

GAO

Testimony  
Before the Subcommittees on Air and  
Land Forces and Seapower and  
Expeditionary Forces, Committee on  
Armed Services, House of Representatives

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For Release on Delivery  
Expected at 2:00 p.m. EDT  
Wednesday, March 24, 2010

# JOINT STRIKE FIGHTER

## Significant Challenges and Decisions Ahead

Statement of Michael Sullivan, Director  
Acquisition and Sourcing Management



| Report Documentation Page                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                    |                                     |                                                           | Form Approved<br>OMB No. 0704-0188                  |                                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|-------------------------------------|-----------------------------------------------------------|-----------------------------------------------------|---------------------------------|
| Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. |                                    |                                     |                                                           |                                                     |                                 |
| 1. REPORT DATE<br><b>MAR 2010</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                    | 2. REPORT TYPE                      |                                                           | 3. DATES COVERED<br><b>00-00-2010 to 00-00-2010</b> |                                 |
| 4. TITLE AND SUBTITLE<br><b>Joint Strike Fighter: Significant Challenges and Decisions Ahead</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                    |                                     |                                                           | 5a. CONTRACT NUMBER                                 |                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                           | 5b. GRANT NUMBER                                    |                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                           | 5c. PROGRAM ELEMENT NUMBER                          |                                 |
| 6. AUTHOR(S)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                    |                                     |                                                           | 5d. PROJECT NUMBER                                  |                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                           | 5e. TASK NUMBER                                     |                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                           | 5f. WORK UNIT NUMBER                                |                                 |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)<br><b>U.S. Government Accountability Office, 441 G Street NW, Washington, DC, 20548</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                    |                                     |                                                           | 8. PERFORMING ORGANIZATION REPORT NUMBER            |                                 |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                    |                                     |                                                           | 10. SPONSOR/MONITOR'S ACRONYM(S)                    |                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                           | 11. SPONSOR/MONITOR'S REPORT NUMBER(S)              |                                 |
| 12. DISTRIBUTION/AVAILABILITY STATEMENT<br><b>Approved for public release; distribution unlimited</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                    |                                     |                                                           |                                                     |                                 |
| 13. SUPPLEMENTARY NOTES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                    |                                     |                                                           |                                                     |                                 |
| 14. ABSTRACT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                    |                                     |                                                           |                                                     |                                 |
| 15. SUBJECT TERMS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                    |                                     |                                                           |                                                     |                                 |
| 16. SECURITY CLASSIFICATION OF:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     | 17. LIMITATION OF ABSTRACT<br><b>Same as Report (SAR)</b> | 18. NUMBER OF PAGES<br><b>19</b>                    | 19a. NAME OF RESPONSIBLE PERSON |
| a. REPORT<br><b>unclassified</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | b. ABSTRACT<br><b>unclassified</b> | c. THIS PAGE<br><b>unclassified</b> |                                                           |                                                     |                                 |



Highlights of [GAO-10-478T](#), a testimony before the Subcommittees on Air and Land Forces and Seapower and Expeditionary Forces, Committee on Armed Services, U.S. House of Representatives

## Why GAO Did This Study

The F-35 Lightning II, also known as the Joint Strike Fighter (JSF), is the Department of Defense's (DOD) most costly and ambitious aircraft acquisition, seeking to simultaneously develop and field three aircraft variants for the Air Force, Navy, Marine Corps, and eight international partners. The JSF is critical for recapitalizing tactical air forces and will require a long-term commitment to very large annual funding outlays. The current estimated investment is \$323 billion to develop and procure 2,457 aircraft.

This statement draws substantively from GAO's March 19, 2010 report ([GAO-10-382](#)). That report discusses JSF costs and schedules, warfighter requirements, manufacturing performance, procurement rates, and development testing plans. This statement also provides an updated analysis of relative costs and benefits from a second (or alternate) engine program.

In previous years, we recommended, among other things, that DOD rethink plans to cut test resources, improve reliability of cost estimates, and reduce the number of aircraft procured before testing demonstrates their performance capabilities. In our March 2010 report, we recommended that DOD (1) make a new, comprehensive assessment of the program's costs and schedule and (2) reassess warfighter requirements. DOD concurred with both recommendations.

View [GAO-10-478T](#) or [key components](#). For more information, contact Michael J. Sullivan at (202) 512-4841 or [sullivanm@gao.gov](mailto:sullivanm@gao.gov).

