated development cost could grow by $883 million by program completion and had identified about $874 million in cost reduction efforts to offset this growth. Actions had not yet been initiated to achieve about half of the cost reduction efforts. Cost growth that is not offset by cost reductions threatens the ability to execute the development program, as planned, within the congressional cost limitation.

Air Force and Lockheed officials attribute recent cost growth to (1) manufacturing and design problems that have caused some tasks for production labor to be rescheduled and accomplished at different times in the assembly sequence than planned, (2) the need to incorporate more engineering changes than planned, (3) underestimated amounts of labor required to complete scheduled tasks, and (4) difficulties with development and integration of avionics. Pratt & Whitney also identified cost growth as the result of technical problems with an engine nozzle and higher than expected overhead rates.

Comparison of Lockheed's Projected Costs and Actual Costs for 2000

Lockheed's cost performance in 2000, coupled with the experience in prior years, brings into question the contractor's ability to control costs enough to complete the development program, as planned, within the cost limitation. Figure 5 shows that Lockheed's actual costs in 2000 exceeded its available budget by more than projected. At the beginning of 2000, cumulative actual costs exceeded Lockheed's budget by $265 million. Lockheed projected that costs would continue to increase above its budget and that at the end of 2000, cumulative costs would exceed the cumulative budget by $359 million. Although Lockheed did better than projected for much of the year, its performance in November and December caused the contractor to exceed its projection at year-end. Actual costs through 2000 exceeded the budget by $373 million or $14 million more than projected.

Figure 5: Comparison of Actual and Projected Cost Growth Above Budget, January Through December 2000 (Cumulative)
(Dollars in millions)



	January	February	March	April	May	June	July	August	September	October	November	December
Projected	275	289	302	313	323	330	335	340	345	351	356	359
Actual	275	276	283	290	299	305	314	327	329	345	365	373

Source: GAO analysis of contractor data.

Air Force Review Recognizes That Costs Are Likely to Exceed Cost Limitation but Increase Has Not Been Requested

A recent review of the estimated cost of F-22 development completed by the Air Force Cost Analysis Improvement Group[16] concluded that the cost to complete development is likely to be about $126 million to $297 million above the current congressional cost limitation of $20.443 billion.

DOD's Director, Operational Test and Evaluation, agrees that an increase is necessary. The Defense Authorization Act for fiscal year 2001 provides for an increase to the cost limitation by up to 1.5 percent, or about $307 million, if the Director determines the increase is necessary to ensure adequate testing. On January 19, 2001, the Director advised the Secretary of the Air Force and the Congress that he had determined the increase in the cost limitation was necessary to ensure adequate testing.

If the Secretary of the Air Force increases the cost limitation by 1.5 percent, or about $307 million, to ensure adequate testing, the Air Force's estimate

[16] An Air Force group whose function it is to provide cost estimates of major weapon system acquisition programs at milestone reviews.

would be within the limitation. While the Air Force expects to increase the cost limitation by that amount, it has yet to request such an increase.

Cost Estimates Do Not Account for Flight-Test Program Extension

Cost estimates do not consider the potential cost growth associated with a schedule extension of the flight-test program. An Air Force review of the program schedule, done in December 2000, concluded that the flight-test program may need to be extended by 4- to 6-months to complete the tests. DOD's Director, Operational Test and Evaluation, has indicated the development test program may need to be extended a year or more. Extending the flight-test program will likely increase costs, and the Air Force and contractor will need to either identify offsetting cost reductions to stay within the cost limitation, such as reducing the scope of the flight-test program, or obtain an increase in the cost limitation.

Air Force officials maintain they are currently prioritizing work within the F-22 development program to allow for completion within the cost limitation. They maintain this prioritization is being done to ensure testing activities related to major F-22 requirements are conducted, but also to potentially delay testing activities related to less significant F-22 requirements. In contrast, DOD's Director, Operational Test and Evaluation, concluded the development test program may need to be extended a year or more to complete required development testing prior to the start of operational testing. We agree with the Director's assessment and are concerned about delaying required test activities. Completion of required testing is likely to increase development program costs further. In commenting on a draft of this report, DOD stated that, in prioritizing the work, some development efforts currently included in the engineering and manufacturing development phase (and cost estimate) of the program would be expected to be shifted to the Operations and Maintenance account in subsequent years.

