



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

For Release on Delivery  
Expected at 2:00 p.m. EDT  
Thursday, March 22, 2007

## DEFENSE ACQUISITIONS

# Analysis of Costs for the Joint Strike Fighter Engine Program

Statement of Michael Sullivan, Director  
Acquisition and Sourcing Management

The web version of this report was reposted on May 8, 2007, to reflect a change to the text in Figure 1 on page 9 since the original version was posted on March 22, 2007. A typographical error was identified in that figure wherein the Assumed Savings rates were depicted as 10, 20, and 30 percent. Those savings rates should instead be 10, 15, and 20 percent. The change does not affect other numbers in Figure 1 or the rest of the report.





Highlights of [GAO-07-656T](#), 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 linchpin of future Department of Defense (DOD) tactical aircraft modernization efforts because of the sheer size of the program and its envisioned role as the replacement for hundreds of aircraft that perform a wide variety of missions in the Air Force, Navy, and Marine Corps. DOD implemented the JSF alternate engine development program in 1996 to provide competition between two engine manufacturers in an effort to achieve cost savings, improve performance, and gain other benefits. This testimony focuses on GAO's cost analysis performed in response to Section 211 of the John Warner National Defense Authorization Act for Fiscal Year 2007. We examined the following areas: (1) sole-source and competitive scenarios for development, production, and sustainment of the JSF engine, (2) results of past engine programs and their related strategies, and (3) impact on the industrial base in the event of the complete cancellation of the JSF alternate engine program. DOD did not provide comments on our findings.

[www.gao.gov/cgi-bin/getrpt?GAO-07-656T](http://www.gao.gov/cgi-bin/getrpt?GAO-07-656T).

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

## DEFENSE ACQUISITIONS

### Analysis of Costs for the Joint Strike Fighter Engine Program

#### What GAO Found

- Continuing the alternate engine program for the Joint Strike Fighter would cost significantly more than a sole-source program but could, in the long run, reduce costs and bring other benefits. The current estimated life cycle cost for the JSF engine program under a sole-source scenario is \$53.4 billion. To ensure competition by continuing to implement the JSF alternate engine program, an additional investment of \$3.6 billion to \$4.5 billion may be required. However, the associated competitive pressures from this strategy could result in savings equal to or exceeding that amount. The cost analysis we performed suggests that a savings of 10.3 to 12.3 percent would recoup that investment, and actual experience from past engine competitions suggests that it is reasonable to assume that competition on the JSF engine program could yield savings of at least that much. In addition, DOD-commissioned reports and other officials have said that nonfinancial benefits in terms of better engine performance and reliability, improved industrial base stability, and more responsive contractors are more likely outcomes under a competitive environment than under a sole-source strategy.
- DOD experience with other aircraft engine programs, including the F-16 fighter in the 1980s, has shown competitive pressures can generate financial benefits of up to 20 percent during the life cycle of an engine program and/or improved quality and other benefits.
- The potential for cost savings and performance improvements, along with the impact the engine program could have on the industrial base, underscores the importance and long-term implications of DOD decision making with regard to the final acquisition strategy solution.

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Mr. Chairmen and Members of the Subcommittees:

I am pleased to be here today to discuss the Joint Strike Fighter (JSF) engine 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 as the replacement for hundreds of aircraft that provide a wide variety of missions in the Air Force, Navy, and Marine Corps. DOD implemented the JSF alternate engine development program in 1996 to provide competition between two engine manufacturers in an effort to achieve cost savings, improve performance, and gain other benefits. Today, my testimony focuses on our cost analysis performed in response to Section 211 of the John Warner National Defense Authorization Act for Fiscal Year 2007.<sup>1</sup> Specifically, it examines the following areas: (1) sole-source and competitive scenarios for development, production, and sustainment of the JSF engine; (2) results of past engine programs and their related strategies; and (3) impact on the industrial base in the event of the complete cancellation of the JSF alternate engine program. While language in the act instructed GAO to report on additional elements related to a firm-fixed-price acquisition strategy and any other approach that could improve cost or schedule, this statement focuses on the areas above, as we determined those to be the most viable options under consideration. Appendix I contains information about scope and methodology for the cost analysis on which this statement is based. We performed our work from January 2007 to March 2007 in accordance with generally accepted government auditing standards.

