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JOINT STRIKE FIGHTER

Impact of Recent Decisions on Program Risks

Statement of Michael Sullivan, Director
Acquisition and Sourcing Management

GAO-08-569T

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Highlights

Highlights of GAO-08-569T, a testimony before the Subcommittees on Air and Land Forces, and Seapower and Expeditionary Forces, Committee on Armed Services, House of Representatives

Why GAO Did This Study

The Joint Strike Fighter (JSF) is the Department of Defense's (DOD) most expensive aircraft acquisition program. DOD is expected to develop, procure, and maintain 2,443 aircraft at a cost of more than $950 billion. DOD plans for the JSF to replace or complement several types of aircraft in the Air Force, Navy, and Marine Corps.

Given the program's cost and importance, it is critical that decisions are made within this program to maximize its benefit to the nation. This testimony highlights a number of those decisions and impacts. It

(1) discusses emerging risks to the overall program, and

(2) updates information for GAO's cost analysis of last year regarding sole-source and competitive scenarios for acquisition and sustainment of the JSF engine.

Information on the overall program is from our mandated annual report, also issued today. GAO tracked annual cost and schedule changes, reasons for changes, decisions affecting development, and compared DOD cost estimating methodologies to best practices. For the two engines, GAO updated cost data from last year's testimony and made new projections.

What GAO Recommends

This testimony does not have recommendations, but GAO's mandated report recommends revisiting the mid-course plan and improving cost estimates. DOD substantially agreed.

To view the full product, including the scope and methodology, click on GAO-08-569T. For more information, contact Michael Sullivan at (202) 512-4841 or sullivanm@gao.gov.

What GAO Found

GAO believes recent DOD decisions, while potentially reducing near-term funding needs, could have long-term cost implications. DOD's recent plan to reduce test resources in order to pay for development cost overruns adds more risk to the overall JSF program. Midway through development, the program is over cost and behind schedule. Difficulties in stabilizing aircraft designs and the inefficient manufacturing of test aircraft have forced the program to spend management reserves much faster than anticipated. To replenish this reserve, DOD officials decided not to request additional funding and time for development at this time, but opted instead to reduce test resources. GAO believes this plan will hamper development testing while still not addressing the root causes of related cost increases. While DOD reports that total acquisition costs have increased by $55 billion since a major restructuring in 2004, GAO and others in DOD believe that the cost estimates are not reliable and that total costs will be much higher than currently advertised. Another restructuring appears likely—GAO expects DOD will need more money and time to complete development and operational testing, which will delay the full-rate production decision and the fielding of capabilities to the warfighter.

This year, DOD is again proposing cancellation of the JSF alternate engine program. The current estimated remaining life cycle cost for the JSF engine program under a sole-source scenario is $54.9 billion. To ensure competition by continuing the JSF alternate engine program, an additional investment of about $3.5 billion to $4.5 billion may be required. However, potential advantages from a competitive strategy could result in savings equal to or exceeding that amount across the life cycle of the engine. GAO's updated cost analysis suggests that a savings of 9 to 11 percent—about 2 percent less than what GAO estimated last year—would recoup that investment. Also, as we noted last year, prior experience indicates that it is reasonable to assume that competition on the JSF engine program could yield savings of at least that much. Further, non financial benefits in terms of better engine performance and reliability, more responsive contractors, and improved industrial base stability are more likely outcomes under a competitive environment than under a sole-source strategy. While cancellation of the program provides needed funding in the near term, recent test failures for the primary JSF engine underscore the importance and long-term implications of DOD decision making with regard to the ultimate engine acquisition approach.

Mr. Chairmen and Members of the Subcommittees:

I am pleased to be here today to discuss the Joint Strike Fighter (JSF) program. The JSF is the linchpin of future Department of Defense (DOD) tactical aircraft modernization efforts because of the program's sheer size and envisioned role to replace or complement several different types of aircraft providing a wide variety of missions in the Air Force, Navy, and Marine Corps. Given the program's cost and military importance, it is critical that decisions are made within this program to maximize its benefit to the nation. Today, my testimony highlights a number of those decisions by (1) discussing emerging risks to the overall program and (2) updating information for the cost analysis we performed last year regarding sole-source and competitive scenarios for development, production, and sustainment of the JSF engine. Information on the overall program risks is taken from our annual mandated report, also being issued today.[1] Using updated cost data, we projected cost and savings for one and two engine programs utilizing the parameters and overall methodology from our testimony of last year.[2] Appendix I describes our scope and methodology. For this testimony, we conducted a performance audit from February 2008 to March 2008 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.