Extent to Which F-22 Development Program Is Meeting Performance Goals

In December 2000, the Air Force estimated that by the time the development program ends, the program will have met, and in some instances exceeded, the major F-22 performance goals. However, flight-test progress is slower than expected, delaying the confirmation that the F-22 will indeed deliver the required performance. Although the Air Force assessment is that they satisfied the criteria for awarding a contract to begin low-rate initial production, many of the criteria required initiation of certain tests, not completion or successful demonstrations. Accordingly,

most testing, particularly of the low observable features, avionics, and structural durability, has yet to be completed.

Confirmation of Performance Estimates Requires Additional Demonstration

The Air Force's performance estimates to date are based on limited flight-test data, computer models, ground tests, and analyses. Most ground and flight-tests will have to be completed before the estimates are confirmed. F-22 performance goals are described in 10 Key Performance Parameters, about which the Air Force reports regularly to the Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics. Through December 2000, the Air Force reported that ground and flight-test experience, engineering analyses, and computer models indicate F-22 performance will meet or exceed all required parameters.

Appendix III shows the goal for each parameter; the estimated performance the Air Force believes is consistent with models, ground tests, analyses, and flight-test for each parameter as of December 2000; and the Air Force's latest estimates of the performance expected to be achieved for each parameter by the end of the development program.

Even though F-22 development began in 1991 and flight-testing began in 1997, a significant amount of testing remains prior to the planned completion of flight-testing in 2002 and the planned completion of development in 2003. The Air Force through 2000 said they had satisfied 9 of 11 criteria for awarding a contract for low-rate production, however, several of the criteria required the initiation of certain tests, not successful completion of a significant amount of testing. Accordingly, substantial testing must yet be accomplished before the capabilities of the F-22 will have been fully demonstrated. For example, avionics flight-testing completed through 2000 represents only 2 hours of a planned 1,970-hour avionics flight-test program.

Table 3 shows several areas of testing that were initiated to comply with the criteria for awarding a contract to begin low-rate initial production. The table also shows the extent of planned testing remaining in these testing areas that were initiated, and in several cases, shows that even at this point in the development program there are still years of planned testing remaining.

Table 3: Additional Testing Required to Fully Demonstrate F-22 Capabilities

Criteria for awarding a contract for low-rate initial production	Estimated completion date at start of 2000	Actual completion	Additional testing required to fully demonstrate capability
Initiate high angle-of-attack testing with weapon bay doors open.	July 2000	Aug. 2000	Over 90 percent, or about 40 flights to be completed by mid-2002.
Initiate fatigue life testing with goal of completing 40 percent of first fatigue life.	Aug. 2000	Dec. 2000	Four lifetimes to be completed in approximately 3 years.
Initiate separation testing of AIM-9 and AIM-120 missiles.	Nov. 2000	Oct. 2000	32 AIM-9 and 30 AIM-120 separation tests extending into 2002.
Initiate radar cross-section flight-testing.	Aug. 2000	Jan. 2001	143 hours of flight-testing remain with scheduled completion at the end of development testing.
Complete avionics block 3.0 first flight, initiating testing of unique functionality.	Nov. 2000	Jan. 2001	Block 3 scheduled to be tested through Spring 2001, plus a total of 1,970 avionics flight hours remaining.

Source: GAO analysis of Air Force data.

Performance May Be Affected by Additional Factors

The F-22's performance may be affected by continuing increases in aircraft weight, and frequency of required maintenance that is still far from its objective. Even though F-22 aircraft weight is not characterized by the Air Force as a key parameter, aircraft weight impacts several of the key parameters, including supercruise, maneuverability, acceleration, and combat radius. And, even though the Air Force continues to estimate that by the end of the development program the F-22 will meet or exceed its supercruise, maneuverability, acceleration, and combat radius key parameters, the aircraft weight continues to increase as it has since 1995. During 2000, the estimated weight increased because of additional requirements and modifications required to add strength to the airframe. The Air Force maintains that even with this latest weight increase, there is a margin of 1,050 pounds until the aircraft's weight begins to have an impact on the F-22's ability to meet its key performance parameters.

