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JOINT STRIKE FIGHTER

Additional Costs and Delays Risk Not Meeting Warfighter Requirements on Time

GAO-10-382

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Highlights

Highlights of GAO-10-382, a report to congressional committees

Why GAO Did This Study

The F-35 Lightning II, also known as the Joint Strike Fighter (JSF), is the Department of Defense's (DOD) most costly and ambitious aircraft acquisition, seeking to simultaneously develop and field three aircraft variants for the Air Force, Navy, Marine Corps, and eight international partners. The JSF is critical for recapitalizing tactical air forces and will require a long-term commitment to very large annual funding outlays. The current estimated investment is $323 billion to develop and procure 2,457 aircraft. As required by law, this report discusses (1) program cost, schedule, and performance; (2) manufacturing results; and (3) test plans and progress. GAO's work includes interviews, cost data, test plans, production measures, and analyses by defense and contractor officials.

What GAO Recommends

GAO recommends that DOD (1) make a new, comprehensive, and independent assessment of the costs and schedule to complete the program, including military construction, JSF-related expenses in other budgets, and life-cycle costs; and (2) reassess warfighter requirements and, if necessary, defer some capabilities to future increments. GAO also suggests that Congress consider requiring DOD to establish a management tool to help Congress better measure the program's progress in maturing the weapon system in a variety of areas to include cost estimating, testing, and manufacturing.

View GAO-10-382 or key components.
For more information, contact Michael J. Sullivan at (202) 512-4841or sullivanm@gao.gov.

What GAO Found

The JSF program continues to struggle with increased costs and slowed progress—negative outcomes that were foreseeable as events have unfolded over several years. Total estimated acquisition costs have increased $46 billion and development extended 2 more years, compared to the program baseline approved in 2007. DOD leadership is now taking some positive steps which, if effectively implemented, should improve outcomes and provide more realistic cost and schedule estimates. Officials increased time and funding for system development, added 4 aircraft to the flight test program, and reduced near-term procurement quantities. Restructuring is not finished and further cost growth and schedule extensions are likely. The program is at risk for not delivering aircraft quantities and capabilities on time. Dates for achieving initial operational capabilities may have to be extended or some requirements deferred to future upgrades. Aircraft unit costs will likely exceed the thresholds established by the statutory provision commonly referred to as Nunn-McCurdy and may require DOD to certify the need for the JSF to Congress. Program setbacks in costs, deliveries, and performance directly affect modernization plans and retirement schedules of the legacy aircraft the JSF is slated to replace.

Manufacturing JSF test aircraft continues to take more time, money, and effort than budgeted. By December 2009, only 4 of 13 test aircraft had been delivered and labor hours to build the aircraft had increased more than 50 percent above earlier estimates. Late deliveries hamper the development flight test program and affect work on production aircraft, even as plans proceed to significantly ramp-up annual procurement rates. Some improvement is noted, but continuing manufacturing inefficiencies, parts problems, and engineering technical changes indicate that design and production processes may lack the maturity needed to efficiently produce aircraft at planned rates. The independent manufacturing review team determined that the planned production ramp rate was unachievable absent significant improvements.

Although restructuring actions should help, there is still substantial overlap of development, test, and production activities while DOD continues to invest in large quantities of production aircraft before variant designs are proven and performance verified. Slowed by late aircraft deliveries, technical problems, and low productivity, the flight test program only completed 10 percent of the sorties planned during 2009. Other technical challenges include (1) relying on an extensive but largely unproven and unaccredited network of ground test laboratories and simulation models to evaluate system performance; (2) developing and integrating very large and complex software requirements; and (3) maturing several critical technologies essential to meet operational performance and logistical support requirements. Collectively, testing and technical challenges will likely add more costs and time to development, affecting delivery of warfighter requirements and hampering start up of pilot and maintainer training and initial operational testing.

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Abbreviations

CAPE	Cost Assessment and Program Evaluation
CTOL	conventional takeoff and landing
DOD	Department of Defense
JSF	Joint Strike Fighter
OSD	Office of the Secretary of Defense
STOVL	short takeoff and vertical landing

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Congressional Committees

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

We have reported on JSF issues for a number of years. We have expressed our concerns about the substantial overlap of development, test, and production activities and resulting cost increases and schedule delays. We have also identified opportunities for the program to reduce risks and improve chances for more successful outcomes. Our recommendations have included adopting a more evolutionary, knowledge-based acquisition strategy and limiting investment in production aircraft until each variant demonstrates required capabilities in flight tests. Our March 2009 report was the fifth and final annual report under a congressional mandate.[1] In that report, we noted the government's increased financial risk from development cost increases, additional delays in manufacturing and testing schedules, and plans to increase procurement in advance of testing. We recommended that DOD report to Congress its plans for mitigating risks and transitioning from cost-reimbursement procurement contracts to fixed-price contracts, and that DOD ensure the prime contractor performs

