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# F-22 AIRCRAFT

## Progress of the Engineering and Manufacturing Development Program

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Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to discuss the progress of the Air Force's F-22 engineering and manufacturing development (EMD) program. The National Defense Authorization Act for Fiscal Year 1998 (P.L. 105-85) requires us to review the F-22 program and report on the extent to which it is meeting planned cost, schedule, and performance goals. We issued a report in response to that requirement earlier this month.<sup>1</sup> My testimony today discusses the challenges that the EMD program is encountering in achieving cost, schedule, and performance goals as well as the impact of program schedule slippages on the Department of Defense's (DOD) request to buy the first two F-22 production aircraft in fiscal year 1999.

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## Background

The F-22 EMD program began in 1991. The objectives of the program are to (1) design, fabricate, test, and deliver ground and flight test vehicles; (2) design, fabricate, integrate, and test the avionics suite; and (3) design, develop, and test the support and training systems. The F-22 has two prime contractors: Lockheed Martin Aeronautical Systems is responsible for the aircraft, and United Technologies Corporation (Pratt & Whitney) is responsible for the engines.

Because of concerns about potential cost growth in the F-22 program, the Assistant Secretary of the Air Force for Acquisition established the Joint Estimating Team in June 1996 to estimate the most probable cost of the F-22 program and to identify realistic initiatives that could be implemented to lower program costs. The team consisted of personnel from the Air Force, DOD, and private industry. In January 1997, the team estimated that F-22 program costs would increase by about \$1.5 billion over previous estimates and that additional time would be required to complete the EMD program. The team made several recommendations to restructure the program, which the Air Force and DOD adopted.<sup>2</sup>

The National Defense Authorization Act for Fiscal Year 1998, enacted in November 1997, imposed cost limitations of \$18.688 billion on the F-22 EMD program and \$43.4 billion on the production program. The limitation on production cost did not specify a quantity of aircraft to be procured.

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<sup>1</sup>F-22 Aircraft: Progress in Achieving Engineering and Manufacturing Development Goals (GAO/NSIAD-98-67, Mar. 10, 1998).

<sup>2</sup>For more information on these recommendations, see Tactical Aircraft: Restructuring of the Air Force F-22 Fighter Program (GAO/NSIAD-97-156, June 4, 1997).

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The act instructed the Secretary of the Air Force to adjust the cost limitations for the amounts of increases or decreases in costs attributable to (1) economic inflation after September 30, 1997, and (2) compliance with changes in federal, state, or local laws enacted after September 30, 1997. Since the law's enactment, the Air Force adjusted the EMD and production cost limitations once and plans to further adjust them to \$18.939 billion and \$40.940 billion, respectively.

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## Results in Brief

The Air Force's cost estimate supporting the fiscal year 1999 budget request indicates that the EMD program can be completed within the adjusted statutory cost. However, the F-22 EMD program has been hindered in achieving schedule goals by several technical and manufacturing problems, which caused the delay of the first flight and projected late deliveries of other flight test aircraft. The Air Force is studying the potential impact of schedule delays to determine if the cost estimate includes sufficient amounts to complete the EMD program. The Air Force expects that the F-22 will meet or exceed all of its established performance requirements. However, the amount of flight testing planned in May 1997 has not been achieved.

The Air Force plans to enter production having completed significantly fewer flight test hours than they had planned to have done. DOD has previously indicated that if major problems exist, they usually occur within the first 10 to 20 percent of flight testing. If the Air Force awards the contract for the first two F-22 production aircraft in December 1998, it will have accomplished only 183 flight test hours, or 4 percent of the total flight test hours planned, instead of 601 flight test hours, or 14 percent of the total flight test hours planned in May 1997.

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## Extent to Which Cost Goals Are Being Met

In the fiscal year 1999 President's budget, the Air Force's estimate to complete the F-22 EMD program was \$18.9 billion. The estimate includes the \$16 billion negotiated price of the major prime contracts with Lockheed Martin and Pratt & Whitney and \$1.5 billion in planned contract modifications as of February 1998. The estimate also includes other government costs and a margin to accommodate future cost growth. Table 1 shows the Air Force's program cost estimate.

**Table 1: Air Force's Estimated Cost of the F-22 EMD Program**

Dollars in billions	
<b>Cost element</b>	<b>Amount</b>
Lockheed Martin and Pratt & Whitney contracts	\$16.0
Planned modifications to contracts	1.5
Other government costs	1.2
Margin for cost growth	0.2
<b>Total cost</b>	<b>\$18.9</b>

Because the F-22 contracts with Lockheed Martin and Pratt & Whitney were modified in August and September 1997, there is limited information on the extent to which contractors are completing scheduled work at the planned costs. When the contracts were modified, the contractors rebaselined the systems that measure cost and schedule progress and calculate how actual costs and schedules vary from contract goals. Before modifying the contracts, Lockheed Martin and Pratt & Whitney reported cost growth at completion of EMD totaling about \$1.2 billion.