## JOINT STRIKE FIGHTER

### Significant Challenges and Decisions Ahead

## What GAO Found

The JSF program continues to struggle with increased costs and slowed progress—negative outcomes that were foreseeable as events have unfolded over several years. Total estimated acquisition costs have increased \$46 billion and development extended 2 ½ more years, compared to the approved program baseline approved in 2007. Aircraft unit costs will likely exceed the thresholds established by the statutory provision referred to as Nunn McCurdy and may require DOD to recertify the need for the JSF to Congress. The program is at risk for not delivering aircraft quantities and capabilities on time. Dates for achieving initial operational capabilities may have to be extended or some requirements deferred to future upgrades. DOD leadership is taking some positive steps that should reduce risk and provide more realistic cost and schedule estimates. Officials increased time and funding for system development, added four aircraft to the flight test program, and reduced near-term procurement quantities. If effectively implemented, these actions should improve future program outcomes. Currently, however, manufacturing JSF test aircraft continues to take more time, money, and effort than budgeted, hampering the development flight test program. Slowed by late aircraft deliveries and low productivity, the flight test program only completed 10 percent of the sorties planned during 2009. Although restructuring actions should help, there is still substantial overlap of development, test, and production activities while DOD continues to invest in large quantities of production aircraft before variant designs are proven and performance verified. Under the current plan, DOD may procure as many as 307 aircraft at a total estimated cost of \$58.2 billion before development flight testing is completed.

Our updated analysis on engine costs shows that, without competition, an estimated \$62.5 billion (engine costs in the analysis are expressed in fiscal year 2002 dollars) will be needed over the remainder of the F135 primary engine effort to cover costs for completing system development, procuring 2,443 engines, production support, and sustainment. Additional investment of between \$4.5 billion to \$5.7 billion may be required should the department continue competition. Under certain assumptions, the additional costs of continuing the F136 alternate engine program could be recouped if competition were to generate approximately 10.1 to 12.6 percent savings over the life of the program. Air Force data on the first 4 years of competition for engines on the F-16 aircraft projected they would recoup at least that much. Actual savings will ultimately depend on factors such as the number of aircraft actually purchased, the ratio of engines awarded to each contractor, and when the competition begins. Competition may also provide non-quantifiable benefits with respect to better contractor responsiveness, technical innovation and improved operational readiness.

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Mr. Chairmen and Members of the Subcommittees:

I am very pleased to be here today to discuss the F-35 Joint Strike Fighter (JSF) program. The JSF is the Department of Defense's (DOD) most costly and, arguably, its most complex and ambitious acquisition, seeking to simultaneously develop, produce, and field three aircraft variants for the Air Force, Navy, Marine Corps, and eight international partners. The JSF is critical to our nation's plans for recapitalizing the tactical air forces and will require a long-term commitment to very large annual funding outlays. The total expected U.S. investment is now more than \$323 billion to develop and procure 2,457 aircraft.

GAO has issued annual reports on the JSF for the last 6 years. Our most recent report was issued last week and discussed relatively poor program cost and schedule outcomes and specific concerns about warfighter requirements, flight testing, manufacturing, and technical challenges as the program moves forward.<sup>1</sup> A recurring theme in our work has been concern about what we believe is undue concurrency of development, test, and production activities and the heightened risks it poses to achieving good cost, schedule, and performance outcomes. We have also raised concerns about the department continuing to buy large quantities of low rate production aircraft on cost reimbursement contracts far in advance of flight and ground testing to verify the design and operational performance. We are pleased that defense leadership has lately agreed with our concerns and those of other defense offices and task forces. The acquisition decision memorandum, dated February 24, 2010, directs numerous critical actions that we believe will, if effectively implemented, significantly improve program outcomes and provide more realistic projections of costs and schedule.

Today, I will discuss (1) JSF current cost and schedule estimates and the significant challenges ahead as DOD substantially restructures the acquisition program; and (2) our updated analysis of potential costs and savings from pursuing a competitive engine program. This statement draws primarily from our March 2010 report, updated to the extent possible with new budget data and a recently revised procurement profile directed by the Secretary of Defense. To conduct this work, we tracked and compared current cost and schedule estimates with those of prior

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<sup>1</sup>GAO, *Joint Strike Fighter: Additional Costs and Delays Risk Not Meeting Warfighter Requirements on Time*, [GAO-10-382](#) (Washington, D.C.: Mar. 19, 2010).

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years, identified changes, and determined causes. We obtained program status reports, manufacturing data, and test planning documents. We conducted our own analyses of the information. We discussed results to date and future plans with DOD, JSF, and aircraft and engine contractor officials. We obtained information on the recent restructuring, including critical inputs from three independent defense teams established to review program execution, manufacturing capacity, and engine performance. For the engine cost analysis, we employed the same methodology first reported in 2007, now updated with current cost and program data.<sup>2</sup> We conducted this performance audit from May 2009 to March 2010 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

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## Significant Challenges Remain as DOD Restructures Program

Continuing cost increases and schedule delays culminated in the extensive restructuring of the JSF program recently announced. Restructuring is not complete and further cost growth and schedule extensions are likely. Manufacturing test aircraft continues to take more time, money, and effort than budgeted, contributing to substantial flight testing delays and raising questions about the ability to ramp up production as rapidly and steeply as planned. There is still substantial overlap of development, test, and production activities while DOD continues to push ahead and invest in large quantities of production aircraft before variant designs are proven and system performance verified.