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## Summary

The current estimated remaining life cycle cost for the JSF engine program under a sole-source scenario is \$53.4 billion. To ensure competition by continuing the JSF alternate engine program, an additional investment of \$3.6 billion to \$4.5 billion may be required. However, the associated competitive pressures from this strategy could result in savings equal to or exceeding that amount across the life cycle of the engine. The cost analysis we performed suggests that a savings of 10.3 to 12.3 percent would recoup that investment, and actual experience from past engine competitions suggests that it is reasonable to assume that competition on the JSF engine program could yield savings of at least that much. These results are dependent on how the government decides to run the

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<sup>1</sup>Pub. L. No. 109-364, 120 Stat. 2083, 2117-2119 (2006).

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competition, the number of aircraft that are ultimately purchased, and the exact ratio of engines awarded to each contractor. In addition, DOD-commissioned reports and other officials have said that non financial benefits in terms of better engine performance and reliability, improved industrial base stability, and more responsive contractors are more likely outcomes under a competitive environment than under a sole-source strategy. DOD experience with other aircraft engine programs, including that for the F-16 fighter, has shown competitive pressures can generate financial benefits of up to 20 percent during the life cycle of an engine program and/or the other benefits mentioned. The potential for cost savings and performance improvements, along with the impact the engine program could have on the industrial base, underscores the importance and long-term implications of DOD decision making with regard to the final acquisition strategy. DOD chose not to provide comments on this statement or the cost analysis on which it is based. The JSF program office reviewed our findings and made technical comments which were incorporated as appropriate.

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## 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 engines, mean the future financial investment will be significant. DOD is expected to develop, procure, and maintain 2,443 aircraft at a cost of more than \$338 billion over the program's life cycle.<sup>2</sup> 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.<sup>3</sup> In addition to its size and cost, the impact of the JSF program is even greater when combined with potential international sales (expected to be between 2,000 and 3,500 additional aircraft) and the current U.S. aircraft that the JSF will either replace or complement to meet mission requirements.

Congress first expressed concern over the lack of engine competition in the JSF program in fiscal year 1996 and in fiscal year 1998 directed DOD to ensure that sufficient funding was committed to develop an alternate engine. Since that time, DOD has initiated multiple studies to determine

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<sup>2</sup>Unless otherwise noted, all dollars in this report are fiscal year 2002 dollars.

<sup>3</sup>Eight allied nations are also participating in the JSF program: United Kingdom, Norway, Denmark, the Netherlands, Canada, Italy, Turkey, and Australia.

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the advantages and disadvantages of the alternate engine program. DOD program management advisory groups conducted studies in 1998 and again in 2002, both resulting in recommendations to continue with the alternate engine program. The advisory groups determined that developing an alternate JSF engine had significant benefits in the areas of contractor responsiveness, industrial base, aircraft readiness, and international participation. They also reported finding marginal benefits in the areas of cost savings and the ability to add future engine improvements. However, they found no benefit with regard to reducing development risk without restructuring the program. The advisory groups noted that these recommendations were made independent of the services' ability to fund the program—meaning overall affordability should be taken into consideration.

In August 2005, DOD awarded a \$2.1 billion contract for alternate engine system development and demonstration, of which \$699 million has been appropriated to date.<sup>4</sup> In its fiscal year 2007 budget submission, DOD proposed canceling the alternate engine program and eliminated funding related to this effort. While Congress restored the majority of the funding for that year, DOD again eliminated alternate engine funding in its proposed budget for fiscal year 2008.

DOD decided to cancel the alternate engine program prior to the fiscal year budget submission, stating that (1) no net 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 reported last year that this decision was made without a new and comprehensive analysis and focused only on the potential up-front savings in engine procurement costs. We stated further that costs already sunk were inappropriately included and long-term savings that might accrue from competition for providing support for maintenance and operations over the life cycle of the engine were excluded from the decision justification. Our position was that DOD's decision to cancel the program was driven by the need to identify sources of funding in order to pay for other, more immediate priorities within the department.