[1]Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005, Pub. L. No. 108-375, § 213 (2004).

detailed schedule risk analyses to provide important insight into use of reserve funds and manufacturing progress.[2]

Our work for this report began under a request from the Chairman and Ranking Member of the House Armed Services Air and Land Subcommittee. Subsequently, we received a new mandate in the National Defense Authorization Act for Fiscal Year 2010 to annually review the JSF program through 2015.[3] This report thus satisfies the original request as well as the first year of the new mandate. In this report, we (1) determine the JSF program's progress in meeting cost, schedule, and performance goals; (2) assess plans and results in manufacturing; and (3) evaluate plans, progress, and risks with testing plans and related technical challenges.

To conduct this work, we tracked and compared current cost and schedule estimates with those of prior years, identified changes, and determined causes. We obtained program status reports, manufacturing data, and test planning documents. We conducted our own analyses of the information. We discussed results to date and future plans to complete JSF development and move further into procurement with DOD, JSF, and contractor officials. We conducted this performance audit from May 2009 to February 2010 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

[2]Previous reports under the 2005 mandate are GAO, *Joint Strike Fighter: Accelerating Procurement before Completing Development Increases the Government's Financial Risk*, GAO-09-303 (Washington, D.C.: Mar. 12, 2009); *Joint Strike Fighter: Recent Decisions by DOD Add to Program Risks*, GAO-08-388 (Washington, D.C.: Mar. 11, 2008); *Joint Strike Fighter: Progress Made and Challenges Remain*, GAO-07-360 (Washington, D.C.: Mar. 15, 2007); *Joint Strike Fighter: DOD Plans to Enter Production before Testing Demonstrates Acceptable Performance*, GAO-06-356 (Washington, D.C.: Mar. 15, 2006); and *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).

[3]National Defense Authorization Act for Fiscal Year 2010, Pub. L. No. 111-84 § 244 (2009).

Background

The F-35 JSF program is a joint, multinational acquisition to develop and field an affordable, highly common family of stealthy, next-generation strike fighter aircraft for the United States Air Force, Marine Corps, Navy, and eight international partners. The JSF is a single-seat, single-engine aircraft incorporating low-observable (stealth) technologies, defensive avionics, advanced sensor fusion,[4] internal and external weapons, and advanced prognostic maintenance capability. There are three variants. The conventional takeoff and landing (CTOL) variant will primarily be an air-to-ground replacement for the Air Force's F-16 Falcon and the A-10 Warthog aircraft, and will complement the F-22A Raptor. The short takeoff and vertical landing (STOVL) variant will be a multi-role strike fighter to replace the Marine Corps' F/A-18C/D Hornet and AV-8B Harrier aircraft. The carrier-suitable variant (CV) will provide the Navy a multi-role, stealthy strike aircraft to complement the F/A-18E/F Super Hornet.

The 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, and the program entered system development and demonstration in October 2001. Pratt & Whitney is the primary engine manufacturer, while General Electric has been funded to develop a potential second source for the engine. DOD officials adopted a "single step" acquisition strategy to develop and acquire full combat capabilities on an aggressive schedule with significant risk associated with concurrently developing, testing, and producing aircraft. In 2004, DOD extended the program schedule to address airframe weight problems discovered during systems integration and design review. DOD rebaselined the program extending development, adding resources, and delaying deliveries. This caused a breach of the significant cost growth threshold, commonly referred to as a Nunn-McCurdy breach.[5] Cost and

[4] Sensor fusion is the ability to take information from both multiple onboard and offboard aircraft sensors and display the information in an easy-to-ue format for the single pilot.

[5] 10 U.S.C. § 2433 establishes the requirement for DOD to perform unit cost reports on major defense acquisition programs or designated major defense subprograms. Two measures are tacked: procurement unit cost (total funds programmed for procurement divided by the total number of fully configured items to be procured) and program acquisition unit cost (total cost of development, procurement, and system-specific military construction divided by the number of fully configured end items to be procured). To eliminate the effects of inflation, costs are expressed in constant base year dollars. If a program exceeds specified cost growth thresholds specified in the law, a Nunn-McCurdy breach, DOD is required to report to Congress. In certain circumstance, DOD is required to reassess the program and submit a certification to Congress in order to continue the program, in accordance with 10 U.S.C. § 2433a.

schedule changes since then resulted in another rebaselining in 2007, the current acquisition program baseline.