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## Cost Increases and Schedule Delays Increase Risk of Not Meeting Warfighter Requirements on Time

The JSF program continues to struggle with increased costs and slowed progress—negative outcomes that were foreseeable as events have unfolded over several years. Total estimated acquisition costs have increased \$46 billion and development extended 2 ½ years, compared to the program baseline approved in 2007. DOD is now taking some positive steps that, if effectively implemented, should improve future outcomes and provide more realistic cost and schedule estimates. Officials increased

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<sup>2</sup> For a detailed discussion on our analytical approach and methodology, see our original testimony GAO, *Defense Acquisitions: Analysis of Costs for the Joint Strike Fighter Engine Program*, [GAO-07-656T](#) (Washington, D.C.: March 22, 2007).

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time and funding for system development, added four aircraft to the flight test program, and reduced near-term procurement quantities by 122 aircraft. However, there is still substantial risk that the program will not deliver the expected number of aircraft and required capabilities on time. Dates for achieving initial operational capabilities may have to be extended or some requirements deferred to future upgrades. Also, aircraft unit costs will likely exceed the thresholds established by the statutory provision commonly referred to as Nunn-McCurdy<sup>3</sup> and require the department to certify the need for the JSF to Congress. Program setbacks in costs, deliveries, and performance directly impact modernization plans and retirement schedules of the legacy aircraft the JSF is slated to replace.

Table 1 summarizes changes in program cost, quantities, and schedules at key stages of acquisition. The 2004 replan estimates reflect a quantity reduction and a major restructuring of the program after integration efforts and design review identified significant weight problems. The 2007 data is the current approved acquisition baseline and the 2011 budget request reflects cost increases stemming from a major reassessment of the program by a joint team comprised of the Office of the Secretary of Defense (OSD), Air Force, and Navy representatives.

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<sup>3</sup> 10 U.S.C. § 2433 establishes the requirement for DOD to prepare unit cost reports on major defense acquisition programs or designated major defense subprograms. If a program exceeds cost growth thresholds specified in the law, this is known as a Nunn-McCurdy breach. DOD is required to report breaches to Congress and, in certain circumstances, DOD must reassess the program and submit a certification to Congress in order to continue the program, in accordance with 10 U.S.C. § 2433a.

**Table 1: Changes in Reported JSF Program Costs, Quantities, and Deliveries**

|                                                     | October 2001<br>(system<br>development start) | December 2003<br>(2004 Replan) | March 2007<br>(Approved<br>Baseline) | Fiscal Year<br>2011 Budget<br>Request |
|-----------------------------------------------------|-----------------------------------------------|--------------------------------|--------------------------------------|---------------------------------------|
| Expected quantities                                 |                                               |                                |                                      |                                       |
| Development quantities                              | 14                                            | 14                             | 15                                   | 14                                    |
| Procurement quantities (U.S. only)                  | 2,852                                         | 2,443                          | 2,443                                | 2,443                                 |
| <b>Total quantities</b>                             | <b>2,866</b>                                  | <b>2,457</b>                   | <b>2,458</b>                         | <b>2,457</b>                          |
| Cost estimates (then-year dollars in billions)      |                                               |                                |                                      |                                       |
| Development                                         | \$34.4                                        | \$44.8                         | \$44.8                               | \$49.3                                |
| Procurement                                         | 196.6                                         | 199.8                          | 231.7                                | 273.3                                 |
| <b>Total program Acquisition(see note)</b>          | <b>\$231.0</b>                                | <b>\$244.6</b>                 | <b>\$276.5</b>                       | <b>\$322.6</b>                        |
| Unit cost estimates (then-year dollars in millions) |                                               |                                |                                      |                                       |
| Program acquisition                                 | \$81                                          | \$100                          | \$113                                | \$131                                 |
| Average procurement                                 | 69                                            | 82                             | 95                                   | 112                                   |
| <b>Estimated delivery dates</b>                     |                                               |                                |                                      |                                       |
| First operational aircraft delivery                 | 2008                                          | 2009                           | 2010                                 | 2010                                  |
| Initial operational capability                      | 2010-2012                                     | 2012-2013                      | 2012-2015                            | 2012-2015                             |

Source: GAO analysis of DOD data.

Note: Military construction costs, typically part of total program acquisition costs, are not included in this table. Construction cost estimates for the JSF program are incomplete and have been inconsistently portrayed at various stages.

Table 2 shows the extension of major milestone dates for completing key acquisition activities. The February 2010 restructure reflects the direction ordered by the Secretary in an acquisition decision memorandum issued on February 24 and revised on March 3. Completing system development and approving full-rate production is now expected in April 2016, about 2 ½ years later than planned in the acquisition program baseline approved in 2007.