DOD did not change the JSF acquisition strategy to reflect its proposed elimination of the alternate engine program, and it continues a dual engine approach. The 2007 Defense Authorization Act has now placed certain

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<sup>4</sup>Prior to this contract, DOD had invested \$722 million in the alternate engine program.

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restrictions on DOD modification of the dual engine approach. According to current JSF program plans, beginning in fiscal year 2007, the program office will award the first of three annual production contracts to Pratt & Whitney for its F135 engine. In fiscal years 2010 and 2011, noncompetitive contracts will be awarded to both Pratt & Whitney and to the Fighter Engine Team<sup>5</sup> for the F136 engine. Beginning in fiscal year 2012, contracts will be awarded 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 safety. Through this approach, the JSF program office hopes to achieve substantial reductions in engine operating and support costs. Traditionally, operating and support costs have accounted for 72 percent of a program's life cycle costs.

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## Our Analysis of Alternatives Suggests Competition Benefits Could Outweigh Costs

Without competition, the JSF program office estimates that it will spend \$53.4 billion over the remainder of the F135 engine program. This includes cost estimates for the completion of system development, procurement of 2,443 engines, production support, and sustainment. Additional investment of between \$3.6 billion and \$4.5 billion may be required should the Department decide to continue competition in the JSF engine program. This includes additional development, procurement, support, and stand-up costs for a second engine provider. While Pratt & Whitney design responsibilities and associated costs may be reduced under a sole-source contract, our analysis shows that competitive pressures may yield enough financial savings to offset the costs of competition over the life of the program. These results are dependent on how the government decides to run the competition, the number of aircraft that are ultimately purchased, and the exact 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 10.3 to 12.3 percent savings. According to actual Air Force data from past engine programs, including for the F-16 aircraft, it is reasonable to expect savings of at least that much. Additionally, there are

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<sup>5</sup>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.

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a number of non financial benefits that may result from competition, including better performance, increased reliability, and improved contractor responsiveness.

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### Sole-Source Alternative Requires Less Short-term Investment

The cost of the Pratt & Whitney F135 engine is estimated to be \$53.4 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 1 shows the costs remaining to develop, procure, and support the Pratt & Whitney F135 engine on a sole-source basis.

**Table 1: Costs to Complete Pratt & Whitney F135 Engine Program (based on 2,443 installed engines and spares)**

Cost element	Cost (FY02\$B)
System development and demonstration costs	\$1.0
Total engine unit recurring flyaway costs	\$17.6
Production support costs (including initial spares, training, manpower, and depot stand-up)	\$3.2
Sustainment costs of fielded aircraft	\$31.6
<b>Total</b>	<b>\$53.4</b>

Source: JSF program office data; GAO analysis.

Costs remaining for the JSF engine program can be broken down into four categories:

- remaining system development and demonstration contract costs;
- engine unit recurring flyaway costs—per unit cost for aircraft, based on rate of learning;
- production support costs related to production spares, training personnel and equipment, manpower, and depot facilities; and
- sustainment costs to maintain fielded aircraft based on engine flight hour costs and usage rates.

Stable requirements and funding, a well-defined acquisition strategy, an appropriately structured contract, and adequate oversight are keys to ensuring the contractor is motivated to perform, especially under a sole-source contract where competitive pressure does not exist. In a sole-

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source environment, the primary benefit comes from the improved rate of progress, or “learning,” achieved by the contractor based on having all production activity.<sup>6</sup> In other words, the greater volume of business given to a single contractor is expected to translate into efficiency in production in a shorter time, thereby lowering associated costs. Learning curves must be established in a manner so that the contractor is not only intent on meeting that curve, but also incentivized to exceed the curve in order to achieve cost reductions. Through analysis of program information and in conversations with Pratt & Whitney and JSF program office personnel, we found examples of initiatives aimed at improving the F135 learning curve. Pratt & Whitney has ongoing and planned activities in areas such as supply chain optimization, technology development, and manufacturing efficiency that it hopes will reduce unit costs through the first 5 years of F135 production.