Summary

In the past year, DOD reported that JSF procurement cost estimates increased by more than $23 billion due to a 7-year extension to the procurement period, future price increases, and airframe material cost increases. The official development cost estimate remained about the same; however, only by reducing requirements, canceling funding for the alternate engine program, and reducing test resources. Repercussions

[1]GAO, *Joint Strike Fighter: Recent Decisions by DOD Add to Program Risks*, GAO-08-388 (Washington, D.C.: March 11, 2008). This report is the fourth as mandated in the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005. See Pub. L. No. 108-375, § 213 (2004).

[2]GAO, *Defense Acquisitions: Analysis of Costs for the Joint Strike Fighter Engine Program*, GAO-07-656T (Washington, D.C.: Mar. 22, 2007).

from late release of engineering drawings to the manufacturing floor, design changes, and parts shortages forced the program to deplete its management reserve funds by $600 million, but DOD officials have decided not to request additional funding and time, opting instead to reduce test resources in order to replenish those reserves. This decision eliminated two development test aircraft, reduced flight tests, revised test verification plans, and accelerated the reduction in the prime contractor's development workforce. Officials from several prominent defense offices found that the plan was too risky because it increases the risks of not finding and fixing design and performance problems until late into production, when it is more expensive and disruptive to do so. We agree and our report recommends revisiting the plan to address these concerns and examine alternatives. DOD stated that it believes the plan is a cost effective approach with a manageable level of risk, but will monitor execution and revise the plan if necessary.

We do not think the official JSF program cost estimate is reliable when judged against best practice cost-estimating standards used throughout the federal government and industry. Specifically, the program cost estimate is not comprehensive, accurate, well documented, or credible. In addition to higher estimates made by the three independent defense organizations, we found that (1) DOD has identified billions of dollars in unfunded requirements; (2) there is continued degradation in the schedule; and (3) both the engine and airframe contracts have substantial negative cost variances. The prime contractor and program office are readying a new estimate, which is expected to be much larger than what is now budgeted. We made several recommendations to improve cost-estimating and the Department generally agreed. Looking to the future, the program makes unprecedented demands for funding from the defense budget—averaging about $11 billion each year for the next two decades—and must compete with other priorities for the shrinking federal discretionary dollar.

This year, DOD is again proposing cancellation of the JSF alternate engine program. Under a sole-source scenario, the current estimated remaining life cycle cost for the JSF engine program is $54.9 billion.[3] By continuing the JSF alternate engine program, an additional investment of about $3.5 billion to $4.5 billion may be required to ensure competition. However, as

[3]To maintain consistency with our statement from last year, unless otherwise noted, all costs related to the engine program are reported in base year 2002 dollars; all other figures in the statement are reported in then year dollars.

we reported last year, a competitive strategy could result in potential savings equal to or exceeding that amount across the life cycle of the engine. In fact, our updated cost analysis suggests that a savings of 9 to 11 percent—about 2 percent less than what we estimated last year—would recoup that investment. Further, prior experience indicates that it is reasonable to assume that competition on the JSF engine program could yield savings of at least that much. Further, non financial benefits in terms of better engine performance and reliability, more responsive contractors, and improved industrial base stability are more likely outcomes under a competitive environment than under a sole-source strategy. While cancellation of the program provides additional funding for other near-term needs, recent test failures for the primary JSF engine show how the ultimate engine acquisition approach selected could have long-term implications on DOD decision making.

Background

The Joint Strike Fighter is DOD's most expensive aircraft acquisition program. The number of aircraft, engines, and spare parts expected to be purchased, along with the lifetime support needed to sustain the aircraft, mean the future financial investment will be significant. DOD is expected to develop, procure, and maintain 2,443 operational aircraft at a cost of more than $950 billion over the program's life cycle. The JSF is being developed in three variants for the U.S. military: a conventional takeoff and landing aircraft for the Air Force, a carrier-capable version for the Navy, and a short takeoff and vertical landing variant for the Marine Corps.[4] In addition to its size and cost, the impact of the JSF program is even greater when combined with the number of aircraft expected for international sales (a minimum of 646 aircraft and potentially as many as 3,500). Finally, because a number of current U.S. aircraft will either be replaced by or used in conjunction with the JSF, the program is critical for meeting future force requirements.

The JSF program began in November 1996 with a 5-year competition between Lockheed Martin and Boeing to determine the most capable and affordable preliminary aircraft design. Lockheed Martin won the competition. The program entered system development and demonstration in October 2001. At that time, officials planned on a 10½ years development period costing about $34 billion (amount includes about $4

[4]Eight allied nations are also participating in the JSF program: United Kingdom, Norway, Denmark, the Netherlands, Canada, Italy, Turkey, and Australia.

billion incurred before system development start). By 2003, system integration efforts and a preliminary design review revealed significant airframe weight problems that affected the aircraft's ability to meet key performance requirements. Weight reduction efforts were ultimately successful but added substantially to program cost and schedule estimates. In March 2004, DOD rebaselined the program, extending development by 18 months and adding about $7.5 billion to development costs. In total, estimated development costs for the JSF are now about $10 billion more than at start of system development.