DOD plans to buy a total of 2,457 JSFs and allies are expected to procure a minimum of 730 CTOL and STOVL aircraft. Because of the program's sheer size and the numbers of aircraft it will replace, the JSF is the linchpin of DOD's long-term plan to modernize tactical air forces. It is DOD's most costly acquisition program and its longest in duration—total acquisition cost is currently estimated at $323 billion with procurement lasting through 2035. The JSF is also DOD's largest cooperative program. Our international partners are providing about $4.8 billion toward development, and foreign firms are part of the industrial base producing aircraft. DOD's funding requirements for the JSF assume economic benefits from these foreign purchases in reducing unit costs for U.S. aircraft.

In our March 2009 report,[6] we noted that more money and time would be needed to complete development. At that time, development costs were projected to increase between $2.4 billion and $7.4 billion and the schedule extended from 1 to 3 years according to two estimates, one by the JSF program office and one by a joint team of Office of Secretary of Defense (OSD), Air Force, and Navy officials. We reported that manufacturing inefficiencies and parts shortages continued to delay the delivery of development test aircraft and would make it difficult for the program to meet its production schedule. In addition, we reported that DOD plans to further accelerate procurement and invest heavily in production aircraft despite a nascent flight test program that was very risky.[7] The risk is reflected by the continued use of cost reimbursement contracts for low- rate production quantities, a contract type that places most of the cost risk on the buyer, which in this case is DOD. DOD concurred with, but has not yet implemented, our two recommendations to report on its plans for mitigating the risks of using cost-reimbursement procurement contracts for low-rate production and transitioning to fixed-price contracting, and to ensure that the prime contractor performs detailed schedule risk analyses to provide important insight into use of reserve funds and manufacturing progress.

[6]GAO-09-303.

[7]Subsequent to the report, DOD cut back on its plans to accelerate procurement, but still expects to significantly invest in procurement prior to completing system development and flight testing.

Because of continuing cost and schedule problems, the Secretary of Defense directed a comprehensive restructuring of the JSF program in February 2010 acquisition decision memorandum. The restructuring was the culmination of an extensive department-wide review of the JSF program directed by OSD in 2009. In addition to input from contractors, the joint program office, and various defense offices, the review considered the findings and recommendations from three independent work groups chartered to assess the program: the Joint Estimating Team (JET) evaluated program execution and resource requirements, the Independent Manufacturing Review Team (IMRT) assessed contractor capabilities and plans for ramping-up and sustaining production at maximum rates, and the Joint Assessment Team (JAT) reviewed F135 engine costs and affordability projections. Among other actions, the restructuring (1) increased funding for the JSF development and procurement programs to the revised JET estimates over the next 5 years; (2) extended development flight testing by 13 months and moved the full rate production decision to April 2016; (3) added 4 aircraft to support the development test program (one new test jet and use of three production jets); (4) expanded software integration capabilities;
(5) reduced near- term procurement quantities; (6) directed the program office and military services to determine the potential impacts of the restructuring on initial operational capabilities; and (7) directed the Air Force and Navy to revise the development and low rate production contracts and fee structures to reward improved cost and schedule performance and to move to fixed-price incentive fee structures as soon as possible. The Under Secretary of Defense for Acquisition, Technology and Logistics stated that the department-wide review would continue and cited 2010 will be a critical year for assessing progress on the new plans and expected delivery of test aircraft, completing of hundreds of test flights, and meeting other key milestones.

Cost Increases and Schedule Delays Increase Risk of Not Delivering Capabilities to the Warfighter on Time

In ordering the restructure, DOD leadership is recognizing the relatively poor cost and schedule outcomes that we and others have previously reported. The restructuring added time and money to the development effort and decreased near-term procurement quantities to help pay the bill. Recent independent assessments projected much higher costs for development and procurement and more testing time needed to ensure that the design and performance of each variant meets requirements and is operationally suitable. Cost increases and further delays pose a substantial risk that the program will not be able to deliver the quantities and capabilities in the time required by the warfighters. It is likely that either the dates for achieving initial operational capabilities must be delayed or

the military services will have to accept less initial capability and defer some requirements to a future upgrade program. Furthermore, higher costs and lesser quantities will likely result in unit cost increases exceeding the thresholds established by the statutory provision commonly referred to as Nunn-McCurdy and may require DOD to certify the need for the program to Congress.