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**Table 2: Changes in Major Milestones**

| Major milestones                                    | Program of record December 2007 | Program of record December 2008 | Restructure February 2010 |
|-----------------------------------------------------|---------------------------------|---------------------------------|---------------------------|
| Development testing complete                        | October 2012                    | October 2013                    | March 2015                |
| Initial operational test and evaluation complete    | October 2013                    | October 2014                    | January 2016              |
| System development and demonstration phase complete | October 2013                    | October 2014                    | April 2016                |
| Full-rate production decision                       | October 2013                    | October 2014                    | April 2016                |

Source: GAO analysis of DOD data.

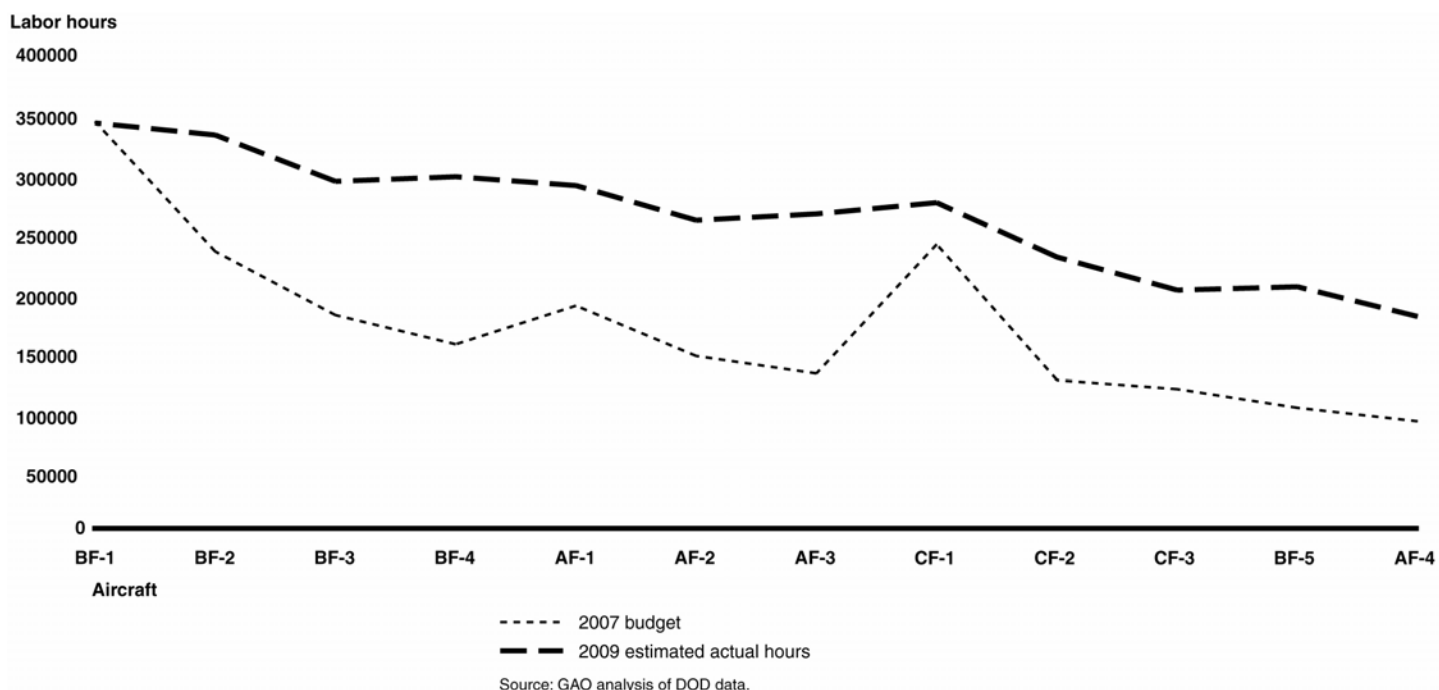
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## Manufacturing and Engineering Challenges Continue to Slow Aircraft Deliveries and Put the Production Schedule at Risk

Manufacturing JSF test aircraft continues to take more time, money, and effort than budgeted. By December 2009, only 4 of 13 test aircraft had been delivered and total labor hours to build the aircraft had increased more than 50 percent above earlier estimates. Late deliveries hamper the development flight test program and affect work on production aircraft, even as plans proceed to significantly ramp up annual procurement rates. Some improvement is noted, but continuing manufacturing inefficiencies, parts problems, and engineering technical changes indicate that design and production processes may lack the maturity needed to efficiently produce aircraft at planned rates. An independent manufacturing review team determined that the planned production ramp rate was unachievable absent significant improvements. While the restructuring has reduced near-term procurement, annual aircraft quantities are still substantial. In addition, the program has procured several lots of low rate initial production (LRIP) aircraft using cost-reimbursement contracts, a contract type that places most of the cost risk on the government. Continued use of cost reimbursement contracts beyond initial LRIP quantities indicate that uncertainties in contract performance exist that do not permit costs to be estimated with sufficient accuracy for the contractor to assume the risk under a fixed price contract. Figure 1 compares labor hour estimates for test aircraft in 2007 and the revised manufacturing plan in 2009.