In August 2005, DOD awarded a $2.1 billion contract for alternate engine system development and demonstration, of which more than $1 billion has been appropriated to date.[5] Since awarding that contract, DOD's last three budget submissions have included no funding for the alternate engine program and DOD has proposed canceling it, stating that (1) no net acquisition cost benefits or savings are to be expected from competition and (2) low operational risk exists for the warfighter under a sole-source engine supplier strategy. We have previously reported that DOD's analysis to support this decision focused only on the potential up-front savings in engine procurement costs. That analysis, along with statements made before this committee last year, inappropriately included cost already sunk in the program and excluded long-term savings that might accrue from competition for providing support for maintenance and operations over the life cycle of the engine.

In fiscal year 2007, the program office awarded the first of three annual production contracts to Pratt & Whitney for its F135 engine. Under that acquisition strategy, the program then planned to award noncompetitive contracts to both Pratt & Whitney and to the Fighter Engine Team in fiscal years 2010 and 2011.[6] Beginning in fiscal year 2012, the program planned to award contracts on an annual basis under a competitive approach for quantities beyond each contractor's minimum sustaining rate. Full-rate production for the program begins in fiscal year 2014 and is expected to continue through fiscal year 2034. The JSF program intends to use a combination of competition, performance-based logistics, and contract incentives to achieve goals related to affordability, supportability, and

[5]Prior to that contract, DOD had invested $722 million in the alternate engine program.

[6]The Fighter Engine Team is a single company, created in July 2002 by General Electric and Rolls-Royce, and formed for the development, deployment, and support of the F136 engine for the JSF program.

safety. Through this approach, the JSF program office hopes to achieve substantial reductions in engine operating and support costs, which traditionally have accounted for 72 percent of a program's life cycle costs.

Recent Decisions by DOD Add to Overall JSF Program Risk

Today, we are issuing our latest report[7] on the JSF acquisition program, the fourth as mandated in the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005.[8] In our report we acknowledge the challenges in managing such a complex and ambitious acquisition and cite recent progress in refining system requirements, forging production agreements with international partners, and beginning flight testing of the prototype aircraft and a flying test bed. DOD also extended the procurement period for 7 years, reducing annual quantities and the rate of ramp up to full production. These actions somewhat lessened, but did not eliminate, the undue concurrency of development and production we have previously reported.

We also report continuing cost increases and development risks resulting from recent decisions by DOD to eliminate test resources to replenish needed management reserve funds. We expect that DOD will eventually need more money and time to complete development and operational testing, potentially delaying the full-rate production decision now planned for October 2013. We further report that the official program cost estimate before the Congress is not reliable for decision-making, based on our assessment of estimating methodologies compared to best practice standards. With almost 90 percent of the acquisition program's spending still ahead, it is important to address these challenges, effectively manage future risks, and move forward with a successful program that meets ours' and our allies' needs.

Program Cost Estimate Increased Since Last Year

DOD reported that total acquisition cost estimate increased by more than $23 billion since our last report in March of 2007, and $55 billion since the program underwent a major restructure in 2004. Recent increases in the procurement cost estimate were principally due to (1) extending the procurement period seven years at lower annual rates; (2) increases to future price estimates based on contractor proposals for the first production lot, and (3) airframe material cost increases. The official

[7] GAO-08-388.

[8] Pub. L. No. 108-375, § 213 (2004).

development cost estimate remained about the same. However, this was largely achieved by reducing requirements, not fully funding the alternate engine program despite congressional interest in the program, and reducing test resources in order to replenish management reserve funds which were spent much faster than budgeted. Table 1 shows the evolution in costs, unit costs, quantities, and deliveries since the start of the JSF's system development and demonstration program.

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

	October 2001 (development start)	December 2003[a]	December 2005[a]	December 2006[a] (latest available data)
Expected quantities				
Development quantities	14	14	15	15[b]
Procurement quantities (U.S. only)	2,852	2,443	2,443	2,443
Total quantities	**2,866**	**2,457**	**2,458**	**2,458**
Cost estimates (then year dollars in billions)				
Development	$34.4	$44.8	$44.5	$44.2
Procurement	196.6	199.8	231.7	255.1
Military construction[c]	2.0	0.2	0.2	0.5
Total program acquisition	**$233.0**	**$244.8**	**$276.5**	**$299.8**
Unit cost estimates (then year dollars in millions)				
Program acquisition	$81	$100	$112	$122
Average procurement	69	82	95	104
Estimated Delivery Dates				
First operational aircraft delivery	2008	2009	2009	2010
Initial operational capability	2010-2012	2012-2013	2012-2013	2012-2015

Source: GAO analysis of DOD data.