Having Pratt & Whitney as the single engine manufacturer may also provide benefits in terms of simpler design and integration responsibilities. Currently, in addition to development of the F135 engine design, Pratt & Whitney has responsibility for design and development of common components that will go on all JSF aircraft, regardless of which contractor provides the engine core. Examples of common components include the lift fan and roll posts for the Marine Corps variant, the exhaust nozzles, and ducts. This responsibility supports the overall F-35 program 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 F136.

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## JSF Engine Competition Could Result in Future Savings

In testimony last year, the Under Secretary of Defense for Acquisition, Technology, and Logistics reported that DOD preferred a sole-source engine strategy for the JSF program. He noted that maintaining two engine suppliers for the program would cost, at that time, an additional \$1.8 billion for the development phase which was not the most efficient use of Department resources. In fact, when considering the costs of

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<sup>6</sup>A learning curve represents the relationship between the unit cost of an item and the cumulative production quantity of that item.



competition over the full life cycle of the F136 program, the additional costs are even greater. The government's ability to recoup the additional investments required to support competition depends largely on (1) the number of aircraft produced,<sup>7</sup> (2) the ratio that each contractor wins out of that total, and (3) the savings rate that competitive pressures drive. We 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 a 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 \$4.5 billion under the first scenario and \$3.6 billion under the second scenario. Table 2 shows the additional cost associated with competition under these two scenarios.

**Table 2: Additional Costs for Competition in JSF Engine Program (based on 2,443 installed engines and spares)**

Additional costs (FY02\$B)	50/50 Aircraft award split	70/30 Aircraft award split
System development and demonstration costs	\$1.4	\$1.4
Total engine unit recurring fly-away costs	\$3.0	\$2.1
Production support costs (including initial spares, training, manpower, and depot standup)	\$.13	\$.13
Sustainment costs of fielded aircraft <sup>a</sup>	N/A	N/A
<b>Total</b>	<b>\$4.5</b>	<b>\$3.6</b>

Source: JSF program office data; GAO analysis.

<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 volumes that is accounted for in the projected unit recurring flyaway costs used to construct each estimate. The other costs include approximately \$1.4 billion in remaining F136 development costs and \$127 million in additional stand-up costs, which would be the same under either competitive scenario.

<sup>7</sup>In conducting our cost analysis of the alternate engine program, we presented the cost of only the U.S. aircraft currently expected for production (2,443). These costs assume the quantity benefits of the 646 aircraft currently anticipated for foreign partner procurement.

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DOD implemented the JSF alternate engine development program to provide competition between two engine manufacturers in an effort to achieve cost savings, improve performance, and gain other benefits. For example, 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 potential factors, we applied a 10 to 20 percent range of potential cost savings to our estimates, where pertinent to a competitive environment.<sup>8</sup> 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, though much of the expected savings do not accrue for decades. Therefore, a net present value calculation (time value of money) must be included in the analysis and, once applied, provides for a better estimate of program rate of return. Figure 1 shows the results of our analysis under different scenarios and accounting for the time value of money.

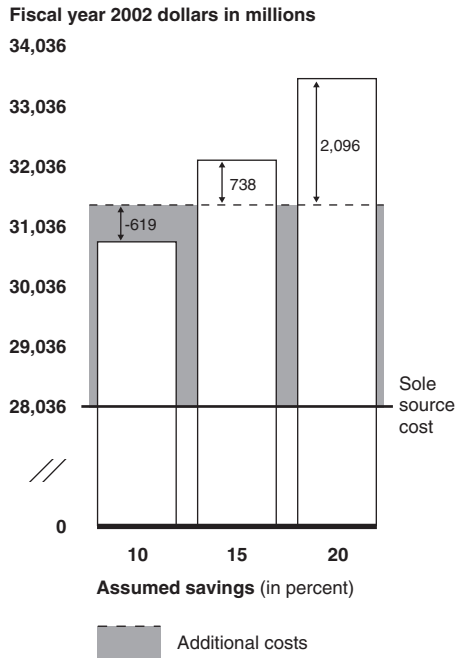
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<sup>8</sup>Our review of DOD data as well as discussions with defense and industry experts, confirmed this as a reasonable range of potential savings to consider.