**Figure 1: JSF Labor Hours for Manufacturing Test Aircraft**



BF= Short take-off and vertical landing aircraft for the Marine Corps  
 AF= Conventional take-off and landing aircraft for the Air Force  
 CF= Carrier variant for the Navy

## Little Progress in Development Testing While Program Continues to Face Technical Challenges

Although DOD's restructuring actions should help, there is still substantial overlap of development, test, and production activities while DOD continues to push ahead and invest in large quantities of production aircraft before variant designs are proven and system performance verified. Given the extended development time and reduced near-term procurement, DOD still intends to procure up to 307 aircraft at an estimated cost of \$58.2 billion before completing development flight testing by mid fiscal year 2015 (see figure 2). At the same time, progress on flight testing is behind schedule—slowed by late aircraft deliveries and low productivity, the flight test program completed only 10 percent of the sorties planned during 2009, according to the Director of Operational Test and Evaluation. Other technical challenges include (1) relying on an extensive but largely unproven and unaccredited network of ground test laboratories and simulation models to evaluate system performance; (2) developing and integrating very large and complex software requirements; and (3) maturing several critical technologies essential to meet operational

performance and logistical support requirements. Collectively, testing and technical challenges will likely add more costs and time to development, slowing delivery of capabilities to warfighters and hampering start up of pilot and maintainer training and initial operational testing.

Figure 2: JSF Procurement Investments and Progress of Flight Testing

|                                              | 2007                                                                               | 2008  | 2009  | 2010   | 2011   | 2012   | 2013   | 2014   | 2015   |
|----------------------------------------------|------------------------------------------------------------------------------------|-------|-------|--------|--------|--------|--------|--------|--------|
| Cumulative procurement (billions of dollars) | \$0.9                                                                              | \$3.6 | \$7.1 | \$14.4 | \$23.6 | \$33.2 | \$45.2 | \$58.2 | \$72.4 |
| Cumulative aircraft procured                 | 2                                                                                  | 14    | 28    | 58     | 101    | 146    | 217    | 307    | 420    |
| Development flight testing                   |  |       |       |        |        |        |        |        |        |

Source: GAO analysis of DOD data.  
Note: U.S. investments only.

Updated Analysis Shows that Competition Savings Still Has Potential to Outweigh Costs Depending on Acquisition Approach

The JSF program began with an acquisition strategy that called for a competitive engine development effort. In the fiscal year 2007 budget submission, DOD stopped requesting funding for the alternate engine (F136). At that time, DOD determined that the risks of a single point failure in a sole source environment were very low and did not justify the extra costs to maintain a second source. Each year since then, Congress has subsequently recommended funding for alternate engine development. We have previously testified on our assessment that, based on past defense competitions (including a fighter engine competition started in the 1980s between these same manufacturers) and making certain assumptions about relative quantities purchased from each, competition could reasonably be expected to yield enough savings across the JSF life cycle to offset the remaining investments required to sustain a second source.<sup>4</sup> Prior studies also indicate a number of nonfinancial benefits from competition, including better performance, increased reliability, and improved contractor responsiveness.

As noted in our prior testimonies, the acquisition strategy for the JSF engine must weigh expected costs against potential rewards—both

<sup>4</sup>GAO, *Joint Strike Fighter: Strong Risk Management Essential as Program Enters Most Challenging Phase*, [GAO-09-711T](#) (Washington, D.C.: May, 20, 2009) is our most recent testimony on engine issues.

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quantifiable and non quantifiable. As a result, we have updated our prior studies conducted in 2007, and later updated in 2008, to assess whether changes in the JSF program have impacted the costs and benefits of the sole-source and competitive scenarios for acquisition and sustainment of the JSF engine. We updated our analysis to include (1) new estimates for Research, Development, Test, and Evaluation (RDT&E) and additional sunk costs, (2) a slower production ramp as a result of the recent program restructure, (3) increased engine unit recurring costs, and (4) updated production support costs. Based on schedule delays with the program, we moved the starting point of the procurement competition to fiscal year 2015, a 3-year slip from our past analysis. This adjustment aligns with the completion of the JSF development flight test program and would start the competition with the last low-rate initial production aircraft buy. We were not provided information that allowed us to update operations and support costs.

Our updated analysis, based largely on data provided by the JSF program office, found that, without competition, an estimated \$62.5 billion<sup>5</sup> will be needed over the remainder of the F135 primary (current) engine to cover costs for completing system development, procuring 2,443 engines, production support, and sustainment. An additional investment of between \$4.5 billion to \$5.7 billion (depending on the competitive scenario) may be required should the department continue competition. Depending on assumptions, the additional costs of the alternate engine investment could be recouped if competition were to generate approximately 10.1 to 12.6 percent savings over the life of the program. Air Force data on the first 4 years of competition for engines on the F-16 aircraft projected they would recoup at least that much. Actual savings will ultimately depend on factors such as the number of aircraft actually purchased, the ratio of engines awarded to each contractor, and when the competition begins. Competition may also provide non-quantifiable benefits with respect to better contractor responsiveness, technical innovation and improved operational readiness. Recent engine cost concerns and past test failures are other factors that should be considered in deciding whether to continue the engine competition.