[a]Data is from the annual Selected Acquisition Reports that are dated in December but not officially released until March or April of the following year. The December 2003 data reflects the 2004 Replan. The December 2006 data is the latest information on total program costs made available to us by DOD.

[b]A subsequent decision by DOD in September 2007 has reduced development test aircraft by 2 to 13.

[c]Military construction costs have not been fully established and the reporting basis changed over time in these DOD reports. The amount shown for December 2006 represents costs currently in the 2008 future years defense plan.

JSF Development Program Faces Increased Risks of Further Cost Increases and Schedule Delays

Midway through its planned 12-year development period, the JSF program is over cost and behind schedule. The program has spent two-thirds of its budgeted funding on the prime development contract, but estimates that only about one-half of the development work has been completed. The contractor has extended manufacturing schedules several times and test aircraft delivery dates have continually slipped. Repercussions from late release of engineering drawings to the manufacturing floor, design changes, and parts shortages continue to cause delays in maturing manufacturing processes and force inefficient production line workarounds.

These design and manufacturing problems depleted management reserve funds to an untenable level in 2007. Facing a probable contract cost overrun, DOD officials decided not to request additional funding and time for development, opting instead to reduce test resources in order to replenish management reserves from $400 million to $1 billion. The decision to replenish management reserves by reducing test resources, known as the Mid-Course Risk Reduction Plan, was ratified by OSD in September 2007. It eliminated two development test aircraft (reducing the total from 15 to 13), reduced flight tests, revised test verification plans, and accelerated the reduction in the prime contractor's development workforce. Officials from several prominent defense offices objected to specific elements of the plan because of risks to the test program and because it did not treat the root causes of production and schedule problems.

We agree with this prognosis and believe the mid-course plan should be re-evaluated to address these concerns, examine alternatives, and correct the causes of management reserve depletion. The plan significantly increases the risks of not completing development testing on time and not finding and fixing design and performance problems until late into operational testing and production, when it is more expensive and disruptive to do so. It also does not directly address and correct the continuing problems that caused the depletion in management reserves. This increases the risk that development costs will increase substantially and schedules will be further delayed. The flight test program has barely begun, but faces substantial risks with reduced assets as design and manufacturing problems continue to cause delays that further compress the time available to complete development. We expect that DOD will have to soon restructure the JSF program to add resources and extend the development period, likely delaying operational testing, the full-rate production decision, and achievement of initial operational capabilities.

JSF Program Cost Estimate Is Not Reliable

We do not think the official JSF program cost estimate is reliable when judged against cost estimating standards used throughout the federal government and industry. Specifically, the program cost estimate: (1) is not comprehensive because it does not include all applicable costs, including $6.8 billion for the alternate engine program; (2) is not accurate because some of its assumptions are optimistic and not supportable—such as applying a weight growth factor only half as large as historical experience on similar aircraft—and because the data system relied upon to report and manage JSF costs and schedule is deficient; (3) is not well documented in that it does not sufficiently identify the primary methods, calculations, results, rationales and assumptions, and data sources used to generate cost estimates; and (4) is not credible according to individual estimates from OSD's Cost Analysis Improvement Group, the Defense Contract Management Agency, and the Naval Air Systems Command.

All three of these defense offices concluded that the official program cost estimate is understated in a range up to $38 billion and that the development schedule is likely to slip from 12 to 27 months. Despite this and all the significant events and changes that have occurred in the 6 years since the start of system development, DOD does not intend to accomplish another fully documented, independent total program life-cycle cost estimate for another 6 years. Twelve years between high-fidelity estimates is not acceptable in our view, especially given the size of the JSF program, its importance to our and our allies' future force structures, the changes in cost and quantity in the intervening years, and the unreliability of the current estimate.