**Figure 1: Net Present Value of JSF Engine Competition**

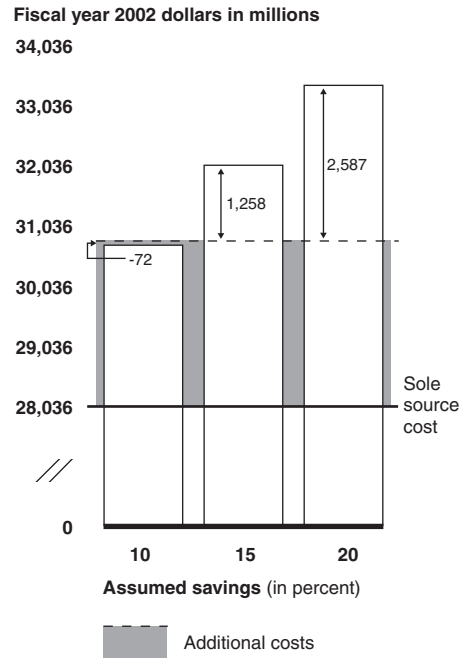
**NPV break-even analysis: 50/50 award**

Additional costs = \$3.3 billion FY 2002  
 Break-even point = 12.3 percentage savings



**NPV break-even analysis: 70/30 award**

Additional costs = \$2.7 billion FY 2002  
 Break-even point = 10.3 percentage savings



Source: JSF program office data; GAO analysis.

Note: Net present value calculated based on fiscal year 2002.

When we assumed overall savings due to competition, our analysis indicated that recoupment of those initial investment costs would occur at somewhere between 10.3 and 12.3 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 10.3 percent savings. A competitive scenario where both contractors receive 50 percent of the production aircraft reaches this point at 12.3 percent savings.<sup>9</sup> 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.

<sup>9</sup>These savings amounts reflect net present value calculations that discount costs and savings for both inflation and the time value of money.

## Competition Offers Potential Benefits beyond Financial Savings

Competition may also provide benefits that do not result in immediate financial savings, but may result in reduced costs or other positive outcomes to the program over time. 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 3 summarizes the benefits determined by those groups.

**Table 3: 1998 and 2002 Program Management Advisory Group Study Findings on the Benefits of an Alternate Engine Program**

Factor assessed	Beneficial		Marginal		No value	
	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 <sup>a</sup>	X	X				
<b>Overall</b>	<b>X</b>	<b>X</b>				

Source: DOD data; GAO analysis and presentation.

<sup>a</sup>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 recommending continuation of 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.

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We spoke with government officials from various organizations who widely concurred with our analysis of the potential benefits of engine competition. Many of these were important benefits realized by past competitions such as that for the Air Force F-16 aircraft engines. Discussions with the Air Force engine manager who co led both advisory group studies explained that these benefits are valuable when trying to manage significant numbers of fighter-type engines to ensure combat readiness. He told us that problems are magnified when trying to manage a single engine system, which can require substantial manpower and extra hours to keep aircraft flying when engine problems occur. In his opinion, the benefits of a dual-source engine would outweigh the costs. He stated that he had not seen anything that would change this conclusion since the last advisory group study was conducted.

The ability of competition to deliver such benefits is important for the JSF program. In addition to considering engine price, the program office has identified a range of potential criteria for competition during the production and support phases of the program, which could include other costs, reliability, and sustainability. It is reasonable to assume that competition under these criteria may drive better engine performance and reliability over the life of the program. Such improvements can positively affect fleet readiness and schedule outcomes while avoiding costs in various other areas for the JSF program.