Lockheed Martin and Pratt & Whitney report monthly to the Air Force concerning their progress in relation to contract costs and schedules. These reports define the cost and schedule variances from the contract plans. In January 1998, Pratt & Whitney and Lockheed Martin reported variances of less than 1 percent from the negotiated contract cost and planned schedule. The most significant variance identified in the reports was a \$70-million unfavorable schedule variance for Lockheed Martin. The contractors' reports showed that the negotiated costs included about \$194 million for management reserves; that is, funds set aside in case of cost increases due to unplanned efforts or cost growth in planned efforts.

Lockheed Martin and Pratt & Whitney also reported in January 1998 that they planned to complete the contract efforts within the negotiated costs. However, the impact of delays in the delivery of wing and aft fuselage assemblies and the flight test program were not reflected in those reports. Lockheed Martin advised the Air Force that it could execute the revised schedule caused by the delays at no increased cost to the EMD contract. At the time of our review, the Air Force was assessing whether changes due to these delays could be accomplished with no cost increase to the EMD contract. The Air Force was also assessing the impact that late software development may have on the estimated cost of the EMD program.

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## Extent to Which Schedule Goals Are Being Met

In January 1998, the F-22 program was not meeting its schedule goals. The first flight of the first F-22 EMD aircraft occurred about 3 months late. Furthermore, the flight test program was suspended after two flights, and its resumption is not expected until late April 1998 to correct a problem discovered in the horizontal tail of the aircraft. Also, the late delivery of the aft fuselage and wing assemblies is expected to delay the delivery of other EMD aircraft and the progress of the flight test program. The Air Force has revised its schedule to reflect the late first flight. However, it had not determined how the late deliveries of aft fuselage assemblies and wing assemblies will impact the overall F-22 EMD schedule. The Air Force planned to complete its evaluation of the schedule impact of these manufacturing problems in March 1998. In addition, Air Force officials are planning to revise software schedules by May 1998.

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## First F-22 Flight Was Delayed

Because of a number of technical problems with the first F-22 EMD aircraft, the first flight was delayed over 3 months, from late May to early September 1997. Among the problems causing the late first flight were a fuel tank leak, a software defect, failure of an auxiliary power unit, and damage from debris being ingested into the engine. Furthermore, the aircraft flight test program was suspended after two flights to accomplish planned ground tests and make minor structural additions to the airframe. The flight test program will not resume until at least late April 1998 because materials in the horizontal tail of the aircraft became disbonded, or separated. Air Force officials said that the identified solution to this problem will not impact other EMD aircraft schedules.

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## Wings and Aft Fuselages Are Expected to Be Delivered Late

F-22 wing deliveries are behind schedule because of problems in developing and manufacturing the large titanium wing castings, which are the foundation for building the wing. As of January 1998, the contractor, Boeing (the subcontractor for the wing assemblies), and the Air Force were still working to resolve these problems. The wings for the third through the sixth flight test aircraft and two ground test articles are expected to be delivered about 2 weeks to over 4 months late to Lockheed Martin.

Delivery of the F-22 aft fuselage—the rear aircraft body section—is also expected to be late for the third through the sixth flight test aircraft and the two ground test articles because of the late delivery of parts and difficulties with welding the many pieces of the fuselage together due to the close tolerances required. An Air Force and contractor team is

currently evaluating potential cost, schedule, testing, and production impacts associated with this problem. The team planned to complete its assessment by March 1998.

As a result of the late deliveries of the wings and aft fuselages, the first flights of the third (aircraft 4003) through the sixth (aircraft 4006) flight test aircraft will be delayed by about 2 weeks to over 5 months. Table 2 shows the scheduled and expected first flights of EMD aircraft.

**Table 2: Comparison of Schedules for First Flights of EMD Aircraft**

<b>EMD aircraft number</b>	<b>Scheduled first flight as of May 1997</b>	<b>Expected first flight as of February 1998</b>	<b>Delay in months</b>
4001	May 29, 1997	September 7, 1997 <sup>a</sup>	3.3
4002	July 9, 1998	July 9, 1998	0
4003	June 16, 1999	November 22, 1999	5.2
4004	August 17, 1999	February 3, 2000	5.6
4005	January 11, 2000	March 31, 2000	2.7
4006	May 18, 2000	May 30, 2000	0.4
4007	September 25, 2000	September 25, 2000	0
4008	February 2, 2001	February 2, 2001	0
4009	June 1, 2001	June 1, 2001	0

<sup>a</sup>The first flight occurred on this date.