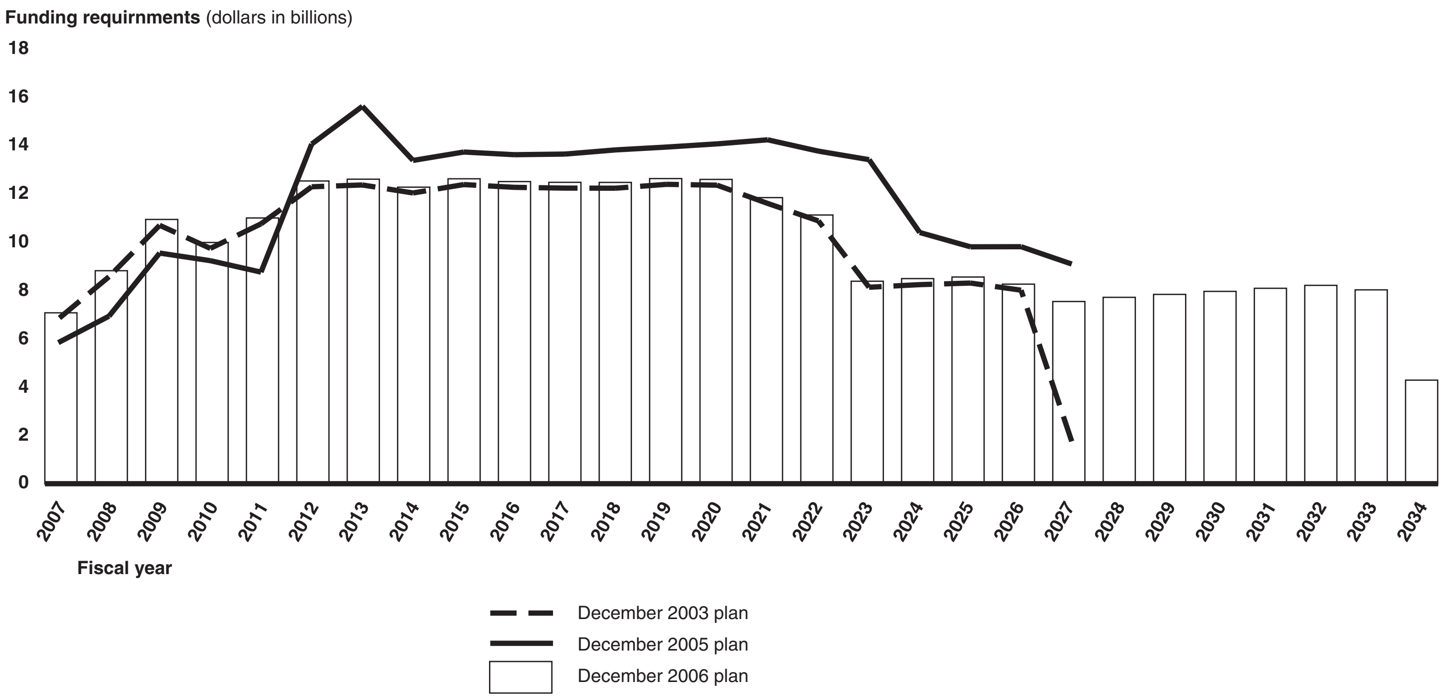
Based on the evidence we collected, we believe a new estimate will likely be much higher than now reported. In addition to the higher estimates made by the three independent defense organizations, we determined that:

- DOD has identified billions of dollars in unfunded requirements that are not in the program office estimate, including additional tooling and procurement price hikes.
- A new manufacturing schedule in the works indicates continued degradation in the schedule and further extends times for first flights.
- Both the aircraft and engine development contracts have persistent, substantial cost variances that cost analysts believe are too large and too late in the program to resolve without adding to budget.
- The prime contractor and program office are readying a new estimate needed to complete the program, which is expected to be much larger than what is now budgeted.

JSF Faces Challenges as Program Moves Forward

The first and foremost challenge for the JSF program is affordability. From its outset, the JSF goal was to develop and field an affordable, highly common family of strike aircraft. Rising unit procurement prices and somewhat lower commonality than expected raise concerns that the United States and its allies may not be able to buy as many aircraft as currently planned. The program also makes unprecedented demands for funding from the defense budget—averaging about $11 billion each year for the next two decades—and must compete with other priorities for the shrinking federal discretionary dollar. Figure 1 compares the current funding profile with two prior projections and shows the impact from extending procurement 7 more years to 2034. This reduced mid-term annual budget requirements, but added $11.2 billion to the total procurement cost estimate.

Figure 1: JSF Acquisition Program's Annual Funding Requirements



Source: GAO analysis of DOD data.

Further, informed by more knowledge as the program progresses, DOD doubled its projection of JSF life-cycle operating and support costs compared to last year's estimate and its expected cost per flight hour now exceeds the F-16 legacy fighter it is intended to replace. With almost 90 percent (in terms of dollars) of the acquisition program still ahead, it is important to address these challenges, effectively manage future risks, and move forward with a successful program that meets our military needs, as well as those of our allies.