Recent Estimates Project Significant Cost Increases and Delays to Complete Development

Several recent defense assessments and our work identified significant cost growth and further schedule delays for completing JSF system development. As a result, DOD restructured the program and added additional time and funding to complete development. The re-estimated effort funded in the fiscal year 2011 budget submission has increased development funding by $4.5 billion and extended the time needed to complete development by 2 ½ years, compared to the current approved baseline. Table 1 compares the new budget data with the original baseline in 2001, the approved baseline in 2007, and the program's interim estimate dated December 2008. The interim estimate had earlier added $1.4 billion to the fiscal year 2010 request to pay for cost overruns on the airframe and engine contracts, technical scope increases, and additional funding to mitigate risk.

Table 1: Estimated Cost and Schedule for System Development

	October 2001 original baseline	March 2007 approved baseline	December 2008 program estimate	Fiscal year 2011 budget request
Total development costs	$34.4 billion	$44.8 billion	$46.2 billion	$49.3 billion
Date to complete development	April 2012	October 2013	October 2014	April 2016

Source: GAO analysis of DOD data.

According to defense officials, the new budget reflects the findings of the JET.[8] Consistent with its previous 2008 study, the JET projected higher development costs and greater schedule delays compared to the internal program estimates reported to Congress. Among other factors, the JET projected (1) more engineering staff needed for longer periods of time to complete development, evaluate test results, and correct deficiencies; (2)

[8]In July 2009, OSD tasked its Cost Assessment and Program Evaluation (CAPE) office to lead an update of its 2008 cost estimate and analysis to reflect actual F-35 performance to date. This included assessing the overall executability of the JSF development program and resource requirements. The F-35 joint estimating team was composed of CAPE, Air Force, and Navy cost and subject-matter experts.

greater growth in software requirements and complexity; (3) longer manufacturing times; and (4) considerably more time and effort needed in development testing.

Additional cost increases and more time to complete development are possible. The preliminary estimate by the JET projected as much as a 30-month extension in the schedule for completing development flight tests, more than the 13-month extension ordered in the restructuring. Defense officials acknowledge that the revised schedule for completing development, testing, and supporting the full-rate production milestone is still aggressive. Also, the 2011 budget estimate does not include costs beyond 2010 for the alternate (or second) engine program. Should that program go forward, an estimated $1.6 billion may be needed to complete development in 2016.

We further note that the prime aircraft contractor is spending management reserves[9] faster than budgeted, likely creating a need for additional funding. The prime contractor has continually struggled to maintain management reserves at a prudent level. As we previously reported,[10] DOD in late 2007 decided to replenish the contractor's depleted reserve with funding provided in part by the elimination of two test aircraft. Since that time, continuing engineering changes, inefficient manufacturing flow, software development challenges, and other factors have again depleted reserves. The prime contractor's management reserve balance declined by over $900 million from August 2008 to November 2009. As of August 2008, the contractor had over $1 billion in its management reserve fund and as of November 2009 had only about $100 million. The prime contractor now estimates it will need an additional $600 million, at a minimum, to adequately resource its reserves needed to complete development.

[9]Management reserve funds are a pool of money set aside to handle unanticipated changes and other risks encountered as a development program proceeds. Prudent defense programs typically strive to maintain a management reserve of from 5 to 10 percent of the estimated funding requirements to complete contracted work. At development start, the JSF program budgeted reserves at 10 percent of contract value and expected to draw on them at about the same rate as contract work was executed.

[10]GAO-08-388.

Engine Manufacturers Encountering Cost and Schedule Growth

Engine cost growth and development delays are also contributing substantially to overall program costs. The F135 primary engine development effort—a separate contract from the airframe development effort—is now estimated to cost about $7.3 billion, a 50 percent increase over the original contract award. This includes an $800 million contract cost overrun in 2008. Engine development cost increases primarily resulted from higher costs for labor and materials, supplier problems, and the rework needed to correct deficiencies with an engine blade during redesign. Engine test problems have also slowed development.

The alternate engine program to develop a second engine source—the F136—is also encountering cost and schedule challenges. The government has invested about $2.9 billion in development through fiscal year 2010. The JET estimates about $1.6 billion would be needed to complete F136 development in 2016. Contractor officials told us that funding stability, engine affordability, and testing issues are key concerns.