In addition, the Air Force estimates that by the end of development, the F-22 will be able to complete 2 flying hours between maintenance actions; and when the F-22 reaches maturity[17] in 2008, F-22s will be able to complete 3 flying hours between maintenance actions (key parameter

[17] Defined as 100,000 flying hours.

number 7, listed in app. III). However, currently the flight-test aircraft are completing 0.6 flying hours between maintenance actions. This means that aircraft are now requiring significantly more maintenance than is expected when the system reaches maturity.

Further, when all factors are considered, more frequent maintenance is being required. When maintenance tasks related to low observable features are included in maintenance statistics, the statistics show that more frequent maintenance is being required. Maintenance of low observable features has historically been more difficult and time-consuming than expected. On the F-22, extensive maintenance has been associated with compounds that are used to fill gaps or seams on the aircraft's surface to help maintain the aircraft's low observable or stealthy nature.[18] In 1999, program officials determined that the compound planned for use on the F-22 was not meeting expectations; under certain conditions, it would swell or crack after application. Since then, a new compound has been formulated and it is being tested and qualified for use.

Status of Aircraft Modifications

Air Force officials said they have largely solved problems identified over the last several years with a section that attaches the wing to the aircraft's body and the aft (rear) fuselage of the aircraft. However, the Air Force is continuing to address problems with the bonding of the horizontal tail section and cracking of the clear section of the aircraft canopy.

Program officials, in late 1998, identified problems with the development and manufacture of large titanium castings that attach the wing to the aircraft's body. These problems caused significant delays in completing test aircraft and making them available to the flight-test program. To resolve these problems, they changed the casting process and increased the frequency of wing inspections on test aircraft. The Air Force estimated the costs of engineering changes, additional castings, and labor at about $25 million for the F-22 development program.

In April 1999, program officials identified structural inadequacies in the aft (rear) fuselage, or rear of the airframe. An airframe structural strength analysis that was done as part of the airframe static test indicated

[18] Because the presence of any seams around maintenance access panels can potentially allow the aircraft to be more easily detected by enemy radar, a compound is applied to these seams to eliminate them and make the aircraft's surface smooth.

insufficient strength in a panel in the rear of the airframe. The test aircraft that had been delivered, and those that had been built with the problem parts had to be repaired and modified to provide additional structural strength. Engineering changes, subcontractor rework, and additional labor costs resulted in $16 million in unanticipated costs to the development program.

Contractor officials also identified a problem with the bonding of the composite materials that make up the F-22's horizontal tail section. While contractor officials noted that they have addressed some of the root causes of this problem, one part of the horizontal tail continues to show cracking. To gain more of an understanding of this problem and possible solutions to producing horizontal tails, the contractor assembled a team of industry experts in June 2000. This team of experts provided the contractor with recommendations, half of which were implemented. The contractor expects to continue work to resolve this problem.

In March 2000, Lockheed personnel discovered cracks emanating from the mounting holes in the clear section of the canopy on aircraft 4001. These cracks triggered an investigation of all these clear sections on the flight-test aircraft, in assembly, and in fabrication. Program officials grounded the flight-test aircraft for several weeks and limited the flight-test conditions after they restarted flight tests to ensure safety of flight. The contractor and the supplier identified a total of 109 potential causes for the cracks and they are developing plans to address each cause. Eighty-five of the potential causes have been investigated and several changes have been implemented to prevent cracks from developing. Two leading causes were susceptibility to harmful solvents and excess stress placed on the clear section during assembly into its frame. To eliminate the two leading causes of the cracks, contractor officials have modified the way these clear sections are manufactured and assembled. Additional changes are still being evaluated.

F-22 Development Plan for Fiscal Year 2002

By the end of fiscal year 2001, the Air Force expects that nine F-22 test aircraft will have been delivered and will have begun flight-tests. For fiscal year 2002, the plan is to complete (1) the remainder of the development flight-test program, scheduled to end in August 2002 and (2) the airframe structural testing and analysis.