Engine Competition Benefits Could Outweigh Costs

As we noted in testimony before this committee last year, the acquisition strategy for the JSF engine must weigh expected costs against potential rewards. Without competition, the JSF program office estimates that it will spend $54.9 billion over the remainder of the F135 engine program. This includes cost estimates for completing system development, procurement of 2,443 engines, production support, and sustainment. Due primarily to the money spent on the engine program over the past year, thereby increasing the sunk costs in our calculations, we believe competition could provide an even better return on investment than our previous assessment. Additional investment of between $3.5 billion to $4.5 billion may be required should the Department decide to continue competition. While Pratt & Whitney design responsibilities and associated costs may actually be reduced under a sole-source contract, we remain confident that competitive pressures could yield enough savings to offset the costs of competition over the program's life. This ultimately will depend on the final approach for the competition, the number of aircraft actually purchased, and the ratio of engines awarded to each contractor. Given certain assumptions with regard to these factors, the additional costs of having the alternate engine could be recouped if competition were to generate approximately 9 to 11 percent savings—about 2 percent less than we estimated previously. According to actual Air Force data from past engine programs, including the F-16 aircraft, we still believe it is reasonable to expect savings of at least that much.

Sole-Source Approach Results in Reduced Upfront Costs

The cost of the Pratt & Whitney F135 engine is estimated to be $54.9 billion over the remainder of the program. This includes cost estimates for the completion of system development, procurement of engines, production support, and sustainment. Table 2 shows the costs remaining to develop, procure, and support the Pratt & Whitney F135 engine on a sole-source basis.

Table 2: Costs to Complete Pratt & Whitney F135 Engine Program (Fiscal year 2002 dollars in billions)

Cost element	Cost
System development and demonstration costs	$0.7
Total engine unit recurring flyaway costs	$19.5
Production support costs (including initial spares, training, manpower, and depot standup)	$3.1
Sustainment costs of fielded aircraft	$31.6
Total	**$54.9**

Source: JSF program office 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, either during initial installation or when replacement is required. 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, instead of potentially compromised design solutions or additional costs needed to support both F135 and the F136, the alternate engine.

JSF Engine Competition Could Result in Future Savings

The government's ability to recoup the additional investments required to support competition depends largely on (1) the number of aircraft produced,[9] (2) the ratio that each contractor wins out of that total, and (3) the savings rate that competitive pressures drive. Our analysis last year, and again for this statement, estimated costs under two competitive scenarios; 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, beginning in fiscal year 2012. Without consideration of potential savings, the additional costs of competition total about $4.5 billion under the first

[9]In conducting our cost analysis of the alternate engine program, we presented the cost of only the 2,443 U.S. aircraft currently expected for production. These costs assume the quantity benefits of the 730 aircraft currently anticipated for foreign partner procurement.

scenario and about $3.5 billion under the second scenario. Table 3 shows the additional cost associated with competition under these two scenarios.

Table 3: Additional Costs for Competition in JSF Engine Program (Fiscal year 2002 dollars in billions)

Additional costs	50/50 Aircraft award split	70/30 Aircraft award split
System development and demonstration costs	$1.1	$1.1
Total engine unit recurring flyaway costs	$3.2	$2.3
Production support costs (including initial spares, training, manpower, and depot standup)	$0.1	$0.1
Sustainment costs of fielded aircraft[a]	N/A	N/A
Total	**$4.5**	**$3.5**

Source: JSF program office data; GAO analysis.

Notes: Based on 2,443 installed engines and spares. Numbers may not add due to rounding.

[a]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 unit recurring flyaway costs used to construct each estimate. The other costs include approximately $1.1 billion for remaining F136 development and $116 million in additional standup costs, which would be the same under either competitive scenario.

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. To reflect these and other factors, we applied a 10 to 20 percent range of potential cost savings to our estimates, where pertinent to a competitive environment.[10] Further, when comparing life cycle costs, 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

[10]Our review of DOD data as well as discussions with defense and industry experts, confirmed this as a reasonable range of potential savings to consider.

(time value of money) in the analysis that, once applied, provides for a better estimate of program rate of return.

When we apply overall savings expected from competition, our analysis indicates that recoupment of those initial investment costs would occur at somewhere between 9 and 11 percent, depending on the number of engines awarded to each contractor. A competitive scenario where one of the contractors receives 70 percent of the annual production aircraft, while the other receives only 30 percent reaches the breakeven point at 9 percent savings—1.3 percent less than we estimated before. A competitive scenario where both contractors receive 50 percent of the production aircraft reaches this point at 11 percent savings—again about 1.3 percent less than last year.[11] We believe it is reasonable to assume at least this much savings in the long run based on analysis of actual data from the F-16 engine competition.

Past Engine Programs Show Potential Financial Benefits from Competition

Results from past competitions provide evidence of potential financial and non financial savings that can be derived from engine programs. One relevant case study to consider is the "Great Engine War" of the 1980s—the competition between Pratt & Whitney and General Electric to supply military engines for the F-16 and other fighter aircraft programs.[12] 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 with regard 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.