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<sup>5</sup> To maintain consistency with our statements in prior years, all costs related to our engine cost analysis are expressed in base year 2002 dollars. Other engine costs in this statement are expressed in then year (inflated) dollars.

Costs of Sole Source Approach

Our updated analysis estimates the remaining costs for the Pratt & Whitney F135 engine is estimated to be \$62.5 billion over the life of the program. This includes cost estimates for the completion of system development, procurement of engines, production support, and sustainment. Table 3 shows the costs remaining to acquire and support the Pratt & Whitney F135 engine on a sole-source basis in our updated analysis.

| Table 3: Costs to Complete Pratt & Whitney F135 Engine Program (Fiscal year 2002 dollars in billions) |        |
|-------------------------------------------------------------------------------------------------------|--------|
| Cost element                                                                                          | Cost   |
| System development and demonstration costs                                                            | \$0.5  |
| Total engine recurring flyaway costs                                                                  | \$24.7 |
| Production support costs (including initial spares, training, manpower, and depot standup)            | \$5.7  |
| Sustainment costs of fielded aircraft                                                                 | \$31.6 |
| Total                                                                                                 | \$62.5 |

Source: JSF program office or other DOD data; GAO analysis.  
Note: Based on 2,443 installed engines and spares.

In addition to development of the F135 engine design, Pratt & Whitney also has responsibility for the common components that will be designed and developed to go on all JSF aircraft, regardless of which contractor provides the engine core. This responsibility supports the JSF program level requirement that the engine be interchangeable—either engine can be used in any aircraft variant. In the event that Pratt & Whitney is made the sole-source engine provider, future configuration changes to the aircraft and common components could be optimized for the F135 engine.

Additional Costs of Competition

Our updated analysis estimated the additional costs under two competitive scenarios beginning in fiscal year 2015: one in which contractors are each awarded 50 percent of the total engine purchases (50/50 split) and one in which there is an annual 70/30 percent award split of total engine purchases to either contractor,. Without consideration of potential savings, the additional costs of competition total about \$5.7 billion under the first scenario and about \$4.5 billion under the second scenario. Table 4 shows the additional cost associated with competition under these two scenarios.

**Table 4: Additional Costs for Competition in JSF Engine Program (Fiscal year 2002 dollars in billions)**

| <b>Additional costs</b>                                                                    | <b>50/50 Aircraft<br/>award split</b> | <b>70/30 Aircraft<br/>award split</b> |
|--------------------------------------------------------------------------------------------|---------------------------------------|---------------------------------------|
| System development and demonstration costs                                                 | \$1.3                                 | \$1.3                                 |
| Total engine recurring flyaway costs                                                       | \$4.3                                 | \$3.1                                 |
| Production support costs (including initial spares, training, manpower, and depot standup) | \$0.1                                 | \$0.1                                 |
| Sustainment costs of fielded aircraft <sup>a</sup>                                         | N/A                                   | N/A                                   |
| <b>Total</b>                                                                               | <b>\$5.7</b>                          | <b>\$4.5</b>                          |

Source: JSF program office or other DOD data; GAO analysis.

Notes: Based on 2,443 installed engines and spares.

<sup>a</sup>No additional sustainment costs were considered because the number of aircraft and cost per flight hour would be the same under either scenario.

The disparity in costs between the two competitive scenarios reflects the loss of learning resulting from lower production volume that is accounted for in the projected recurring flyaway costs used to construct each estimate. The other costs include approximately \$1.3 billion for remaining F136 development and \$140 million in additional standup costs, which would be the same under either competitive scenario.

## Level of Savings Needed to Recoup Additional Costs Varies Based on Assumptions

Competition may incentivize the contractors to achieve more aggressive production learning curves, produce more reliable engines that are less costly to maintain, and invest additional corporate money in technological improvements to remain competitive. However, it is important to consider that many of the additional investments associated with competition are often made earlier in the program's life cycle, while much of the expected savings do not accrue for decades. As such, we include a net present value calculation (time value of money) in the analysis that, once applied, provides for a better estimate of program rate of return. Our analysis indicates that recoupment of those initial investment costs would occur at somewhere between 10.1 and 12.6 percent, depending on the number of engines awarded to each contractor. A competitive scenario, where one contractor receives 70 percent of the annual procurement and the other receives 30 percent, reaches the breakeven point at 10.1 percent savings. A competitive scenario where both contractors receive 50 percent of the procurement reaches this point at 12.6 percent savings.