The planned F-22 funding for fiscal year 2002 and the remainder of the development program is shown in table 4. The funding plans for fiscal years

2002 and 2003 are consistent with completion of the development program at a total cost that equates to the congressional cost limitation. However, the plans do not address the need to extend the test program 4- to 6-months to accommodate the delay the Air Force has recognized or the possibility of increasing the congressional cost limitation to allow for the costs associated with this delay.

Table 4: Remaining F-22 Development Funding

Dollars in millions

Cost category	Fiscal year 2002	Fiscal year 2003	Total to complete development
Air vehicle	$415.9	$131.2	$547.1
Avionics	116.4	54.3	170.7
Production representative test vehicles	124.3	$0.0	124.3
Engine	33.6	16.1	49.7
Other government cost	170.2	116.8	287.0
Total	**$860.4**	**$318.4**	**$1,178.8**

Source: Air Force.

While the F-22 development program and associated funding are scheduled to end in fiscal year 2003, the Air Force budget plans include $580.7 million for post-development activities in fiscal years 2002 through 2007 (see table 5). The Air Force classified this funding as post-development funding for various activities.[19] Air Force officials told us they consider this post-development funding separate from and outside the scope of the F-22 development program, which is subject to the congressional cost limitation of $20.443 billion.

[19] These activities include blocks 4 and 5 of avionics, partial funding for a ground collision avoidance system, flight-testing infrastructure at Edwards Air Force Base, laboratory support, and a classified project.

Table 5: F-22 Post-Development Funding Planned for Fiscal Years 2002 Through 2007

Funding	Fiscal year 2002	Fiscal year 2003	Fiscal year 2004	Fiscal year 2005	Fiscal year 2006	Fiscal year 2007	Total
Post-development	$16.0	$51.0	$136.1	$100.0	$121.2	$156.4	**$580.7**

Source: Air Force.

Plan to Increase Low-Rate Initial Production Before Development Program Is Completed

The Fiscal Year 2001 Defense Appropriations Act provided funds for low-rate initial production of 10 F-22 aircraft but prohibited award of a fully funded contract until DOD meets prerequisites specified in the act. The act also provided funds for advance procurement for 16 F-22s planned for procurement in fiscal year 2002. The Air Force plans to procure 24 aircraft in fiscal year 2003, and begin full-rate production of 36 aircraft per year beginning in fiscal year 2004.

In several reports over the last 6 years, and as recently as March 2000, we concluded that DOD should minimize commitments to F-22 production to six to eight aircraft a year until completion of initial operational test and evaluation, now planned for the second quarter of fiscal year 2003. Current flight-testing progress and an independent assessment by the Director, Operational Test and Evaluation, reinforce our prior conclusion. Buying production articles before they can be adequately tested can result in buying systems that require significant, and sometimes costly, modifications to achieve satisfactory performance; accepting less capable systems than planned; and deploying substandard systems to combat forces. Also, deferring a substantial increase in production rates until completion of initial operational test and evaluation will reduce the amount of needed production funding committed, which may be an attractive option to maintain the aircraft procurement budget and overall defense budget within congressional targets. Conversely, Air Force officials have stated that lower production rates could increase average procurement cost over the life of the program.

As indicated earlier, the F-22 program has experienced cost growth due to manufacturing and design problems, the need to incorporate more than the planned numbers of engineering changes, underestimated amounts of labor required to complete scheduled tasks, and difficulties with development and integration of avionics. Adding the significant amount of testing that is yet to be completed, we believe it prudent to mitigate risks by limiting

low-rate initial production to no more than 10 aircraft a year—the quantity approved in fiscal year 2001 appropriations and authorization acts—until initial operational test and evaluation is completed.

Conclusions

The Air Force has made progress in developing the F-22, particularly with respect to fulfilling the criteria for awarding a fully funded contract for low-rate initial production. Nevertheless, it is significantly behind in flight-testing, due to continuing assembly and manufacturing delays, and it is behind schedule in completing nonflying tests that assess the structural integrity of the aircraft. These delays increase the risk that the Air Force will likely have to extend the test program past the planned completion date or proceed to the next stages of the program without completing all flight-tests. Moreover, the scheduling delays increase the likelihood that costs will not fall within the congressional limitation, especially if all planned offsets are not implemented and if additional time called for by DOD's Director, Operational Test and Evaluation, is agreed to.