[11] These savings amounts reflect net present value calculations that discount costs and savings for both inflation and the time value of money.

[12] Other engine competitions include those for the F-15, F/A-18, and F-22A fighter aircraft.

The Great Engine War was able to generate significant benefits because competition incentivized contractors to improve designs and reduce costs during production and sustainment.

Multiple Studies and Analyses Show Additional Benefits from Competition

Competition for the JSF engines may also 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, indicate there are a number of non financial benefits that may result from competition, including better performance, increased reliability, and improved contractor responsiveness. In addition, the long term impacts of the JSF engine program on the global industrial base go far beyond the two competing contractors.

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. Table 4 summarizes the benefits determined by those groups.

Table 4: 1998 and 2002 Program Management Advisory Group Study Findings on the Benefits of an Alternate Engine Program

	Beneficial		Marginal		No value	
Factor assessed	**1998**	**2002**	**1998**	**2002**	**1998**	**2002**
Costs			X	X		
Development risk reduction					X	X
Engine growth potential			X	X		
Fleet readiness	X	X				
Industrial base	X	X				
International implications	X	X				
Other considerations[a]	X	X				
Overall	**X**	**X**				

Source: DOD data; GAO analysis and presentation.

[a]Other considerations include contractor responsiveness, improved design solutions, and competition at the engine subsystem level.

While the benefits highlighted may be more difficult to quantify, they are no less important, and ultimately were strongly considered in an earlier recommendation 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.

Another potential benefit of having an alternate engine program, and one also supported by the program advisory group studies, is to reduce the risk that a single point, systemic failure in the engine design could substantially affect the fighter aircraft fleet. This point is underscored by recent failures of the Pratt & Whitney test program. In August 2007, an engine running at a test facility experienced failures in the low pressure turbine blade and bearing, which resulted in a suspension of all engine test activity. In February 2008, during follow-on testing to prove the root cost of these failures, a blade failure occurred in another engine, resulting in delays to both the Air Force and Marine Corps variant flight test programs.

The JSF program continues to work toward identifying and correcting these problems. Though current performance data indicate it is unlikely that these or other engine problems would lead to fleetwide groundings in modern aircraft, having two engine sources for the single-engine JSF further reduces this risk as it is more unlikely that such a problem would occur to both engine types at the same time.

Concluding Observations

DOD is challenged once again with weighing short-term needs against potential long-term payoffs within the JSF program, especially in terms of the test program and the approach for developing, procuring, and sustaining the engine. We and others believe that the JSF risk reduction plan is too risky—cutting test resources and flight tests will constrain the pace and fidelity of development testing—and additional costs and time will likely be needed to complete JSF development. Finding and fixing deficiencies during operational testing and after production has ramped up is costly, disruptive, and delays getting new capabilities to the warfighter. Further, without directly addressing the root causes of manufacturing delays and cost increases, the problems will persist and continue to drain development resources and impact low-rate production that is just beginning. These actions may postpone events, but a major restructuring appears likely—we expect DOD will need more money and time to complete development and operational testing, which will delay the full-rate production decision.

Because the JSF is entering its most challenging phase—finalizing three designs, maturing manufacturing processes, conducting flight tests, and ramping up production in an affordable manner—decision making and oversight by Congress, top military leaders, and our allies is critical for successful outcomes. The size of the JSF acquisition, its impact on our tactical air forces and those of our allies, and the unreliability of the current estimate, argue for an immediate new and independent cost estimate and uncertainty analysis, so that these leaders can have good information for effective decision making. Likewise, the way forward for the JSF engine acquisition strategy entails one of many critical choices facing DOD today, and underscores the importance of decisions facing the program. Such choices made today on the JSF program will have long term impacts.

Mr. Chairmen, this concludes my prepared statement. I will be happy to answer any questions you or other members of the subcommittee may have.

Contacts and Acknowledgments

For future questions regarding this testimony, please contact Michael J. Sullivan, (202) 512-4841. Individuals making key contributions to this testimony include Marvin Bonner, Jerry Clark, Bruce Fairbairn, J. Kristopher Keener, Matt Lea, Brian Mullins, Daniel Novillo, and Charles Perdue.

Appendix I: Scope and Methodology

To conduct our mandated work on the JSF acquisition program, we tracked and compared current cost and schedule estimates with prior years, identified major changes, and determined causes. We visited the prime contractor's plant to view manufacturing processes and plans for low rate production. We obtained earned value data, contractor workload statistics, performance indicators, and manufacturing results. We reviewed the Mid Course Risk Reduction Plan and supporting documents, discussed pros and cons with DOD officials, and evaluated potential impacts on flight plans and test verification criteria.