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The government's ability to recoup the additional investments required to support competition depends largely on (1) the number of aircraft procured,<sup>6</sup> (2) the ratio that each contractor wins out of that total, and (3) the savings rate that competitive pressures drive. Another key variable is when the competition actually begins. In our analysis described above, we assume competition begins with the fiscal year 2015 buy which would be after the JSF system development flight test program is currently scheduled to be completed and would be the last low rate initial production order. We also ran an alternative scenario where competition did not begin until 2017, or 2 years later. Such a delay would increase the level of savings needed to recoup the additional investments. This was primarily due to the fact that savings from the competition began later in the life cycle and fewer engines from the total 2,443 procurement would be available for competition. Assuming competition starts in 2017, recoupment of the additional investment would occur at 11.3 to 14.1 percent savings depending on whether competitive buys are split either 70/30 or 50/50 between contractors. This range compares to the 10.1 to 12.6 percent range if the competition began in 2015.

Prior experience suggests it may be reasonable to expect savings of at least that much from a JSF engine competition. While we did not do an in-depth analysis of the competition, the "Great Engine War", may provide a good example of the potential savings achievable. The competition was between Pratt & Whitney and General Electric to supply military engines for the F-16 and other fighter aircraft programs. At that time, all engines for the F-14 and F-15 aircraft were being produced on a sole-source basis by Pratt & Whitney, which was criticized for increased procurement and maintenance costs, along with a general lack of responsiveness to government concerns about those programs. Beginning in 1983, the Air Force initiated a competition that resulted in significant cost savings in the program. For example, in the first 4 years of the competition, when comparing actual costs to the program's baseline estimate, results included

- Nearly 30 percent cumulative savings for acquisition costs,
- Roughly 16 percent cumulative savings for operations and support costs, and
- Total savings of about 21 percent in overall life cycle costs.

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<sup>6</sup> In conducting our cost analysis of the alternate engine program, we presented the cost of only 2,443 U.S. aircraft currently expected for production.

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It is difficult to estimate the costs that would have been incurred if there never were a competition. However, prior to the competition, there was an upward trend in the expected unit costs of the F-16 primary engine. When the alternate engine was introduced as a competitor, the upward trend stopped.

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### Multiple Studies and Analyses Show Additional Benefits from Competition

Competition for the JSF engines may provide benefits that do not result in immediate financial savings, but could result in reduced costs or other positive outcomes over time. Our prior work, along with studies by DOD and others, indicated there are a number of non financial benefits that may result from competition, including better performance, increased reliability, and improved contractor responsiveness. DOD and others have performed studies and have widespread concurrence as to these other benefits, including better engine performance, increased reliability, and improved contractor responsiveness. In fact, in 1998 and 2002, DOD program management advisory groups assessed the JSF alternate engine program and found the potential for significant benefits in these and other areas. While the benefits highlighted may be more difficult to quantify, they were strongly considered in earlier recommendations to continue the alternate engine program. These studies concluded that the program would

- Maintain the industrial base for fighter engine technology,
- Enhance readiness,
- Instill contractor incentives for better performance,
- Ensure an operational alternative if the current engine developed problems, and
- Enhance international participation.

In the OSD Cost Analysis Improvement Group's (now Cost Assessment and Program Evaluation) 2007 Joint Strike Fighter Alternate Engine Acquisition and Independent Cost Analyses Report, it also concluded that there are nonfinancial benefits to competition.

Another potential benefit from an alternate engine program cited by the program management advisory group studies is the hedge against a catastrophic risk that a single point, systemic failure in the engine design could substantially affect the fighter aircraft fleet. Though current data indicate that it is unlikely that engine problems would lead to fleet wide groundings in modern aircraft, having two engine sources for the single-engine JSF further reduces this risk as it is less likely that such a problem would occur to both engine types at the same time. Because the JSF is

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expected to be the primary fighter aircraft in the U.S. inventory, and Pratt & Whitney is also the sole-source provider of F119 engines for the F-22A aircraft, DOD is faced with the potential scenario where most of the fleet could be dependent on similar engine cores, produced by the same contractor in a sole-source environment.

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### JSF Engine Costs and Flight Test Progress Have Not Met Expectations

Both the F135 and F136 have experienced cost growth and delays. The F135 primary engine development effort—a separate contract from the airframe development effort—is now estimated to cost about \$7.3 billion, about a 50 percent increase over the original contract award. This includes an \$800 million contract cost overrun in 2008. Engine development cost increases primarily resulted from higher costs for labor and materials, supplier problems, and the rework needed to correct deficiencies with an engine blade during redesign. Engine redesigns and test problems caused slips in engine deliveries, according to program officials. Officials note that these late engine deliveries have not yet critically affected the delivery of test aircraft because airframe production lagged even further behind. However, the prime contractor has been forced to perform out-of-station engine installations and other workarounds as a result of engine issues. As of January 2010, 17 of 18 F135 development flight test engines have been delivered, seven of which have flown. However, the initial service release date for the short take-off and vertical landing (STOVL) variant has slipped from 2007 plans about 21 months until the third quarter 2010.