### Progress in Completing Software Development Is Concern

Since completing the audit work for the report we issued earlier this month, we learned that the schedule for developing F-22 avionics is a potential concern. In 1993, DOD's Defense Science Board rated the integrated avionics as the highest technical risk in the F-22 program and therefore indicated the need for a long period of evolutionary software development. The Air Force is concerned that the writing and testing of avionics software may not be progressing sufficiently to provide software deliveries on schedule. The Air Force is assessing the progress of the avionics software development effort to determine a revised schedule and the estimated impact on cost. The Air Force expects to complete this assessment by May 1998.

## Impact of Late Aircraft Deliveries on Flight Test Plans for Fiscal Years 1998-99

The delay in first flight and expected delays in delivery of the third through sixth EMD flight test aircraft have affected the number of flight test hours planned for fiscal years 1998 and 1999. About 55 percent of the flight test hours planned for fiscal year 1998 (120 of 217) and about 11 percent of the flight test hours planned for fiscal year 1999 (51 of 449 hours) have been deferred until later in the test program. As a result, only about one-third of the flight test hours that were planned as of May 1997 (183 of 601) will be completed before the scheduled award date of the contract for the first two production aircraft in December 1998. The planned number of flight test hours before production contract award has declined since November 1994, as shown in table 3.

**Table 3: Comparison of F-22 Flight Test Hours Planned**

Flight test schedule as of	Total flight test hours planned	Flight test hours planned before production award	Percent of flight test hours planned before production award
November 1994	5,191	1,400	27
May 1997	4,337	601	14
February 1998	4,337	183	4

The Air Force acknowledges that fewer flight test hours than planned will be completed before production contract award than were planned by the Joint Estimating Team in May 1997. In response to our 1995 report on the F-22 program,<sup>3</sup> DOD cited a Defense Science Board report that denoted that when major program problems occur, it is usually within the first 10 to 20 percent of flight testing. The Board stated that if the F-22 could complete 1,000 flight test hours before the first production contract award, it would be equivalent to 10 to 20 percent of the total number of flight test hours planned for the F-22 program. Although the 601 flight test hours that the Air Force had previously planned in May 1997 was 14 percent of the total flight test program, the 183 flight test hours planned as of February 1998 represent only 4 percent of the total program. Accordingly, the Air Force plans to enter production having completed significantly fewer flight test hours than the amount that would likely identify any major problems.

The Air Force maintains that the confidence gained in the aircraft's design from the first 200 hours of flight testing will be proportionately greater than the later 400 hours. The officials stated that the later 400 hours will provide only minimal increased confidence and should not be the basis for

<sup>3</sup>Tactical Aircraft: Concurrency in Development and Production of F-22 Aircraft Should Be Reduced (GAO/NSIAD-95-59, Apr. 19, 1995).



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accepting higher program costs from delaying the fiscal year 1999 contract award. The Air Force believes that maintaining the planned schedule and awarding the full production contract for two aircraft in December 1998 is the most cost-effective strategy.

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## Extent to Which Performance Goals Are Being Met

As of January 1998, the Air Force estimated that, at the end of the EMD program, the F-22's performance will meet or exceed the goals for all of its 10 established parameters. The 10 parameters are radar cross section from the front sector of the aircraft, supercruise, acceleration, maneuverability, payload, combat radius, radar detection range, airlift support, sortie generation rate, and mean time between maintenance. Performance estimates are engineering judgments based on computer and other models, ground and limited flight testing, and analyses. The goal for each parameter is based on the EMD contract specifications.

We identified and reviewed two additional features—situational awareness and low observability—that are integral to the F-22's being able to operate as intended. Although these additional features are not official performance parameters, the Air Force considers them to be critical system characteristics, which it describes as generic characteristics that do not lend themselves well to measurement and reporting.

The F-22 sensors, advanced aircraft electronics, and cockpit display screens are required to provide the pilot with improved situational awareness of potential enemy threats and targets. This increased awareness is to improve pilot response time to the threats, thus increasing the lethality and survivability of the aircraft. The F-22's low observable, or stealthy, features allow it to evade detection by enemy aircraft and surface-to-air missiles. As of January 1998, the Air Force estimated that the F-22 would meet the performance requirements of these two additional features.

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Mr Chairman, this concludes my prepared statement. I would be happy to respond to any questions you or other members of the Subcommittee may have.

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