We reviewed the cost estimating methodologies, data, and assumptions used by the JSF joint program office to project development, procurement, and sustainment costs. We assessed the program office's procedures and methodologies against GAO's *Cost Assessment Guide* and best practices employed by federal and private organizations. We obtained cost estimates prepared by the Cost Analysis Improvement Group, Naval Air Systems Command, and Defense Contract Management Command and discussed with the cost analysts the methodologies and assumptions used by those organizations. We discussed plans, future challenges, and results to date with DOD and contractor officials.

For our work on the alternate engine we used the methodology detailed below, the same as had been used in support of our statement in March 2007. For this statement, we collected similar current information so the cost information could be updated. In conducting our analysis of costs for the Joint Strike Fighter (JSF) engine program, we relied primarily on program office data. We did not develop our own source data for development, production, or sustainment costs. In assessing the reliability of data from the program office, we compared that data to contractor data and spoke with agency and other officials and determined that the data were sufficiently reliable for our review.

Other base assumptions for the review are as follows:

- Unit recurring flyaway cost includes the costs associated with procuring one engine and certain nonrecurring production costs; it does not include sunk costs, such as development and test, and other costs to the whole system, including logistical support and construction.
- Engine procurement costs reflect only U.S. costs, but assumes the quantity benefits of the 730 aircraft currently anticipated for foreign partner procurement.

- Competition, and the associated savings anticipated, begins in fiscal year 2012.
- Engine maturity, defined as 200,000 flight hours with at least 50,000 hours in each variant, is reached in fiscal year 2012.
- Two years are needed for delivery of aircraft.
- Aircraft life equals 30 years at 300 flight hours per year.

For the sole-source Pratt & Whitney F135 engine scenario, we calculated costs as follows:

Development

- Relied on JSF program office data on the remaining cost of the Pratt & Whitney development contract. We considered all costs for development through fiscal year 2008 to be sunk costs and did not factor them into analysis.

Production

- For cost of installed engine quantities, we multiplied planned JSF engine quantities for U.S. aircraft by unit recurring flyaway costs specific to each year as derived from cost targets and a learning curve developed by the JSF program office.
- For the cost of production support, we relied on JSF program office cost estimates for initial spares, training, support equipment, depot stand-up, and manpower related to propulsion. Because the JSF program office calculates those numbers to reflect two contractors, we applied a cost reduction factor in the areas of training and manpower to reflect the lower cost to support only one engine type.

Sustainment

- For sustainment costs, we multiplied the planned number of U.S. fielded aircraft by the estimated number of flight hours for each year to arrive at an annual fleet total. We then multiplied this total by JSF program office estimated cost per engine flight hour specific to each aircraft variant.
- Sustainment costs do not include a calculation of the cost of engine reliability or technology improvement programs.

For a competitive scenario between the Pratt & Whitney F135 engine and the Fighter Engine Team (General Electric and Rolls-Royce), we calculated costs as follows:

Development

- We used current JSF program office estimates of remaining development costs for both contractors and considered all costs for development through fiscal year 2008 to be sunk costs.

Production

- We used JSF program office data for engine buy profiles, learning curves, and unit recurring flyaway costs to arrive at a cost for installed engine quantities on U.S. aircraft. We performed calculations for competitive production quantities under 70/30 and 50/50 production quantity award scenarios.
- We used JSF program office cost estimates for production support under two contractors. We assumed no change in support costs based on specific numbers of aircraft awarded under competition, as each contractor would still need to support some number of installed engines and provide some number of initial spares.

Sustainment

- We used the same methodology and assumptions to perform the calculation for sustainment costs in a competition as in the sole-source scenario.

Savings

- We analyzed actual cost information from past aircraft propulsion programs, especially that of the F-16 aircraft engine, in order to derive the expected benefits of competition and determine a reasonable range of potential savings.
- We applied this range of savings to the engine life cycle, including recurring flyaway costs, production support, and sustainment. We assumed costs to the government could decrease in any or all of these areas as a result of competitive pressures.
- We did not apply any savings to the system development and demonstration phase or the first five production lots because they are not fully competitive. However, we recognize that some savings may accrue as contractors prepare for competition.

In response to the request to present our cost analyses in constant dollars, then year dollars, and using net present value, we:

- calculated all costs using constant fiscal year 2002 dollars,
- used separate JSF program office and Office of the Secretary of Defense inflation indices for development, production, production support, and sustainment to derive then year dollars; when necessary for the out years, we extrapolated the growth of escalation factors linearly; and
- utilized accepted GAO methodologies for calculating discount rates in the net present value analysis.

Our analysis of the industrial base does not independently verify the relative health of either contractors' suppliers or workload.

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