The Director, Operational Test and Evaluation, has also indicated that based on the current status of the test program, operational testing, with the objective of determining the operational effectiveness and suitability of the F-22, cannot be started as scheduled without clearly unacceptable risks and will probably be delayed almost a year. We agree with his assessment. With this likely delay in starting operational testing, the Director also concluded there was no reason to authorize low-rate production in January 2001 and some justification to delay it. Cost growth in the development program due to manufacturing and design problems and underestimated amounts of labor required to complete scheduled tasks points to a lack of stability in both design and fabrication. We believe limiting low-rate initial production to no more than the 10 aircraft per year included in appropriations and authorization acts for fiscal year 2001 is a prudent way to mitigate risks until initial operational test and evaluation is completed.

Recommendations for Executive Action

Because the Air Force is unlikely to complete F-22 development within the current cost limitation, we recommend that the Secretary of the Air Force, as a supplement to the fiscal year 2002 budget request, provide (1) information showing planned testing not yet completed; (2) information on any additional funding that would be necessary, above the cost limitation amount, to complete the testing as planned; and (3) any actual

and proposed changes to the test plans, such as a deletion or postponement of test activities, and the justification for these changes.

To reduce risks and preclude manufacture and delivery of F-22 aircraft that have not been fully tested, we recommend that the Secretary of Defense limit low-rate initial production to no more than 10 aircraft a year until initial operational test and evaluation is completed.

Agency Comments and Our Evaluation

DOD provided written comments on a draft of this report. In regard to the first recommendation, DOD agreed there are concerns regarding completion of development testing within the period remaining for engineering and manufacturing development. DOD also agreed that adjustments are needed in the F-22 program to ensure adequate development testing is completed prior to entry into operational test and evaluation. Also, in its comments, DOD stated that on January 19, 2001, the Director, Operational Test and Evaluation, made a determination provided for in the authorization act for fiscal year 2001, that permits the Secretary of the Air Force to increase the cost limitation for F-22 development by 1.5 percent, or about $307 million.

Although we agree that a 1.5-percent increase in the cost limitation is warranted based on the progress of the program, DOD has not yet certified to the Congress that F-22 development can be completed within the cost limitation, even considering the 1.5-percent increase. The Director, Operational Test and Evaluation, concluded that a 1.5-percent increase may be sufficient to support an Air Force plan that would defer completion of development testing by 4- to 6-months. However, the Director stated that a longer delay may be needed to complete required testing. Additional comments DOD provided indicated that the Air Force proposed additional actions that entail shifting some remaining development efforts to the Operations and Maintenance account to allow the F-22 engineering and manufacturing development program to be completed within the cost limitation. Considering the uncertainty about the Air Force's ability to complete the development program within the limitation as adjusted, and within the schedule as currently planned, and the proposal to shift funding for some efforts to the Operations and Maintenance account, we believe our recommendation continues to be valid. We continue to believe DOD should, in a supplement to its fiscal year 2002 budget request, or as part of any revised acquisition plan submitted to congressional defense committees, identify the testing that has yet to be completed, the funding necessary, and the changes that are planned to the test program.

In regard to the second recommendation, DOD officials said they did not concur with the recommendation and stated it was premature to comment on any change in the rate of low-rate initial production, pending further progress in a defense program review directed by the President. We believe DOD's comment obfuscates the issue at hand. We recognize that the President has directed that the defense program be reviewed and that the timing, cost, and quantity of F-22 production are likely to be important considerations. However, the slow progress of the F-22 program during 2000, particularly the flight-test program, does not justify accelerating production in fiscal year 2002. We believe the Air Force should not continue with its plans to increase the rate of production beyond 10 aircraft a year until operational test and evaluation is complete and the operational suitability and effectiveness of the F-22 has been successfully demonstrated.