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. Though current performance data indicate 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 more unlikely that such a problem would occur to both engine types at the same time. Because the JSF is expected to be the primary fighter aircraft in the U.S. inventory, and Pratt & Whitney will also be the sole-source provider of F119 engines for the F-22A aircraft,<sup>10</sup> DOD is faced with the potential scenario where almost the entire fleet could be dependent on similar engine cores, produced by the same contractor in a sole-source environment.

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<sup>10</sup>The F135 engine is a derivative of the F119 engine, which means many of the same or similar parts and processes are used to manufacture both engines. It also means that the F135 can benefit from lessons learned or be susceptible to any systemic problems associated with the F119.

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## Past Engine Programs Show Potential 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. 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. For example, safety issues on the single-engine F-16 aircraft were seen as having greater consequences than the twin-engine F-14 or F-15 aircraft. To address concerns, the Air Force began to fund the development and testing of an alternate engine to be produced by General Electric; the Air Force also supported the advent of an improved derivative of the Pratt & Whitney engine. Beginning in 1983, the Air Force initiated a competition that Air Force documentation suggests resulted in significant cost savings in the program. For example, in the first 4 years of the competition, when actual costs are compared 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.

While sole-source competitions have been the general rule for engine program strategies, evidence shows that when competition was utilized for even part of those programs, positive outcomes were often realized. Other than the Great Engine War, there have been a number of U.S. competitions for modern fighter engines, including those for the F-15, F/A-18, and F-22A fighter aircraft. During the course of this review, government and contractor personnel told us that the difference between these programs and the F-16 was that competition was limited to only one phase of the program (i.e., program initiation or production phase). For example, the General Electric F404 engine, which today powers the Navy F/A-18 aircraft and the Air Force F-117A aircraft, was competed in the mid-1980s. In that case, the Navy had decided to upgrade the A-6 aircraft to the A-6F model with two F404 engines, thereby increasing the number of F404 engines in the fleet. The Navy leadership recommended a second source for that engine, and Pratt & Whitney was awarded a “build-to-print” contract, which meant it would produce additional F404 engines according to the General Electric design. While this competition did provide some improvements in contractor responsiveness, government and contractor

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officials told us this was not an optimum competitive environment as it provided no design competition.

The Great Engine War was able to generate significant benefits because competition incentivized contractors to improve designs and reduce costs during production and sustainment. Competitive pressure continues today as the F-15 and F-16 aircraft are still being sold internationally. While the other competitions resulted in some level of benefits, especially with regard to contractor responsiveness, they did not see the same levels of success absent continued competitive pressures.

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## JSF Program Could Have Long-term Impact on Industrial Base

The economic stakes in the JSF engine program are likely to be high given the size of the program, international participation, and the expected supplier base. Participation in the development, production, and support of the JSF engine program will position Pratt & Whitney, the Fighter Engine Team, and their respective supplier base to compete for future military development and acquisition programs. According to government officials, Pratt & Whitney faces a decline in the area of large commercial engines, which could result in a shift of workforce and overhead costs to military programs. While it is the sole-source provider of the engine for the Air Force F-22A aircraft, production will likely end in 2012 for that program. Pratt & Whitney will at a minimum provide at least some of the engines for the JSF program, the extent to which is to be determined by whether or not the Fighter Engine Team remains a competitor and, if so, the amount of contract awards that company can win. Should the JSF program suffer substantial schedule slips beyond 2011 or 2012, the gap between the end of F-22A production and the onset of JSF production could grow, resulting in workforce disruptions or other negative effects.

General Electric is a significant entity in the market for large commercial engines. However, the company faces declining production within its other fighter engine programs, such as the Navy's F/A-18E/F, which could result in erosion of specialized skills should the company not continue as a participant in the JSF program. While the overall health of the company is very strong, business decisions as to where to invest company resources could favor the commercial side, should military business decline substantially.