The alternate engine program has been an area of contention between DOD and Congress. Congress has directed DOD to develop a second source for the JSF engine to induce competition and to reduce future operational risks by ensuring that the failure of one type of engine would not ground all F-35 fleets. DOD does not think the risks are worth the extra costs to maintain a second source and has removed funding from the JSF program line the last four years through fiscal year 2010. Each year, Congress has subsequently provided funding for engine development efforts to continue. We have previously testified[11] on our assessment that, based on past defense competitions (including a fighter engine competition started in the 1980s between these same manufacturers) and making certain assumptions about relative quantities purchased from each, competition could be expected to yield enough savings to offset the additional investments required to sustain a second source. Prior studies also indicate a number of nonfinancial benefits from competition, including better performance, increased reliability, and improved contractor responsiveness.

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

Projected Procurement Cost Increases May Trigger a Nunn-McCurdy Cost Breach

As part of the ongoing restructuring, DOD revised procurement plans, reducing purchases by 122 aircraft over the next 5 years, and moving these purchases to future years. On the basis of the revised plans, the fiscal year 2011 budget data projects total procurement funding requirements of $273.3 billion. This new estimate is $41.6 billion (18 percent) more than the current approved baseline. This increase raises the expected average price for each aircraft to $112 million compared to $95 million in the current baseline approved in March 2007. Table 2 compares the 2011 budget submission with the original and approved program baselines and the December 2008 program interim estimate.

Table 2: Total Projected Procurement Funding Requirements

	October 2001 original baseline	March 2007 approved baseline	December 2008 program estimate	Fiscal year 2011 budget request
Procurement funding requirements	$196.6 billion	$231.7 billion	$255.0 billion	$273.3 billion
Procurement quantity	2,852	2,443	2,441	2,443
Average procurement unit cost	$69 million	$95 million	$104 million	$112 million

Source: GAO analysis of DOD data.

Note: The December 2008 estimate recognizes the two aircraft deleted by Congress in the 2009 budget. However, officials plan to reinsert these two aircraft in later years to restore the full complement of 2,443 aircraft.

While aircraft affordability has been an issue for several years and the largest driver behind procurement costs, engine affordability has become a growing concern of late. Program officials earlier added $1.2 billion more to DOD's 2010 procurement budget request from the previous year's estimate to pay for higher than expected engine costs, tooling, and other items. For the fiscal year 2009 buy, the negotiated unit price for the STOVL engine and lift fan increased by $5.8 million, 21 percent higher than the budget estimate ($33.4 million from $27.6 million). The negotiated unit price for the CTOL engine increased by $5.2 million, 42 percent higher than budgeted ($17.7 million from $12.5 million). The F135 engine contractor has acknowledged the affordability risks and is taking steps designed to reduce engine unit costs. The JAT review identified cost drivers and opportunities to reduce cost. Officials concluded that engine contractor improvement plans were credible but challenging, and would require additional investment by the contractor for cost reduction initiatives.

The JET review and an adjunct analysis by the Naval Air Systems Command indicate that procurement costs could increase still further from the total projected in the 2011 budget. For the budget projection, cost

estimators used the JET data through fiscal year 2015 and then applied current program office assumptions on manufacturing span times and expected learning curves[12] to estimate total procurement funding requirements through completion of acquisition in 2035. A JET official said these program office assumptions were overly optimistic and that the JET analysis suggests a more moderate gain in learning over time as well as longer manufacturing span times and other assumptions. This official said the DOD analysts are continuing to study out-year costs. NAVAIR's October 2009 cost assessment estimated total procurement costs of $314 billion—$41 billion more than the 2011 budget submission, an increase of about 15 percent with a corresponding increase in unit costs. Because NAVAIR's assessment was based on the production profile before the changes made by the restructuring, it is not directly comparable to the budget estimate, but we agree with its underlying basis. NAVAIR officials projected higher future procurement costs due to continuing manufacturing challenges and significant future retrofit requirements among other factors. They expected parts shortages and engineering changes to continue to affect production, especially as procurement quantities increase. Officials also factored in assumed costs for retrofitting fielded aircraft as design and performance problems are discovered during testing.

As shown in table 2 above, the new budget estimate would increase aircraft average unit costs to $112 million, an increase of $17 million (18 percent) over the 2007 baseline estimate and $43 million (62 percent) more than the original baseline. Naval Air Systems Command (NAVAIR) data projects greater increases. Increased costs are expected to result in the JSF program exceeding unit cost growth thresholds established by the statutory provision commonly referred to as Nunn-McCurdy.[13] Until

[12]Learning curves are mathematical projections that account for the effects of learning—the expectation that time and cost for building a new system decreases over time as production processes mature over time and workers become more productive through experience.