Engine procurement unit costs are higher than earlier budget estimates. For example, the negotiated unit cost (2009 buy) for the conventional take-off and landing variant is now \$17.7 million—42 percent higher than the program's budget estimate of \$12.5 million. Similarly, the unit cost for the STOVL engine (including lift fan and related parts) rose from \$27.6 million, to \$33.4 million, a 21 percent increase. JSF program officials cite several reasons for the higher than budgeted unit costs, including configuration changes and quantity reductions. Based on recent data provided by the program office, the average unit costs projected through the end of procurement has increased by 45 to 55 percent since 2006, depending on the variant.

As planned, the F136 second engine development is about 3 years behind F135 engine development. While the time lag and funding instability make precise assessments more difficult, the second engine contractor is also facing cost and schedule challenges. Through fiscal year 2010, the government has invested about \$2.9 billion in developing the second engine and DOD cost analysts estimate that about \$1.6 billion more would



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be needed to complete F136 development in 2016. F136 contractor officials told us that funding stability, engine affordability, and testing issues are key concerns for the program to go forward. According to the F136 contractor, it believes system development could be completed earlier by 2014, with less funding. While the F136 engine has not yet been flown, it has experienced delays. For example, its initial release for flight testing for the short take-off and vertical landing variant has slipped by about 21 months to late 2011.

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## Concluding Remarks

The JSF is DOD's largest and most complex acquisition program and the linchpin of the United States and its allies' long-term plans to modernize tactical air forces. It will require exceptional levels of funding for a sustained period through 2035, competing against other defense and nondefense priorities for the federal discretionary dollar. The Department has recently taken some positive steps that, if effectively implemented, should improve outcomes and provide more realistic, executable program. However, the program will still be challenged to meet cost and schedule targets. To date, the Department does not have a full, comprehensive cost estimate for completing the program. Credible costs and schedules estimates are critical because they allow DOD management to make sound trade-off decisions against competing demands and allow Congress to perform oversight and hold DOD accountable. Because the JSF is expected to eventually make up most of the tactical aircraft fleet, the services should have a high degree of confidence in their ability to meet their initial operational capability requirements and to acquire JSFs in quantity so that DOD can plan its overall tactical aircraft force structure strategy. However, the Department has not yet defined reasonable expectations for achieving initial operational capabilities for each of the services given the recent restructuring. While the Department has lowered cost risk by reducing near term procurement quantities, there is still substantial overlap of development, test, and production activities now stretching into 2016. Constant program changes and turbulence have made it difficult to accurately and confidently measure program progress in maturing the aircraft system. Tying annual investments more directly to demonstrated progress in developing, testing, and manufacturing aircraft may be a prudent fiscal measure for ensuring government funds are invested wisely.

In previous years, we recommended, among other things, that DOD rethink plans to cut test resources, improve reliability and completeness of cost estimates, and reduce the annual number of aircraft procured before testing demonstrates their performance capabilities. In our March 2010

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JSF report, we recommended that DOD (1) make a new, comprehensive and independent assessment of the costs and schedule to complete the program, including military construction, other JSF-related expenses, and life cycle costs; and (2) reassess warfighter requirements and, if necessary, defer some capabilities to future increments. The department concurred with both recommendations. We also included a matter for congressional consideration regarding development of a system maturity matrix as a tool for measuring progress and evaluating annual budget requests.

A decision whether to continue the alternate engine program will likely have long term implications for the JSF program, industrial base, and fleet readiness. Expected costs must be weighed against potential benefits, both quantifiable and unquantifiable. Last year, Congress enacted legislation to help improve weapons acquisition outcomes. The legislation, referred to as the Weapon Systems Acquisition Reform Act of 2009, included a provision requiring DOD to ensure that the acquisition strategy for each major defense acquisition program includes measures to ensure competition, or the option of competition, throughout the life of the program. The long-term impact on the industrial base is likely to be high given the size of the JSF program, international participation, and the expected supplier base. Depending on the assumptions made, a competitive environment could yield enough financial savings over the life of the program to offset the immediate cost of investing in competition. Specifically, key assumptions include the number of aircraft purchased, the ratio of engines each contractor wins, and savings competitive pressures drive. The timing of when a competition occurs will also have a direct bearing on the amount of savings that is needed to recoup the additional costs of competition. Competition could also provide many intangible benefits that do not result in immediate financial savings but could result in reduced costs or other positive outcomes over time. It is important that DOD and Congress reach an agreement on the best path forward.

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Mr. Chairman, this completes my prepared statement. I would be pleased to respond to any questions you or other Members of the Committee may have.

For further information on this statement, please contact Michael Sullivan at (202) 512-4841 or [sullivanm@gao.gov](mailto:sullivanm@gao.gov). Contact points for our Office of Congressional Relations and Public Affairs may be found on the last page of this statement. Individuals making key contributions to this statement are Bruce Fairbairn, Matt Lea, Kris Keener, Ridge Bowman, Charlie Shivers, Charles W. Perdue, and Greg Campbell.

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