DOD's comments are reproduced in appendix IV. DOD also provided updated information and suggested additional technical changes, which we incorporated in the report where appropriate.

Scope and Methodology

To determine whether the program is expected to meet schedule goals, we reviewed program and avionics schedules and discussed potential changes to these schedules with F-22 program officials. We also compared current schedules with those developed in 1997 as a result of a study by a cost estimating team. We tracked progress in the flight-test program, evaluated schedule variances in the contractors' performance management system, and compared planned milestone accomplishment dates with actual dates. We also tracked technical problems in manufacturing and assembling the development aircraft.

To determine whether the program is likely to meet the cost limitation, we examined (1) the extent to which the development program cost goals are being met, (2) the Air Force's plans to fund the program for fiscal year 2001, and (3) the consistencies between the program funding plan and the cost limitation. We compared the estimated cost at completion of the prime contracts with planned amounts, evaluated cost variances identified in the contractors' cost reporting systems, and reviewed the status of initiatives designed to avoid cost growth. We reviewed DOD validations of Lockheed's earned value management system and tested a small sample of expenditures to determine if they had been properly recorded.

To determine whether the development program is likely to meet performance goals, we analyzed information on the performance of key performance parameters and those sub-parameters that are measured. We compared performance goals established by the Under Secretary of Defense for Acquisition, Technology, and Logistics with the Air Force's current estimates of performance in December 2000 and at completion of development.

To identify the status of F-22 modifications, we collected updated information on the status of existing aircraft structural problems that have required aircraft modifications. We also collected and analyzed information on problems identified in 2000 that will require some aircraft modifications to resolve.

To identify the program's plan for fiscal year 2002, we collected information on what development activities are expected to be completed by the end of fiscal year 2001 and the planned development activities and planned funding for fiscal year 2002.

To assess the Air Force's plan for increasing the annual initial rate of production, we determined the amount of overlap between the development program and the production plans, particularly in reference to the completion of initial operational test and evaluation.

In making these determinations, assessments, and identifications, we required access to current information about schedule achievements and revisions, costs being incurred, test results and performance estimates, aircraft modifications, and the program's plans for continued development and initial production. The Air Force and the contractors gave us access to sufficient information to make informed judgments on the matters covered in this report.

In performing our work, we obtained information or interviewed officials from the Office of the Secretary of Defense, Washington D.C.; the F-22 System Program Office, Wright-Patterson Air Force Base, Ohio; the Defense Contract Management Agency, Marietta, Georgia; Lockheed Martin Aeronautical Systems, Marietta, Georgia; Lockheed Martin Tactical Aircraft Systems, Fort Worth, Texas; and Boeing Military Aircraft, Seattle, Washington. We performed our work from April 2000 through February 2001 in accordance with generally accepted government auditing standards.

We are sending copies of this report to the Honorable Donald H. Rumsfeld, Secretary of Defense; the Honorable Lawrence Delaney, Acting Secretary of the Air Force; and the Honorable Mitchell E. Daniels, Jr., Director, Office of Management and Budget. Copies will also be made available to others on request. Please contact me at (202) 512-4841 or Robert D. Murphy at (937) 258-7904 if you or your staff have any questions concerning this report. GAO staff acknowledgments to this report are listed in appendix V.

Allen Li
Director, Acquisition and Sourcing Management

List of Congressional Committees

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

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

The Honorable Bob Stump
Chairman
The Honorable Ike Skelton
Ranking Minority Member
Committee on Armed Services
House of Representatives

The Honorable Jerry Lewis
Chairman
The Honorable John P. Murtha
Ranking Minority Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Air Force Assessment of Development and Test Criteria Required to Proceed to Low-Rate Initial Production

Criteria	Completion status
1. Initiate high angle-of-attack testing with weapon bay doors open	Completed
2. Complete critical design review for avionics block 3.1	Completed
3. Complete test aircraft 4008 fuselage, wing, and empennage (tail section) mate	Completed
4. Initiate fatigue life testing with the goal of completing 40 percent of first fatigue life	Completed[a]
5. Complete air vehicle final production readiness review	Completed
6. Complete first portion of engine qualification test	Completed
7. Initiate separation of air intercept missile-9 and air intercept missile-120	Completed
8. Complete aircraft first flights	
Aircraft 4003	Completed
Aircraft 4004	Completed
Aircraft 4005	Completed
Aircraft 4006	Completed[b]
9. Initiate radar cross section flight-testing	Completed[c]
10. Complete static structural testing	Completed
11. Complete avionics block 3.0 first flight, initiating testing of unique functionality	Completed

[a] Testing initiated on Dec. 21, 2000. Completion of 40 percent of the first fatigue life is scheduled for Mar. 2001.