Due to the size of the JSF program, the industrial base implications reach far beyond Pratt & Whitney and the Fighter Engine Team. With JSF contracts awarded to suppliers within both the U.S. and international partner countries, JSF propulsion production and support business will

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contribute to the global engine industrial base for almost 60 years. While companies that participate are likely to see increased business opportunities, if the JSF comes to dominate the market for tactical aircraft, as DOD expects, companies that are not part of the program could see tactical aircraft business decline.

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## Concluding Observations

DOD officials noted in 2006 that canceling the F136 engine program would save DOD \$1.8 billion in needed investments over the remaining 7 years of development, which could be used to fund higher-priority programs. According to our analysis that figure is now \$1.4 billion; and does not include the approximately \$2.2 billion to \$3.1 billion of additional investments for procurement, production support, and stand-up investments necessary for competition. However, our analysis indicates that this investment may be recouped under a competitive approach if it generates savings of 10.3 to 12.3 percent. Historical data indicate that it is reasonable to assume savings of that much and more. Choices made today will ripple forward and influence additional, and perhaps even more challenging, decisions in the future. The JSF engine acquisition strategy is one such choice facing DOD today. The results of our work indicate that with the proper structure and attention, and the up-front investments, the alternate engine can ultimately recover those investments and potentially provide additional benefits to the program. Prior engine programs and more recent DOD studies and analyses also suggest these outcomes to be reasonable. DOD is now faced with prioritizing its short-term needs against potential long-term payoffs through competition for JSF engine development, procurement, and sustainment.

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

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## 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 Brian Mullins, Assistant Director; J. Kristopher Keener; Daniel Novillo; Greg Campbell; Charles Perdue; and Adam Vodraska.



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## GAO Related Products

*Joint Strike Fighter: Progress Made and Challenges Remain*, [GAO-07-360](#). Washington, D.C.: Mar. 15, 2007.

*Tactical Aircraft: DOD's Cancellation of the Joint Strike Fighter Alternate Engine Program Was Not Based on a Comprehensive Analysis*, [GAO-06-717R](#). Washington, D.C.: May 22, 2006.

*Recapitalization Goals Are Not Supported By Knowledge-Based F-22A and JSF Business Cases*, [GAO-06-487T](#). Washington, D.C.: Mar. 16, 2006.

*Joint Strike Fighter: DOD Plans to Enter Production before Testing Demonstrates Acceptable Performance*, [GAO-06-356](#). Washington, D.C.: Mar. 15, 2006.

*Tactical Aircraft: F/A-22 and JSF Acquisition Plans and Implications for Tactical Aircraft Modernization*, [GAO-05-519T](#). Washington, D.C.: Apr. 6, 2005.

*Defense Acquisitions: Assessments of Selected Major Weapon Programs*, [GAO-05-301](#). Washington, D.C.: Mar. 31, 2005.

*Tactical Aircraft: Opportunity to Reduce Risks in the Joint Strike Fighter Program with Different Acquisition Strategy*, [GAO-05-271](#). Washington D.C.: Mar. 15, 2005.

*Tactical Aircraft: Status of F/A-22 and JSF Acquisition Programs and Implications for Tactical Aircraft Modernization*, [GAO-05-390T](#). Washington, D.C.: Mar. 3, 2005.

*Joint Strike Fighter Acquisition: Observations on the Supplier Base*, [GAO-04-554](#). Washington, D.C.: May 3, 2004.

*Joint Strike Fighter Acquisition: Managing Competing Pressures Is Critical to Achieving Program Goals*, [GAO-03-1012T](#). Washington, D.C.: July 21, 2003.

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# Appendix I: Scope and Methodology

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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 646 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 2007 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.

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#### 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 2007 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.

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- 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.

No cost analysis was performed for the scenario where a fixed-price contract would be awarded in fiscal year 2008 for the entire life of the engine program because neither the contractor nor the Department of Defense calculates the necessary cost data. During our discussions with both DOD officials and contractor representatives, it was determined that neither viewed a fixed-price contract as a viable option for which they could quantify a risk premium.

We did not perform cost analyses of alternative strategies, as we determined no other alternative could be implemented without disruption to the JSF program's cost and schedule.

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

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