[b] Completed on Feb. 5, 2001.

[c] Completed on Jan. 31, 2001.

Comparison of Schedules for First Flight Dates of Test Aircraft

Test aircraft	First flight dates as planned in 1997	First flight dates as planned in Mar. 1999	First flight dates as planned in June 1999	First flight dates as planned in Dec. 2000	Total delay of first flight dates (months) as of Dec. 2000
4001	May 1997	Sept. 1997[a]	Sept. 1997[a]	Sept. 1997[a]	3.37
4002	July 1998	June 1998[a]	June 1998[a]	June 1998[a]	-0.33
4003	June 1999	Nov. 1999	Feb. 2000	Mar. 2000[a]	8.80
4004	Aug. 1999	Feb. 2000	May 2000	Nov. 2000[a]	15.20
4005	Jan. 2000	Mar. 2000	June 2000	Dec. 2000[b]	11.43
4006	May 2000	May 2000	Aug. 2000	Dec. 2000[b]	7.50
4007	Sept. 2000	Sept. 2000	Oct. 2000	Aug. 2001	10.40
4008	Feb. 2001	Feb. 2001	Feb. 2001	Oct. 2001	8.70
4009	June 2001	June 2001	June 2001	Sept. 2001	3.90
Total delay (months)					**68.97**

[a] Actual first flight date.

[b] First flight did not occur in December 2000.

Estimates of Performance for Key Parameters

Key performance parameter	Goal (acquisition program baseline)	Air Force assessment of estimated performance through Dec. 2000	Estimated performance at completion of development
1. Supercruise	100 percent	114 percent	115 percent
2. Acceleration (< 100 percent is favorable)[a]	100 percent	89 percent	87 percent
3. Maneuverability	100 percent	102 percent	102 percent
4. Airlift support (C-141 equivalents)	8	7.4	7.4
5. Sortie generation rate	100 percent	100 percent	100 percent
6. Radar cross section (front sector only)	100 percent	Favorable (data classified)	Favorable (data classified)
7. Average flight hours between maintenance	3.0	0.6	2.0 (at end of development) 3.0 (by system maturity in year 2008)
8. Payload (missiles)	Four medium-range, two short-range	Six medium-range, two short-range	Six medium-range, two short-range
9. Combat radius	100 percent	113 percent	115 percent
10. Radar detection range	100 percent	117 percent	117 percent

[a] The acceleration parameter is a measure of the time it takes the aircraft to increase speed to a certain level. If the aircraft is able to increase speed to a certain level in less time than expected, this is considered favorable. Therefore, a measure of less than 100 percent is favorable.

Comments From the Department of Defense

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

ACQUISITION AND TECHNOLOGY

07 MAR 2001

Mr. Allen Li
Associate Director, Defense Acquisitions Issues
National Security and International
Affairs Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Li:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "TACTICAL AIRCRAFT: Cost to Complete Planned F-22 Development Likely to Exceed Congressional Cost Limitation," Dated January 31, 2001 (GAO Code 707530/ OSD Case 3033).

The F-22 development test effort, particularly flight testing, has made considerable progress, but did not show the upswing in test point achievement that was expected last year. This has raised concerns regarding completion of developmental testing within the remaining Engineering and Manufacturing Development period.

The Department partially concurs with Recommendation 1, agreeing that F-22 program adjustments are needed to ensure that adequate developmental testing is completed prior to entry into Initial Operational Test and Evaluation. Regarding Recommendation 2, proposing a limit on the number of aircraft in future Low-Rate Initial Production lots, the Department considers it premature to comment on production plans pending further progress in the defense program review directed by the President.

Comments on the GAO recommendations are enclosed. The Department has separately provided comments to correct inaccuracies, and to provide updated information.

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

Sincerely,

George R. Schneiter
Director
Strategic and Tactical Systems

GAO DRAFT REPORT DATED JANUARY 31, 2001
(GAO Code 707530/OSD CASE 3033)

"TACTICAL AIRCRAFT: Cost to Complete Planned F-22 Development Likely to Exceed Congressional Cost Limitation"

DEPARTMENT OF DEFENSE COMMENTS ON THE RECOMMENDATIONS

****

RECOMMENDATION 1: Because the Air Force is unlikely to complete F-22 development within cost limitations, the GAO recommended that the Air Force, as a supplement to the Fiscal Year 2002 budget request, provide (1) information showing planned testing not yet completed, (2) information on any additional funding that would be necessary, above the cost limitation amount, to complete the testing as planned, and (3) any actual and proposed changes to the test plans, such as deletion or postponement of test activities, and the justification for these changes. (p. 35/GAO Draft Report)

DOD RESPONSE: **Partially concur.** The Department is continuing its review of the Engineering and Manufacturing Development (EMD) program. The Department agrees that F-22 program adjustments are needed to ensure that adequate developmental testing is completed prior to entry into Initial Operational Test and Evaluation (IOT&E).

In January, the Director, Operational Test and Evaluation (DOT&E) sent a letter to Congress indicating that he had determined that a 1.5 percent increase in the EMD cost cap is necessary to ensure adequate testing. The DOT&E made this determination in a January 19, 2001, memorandum to the Secretary of the Air Force in accordance with section 219 of the Floyd D. Spence Authorization Act for Fiscal Year 2001 (P.L. 106-398) which amended section 217 (c) of the National Defense Authorization Act for Fiscal Year 1995 (P.L. 105-85), to permit the Secretary of the Air Force to increase the EMD cost cap upon the DOT&E's determination.

RECOMMENDATION 2: To reduce risks and preclude manufacture and delivery of F-22 aircraft that have not been fully tested, the GAO recommended that the Secretary of Defense limit low-rate initial production to no more than 10 aircraft a year until Initial Operational Test and Evaluation is completed. (p. 35/GAO Draft Report)

DOD RESPONSE: **Non-Concur**. It is premature to comment on any change in the rate of low-rate initial production.

GAO Staff Acknowledgments

Acknowledgements

Mark Abraham, Marvin E. Bonner, Christopher T. Brannon, Arthur Cobb, Don M. Springman, and John Van Schaik made key contributions to this report.

Related GAO Products

Defense Acquisitions: Recent F-22 Production Cost Estimates Exceeded Congressional Limitation (GAO/NSIAD-00-178, Aug.15, 2000).

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

Budget Issues: Budgetary Implications of Selected GAO Work for Fiscal Year 2001 (GAO/OCG-00-8, Mar. 31, 2000).

F-22 Aircraft: Development Cost Goal Achievable If Major Problems Are Avoided (GAO/NSIAD-00-68, Mar. 14, 2000).

Defense Acquisitions: Progress in Meeting F-22 Cost and Schedule Goals (GAO/T-NSIAD-00-58, Dec. 7, 1999).

Fiscal Year 2000 Budget: DOD's Procurement and RDT&E Programs (GAO/NSIAD-99-233R, Sept. 23, 1999).

Budget Issues: Budgetary Implications of Selected GAO Work for Fiscal Year 2000 (GAO/OCG-99-26, Apr. 16, 1999).

Defense Acquisitions: Progress of the F-22 and F/A-18E/F Engineering and Manufacturing Development Programs (GAO/T-NSIAD-99-113, Mar. 17, 1999).

F-22 Aircraft: Issues in Achieving Engineering and Manufacturing Development Goals (GAO/NSIAD-99-55, Mar. 15, 1999).

F-22 Aircraft: Progress of the Engineering and Manufacturing Development Program (GAO/T-NSIAD-98-137, Mar. 25, 1998).

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