[13]10 U.S.C. § 2433 establishes the requirement for DOD to prepare unit cost reports on major defense acquisition programs or designated major defense subprograms. Two measures are tracked: procurement unit cost (total funds programmed for procurement divided by the total number of fully configured items to be procured) and program acquisition unit cost (total cost of development, procurement, and system-specific military construction divided by the number of fully configured end items to be procured). To eliminate the effects of inflation, costs are expressed in constant base year dollars. If a program exceeds cost growth thresholds specified in the law, this is known as a Nunn-McCurdy breach and DOD is required to report the breach to Congress.

restructuring is complete and a new comprehensive procurement cost estimate is finalized (and expressed in constant-year dollars), we do not know whether unit cost increases will breach the "critical" or "significant" cost growth threshold.[14] Breaches of either cost growth threshold require reporting to the Congress, and a critical breach would also require DOD to justify the continued need for the JSF program to Congress.

Achieving Warfighter Requirements on Time Is at Risk

JSF cost increases and schedule delays increase the risk that the program will not be able to meet warfighter requirements regarding capability and quantities on time. Overall program performance in 2009 did not meet expectations and the schedule for completing key milestones and development activities continued to slip from prior years. Table 3 shows the extension in time from successive estimates for meeting key program milestones to ensure that the design and performance of the three JSF variants meet warfighter capability requirements and are suitable for military operations.

Table 3: Changes in Major Milestones

Major Milestones	Program of record December 2007	Program of record December 2008	Restructure February 2010
Development Testing Complete	October 2012	October 2013	March 2015
Initial Operational Test and Evaluation Complete	October 2013	October 2014	January 2016
System Development and Demonstration Phase Complete	October 2013	October 2014	April 2016
Full Rate Production Decision	October 2013	October 2014	April 2016

Source: GAO analysis of DOD data.

Despite the steady deterioration in meeting major schedule events, the military services have not revised their milestones for achieving initial operational capability. Historically, initial operational capability dates are critical milestones when the warfighter requires a new system to be operational and available in quantity for wartime use based on future threats and force structure projections. Table 4 summarizes the current initial operational capability requirements for the services. The Marine Corps requires operational STOVL aircraft with initial warfighting capabilities, basic weapons, and moderate mission system capabilities by March 2012. The Air Force and Navy require operational squadrons with full warfighting capabilities and mission functionality by March 2013 and

[14] 10 U.S.C. § 2433.

March 2015, respectively. However, these goals were set several years ago when system development and testing was expected to be substantially completed by now. Key milestone dates for developing and testing aircraft have slipped about 3 years from the times expected when the current program baseline was established.

Table 4: Initial Operational Capability Requirements

Service	Variant	Quantities	Date required	Capability
Marine Corps	STOVL	30	March 2012	Interim warfighting capabilities. Some functionality for close air support, moving targets, electronic attack, and air interdiction. Ability to fuse information from other JSFs and increased logistics support with advanced prognostics capabilities. Qualification of some bombs and missiles.
Air Force	CTOL	51	March 2013	Full warfighting capability. Warfighters' desired capability. Concludes avionics development, including ability to fuse information from other platforms or sensors for increased situational awareness. Suppression and destruction of enemy air defenses and deep strike capabilities and qualification of additional weapons.
Navy	Carrier Variant	28	March 2015	

Source: GAO analysis of DOD data.

The Under Secretary of Defense for Acquisition, Technology and Logistics' February 2010 restructuring acquisition decision memorandum directs the JSF program office to determine potential impacts of the restructured program on the schedule for achieving initial operational capabilities. At the time this report was published, we understood that the Air Force and Navy are expected to extend initial operational capability dates, while the Marine Corps still plans initial operational capability in 2012.

Continuing delays in development testing, finding and fixing deficiencies, maturing software, and full mission integration efforts will likely impede proving out required capabilities. In its October 2009 risk assessment, NAVAIR reported that the program's ability to deliver Marine Corps and Navy requirements at the initial operational capability dates within the current cost and schedule parameters is not achievable given the technical risks, system immaturity, lack of demonstrated system integration, and lack of progress in the test plan. NAVAIR also noted that pilot training cannot be expanded without the full complement of development test aircraft still to be delivered. In addition, the Director of Operational Test and Evaluation (DOT&E) is now predicting initial operational testing of the full warfighting capability by mid-2016, but only if additional flight test aircraft are added, software is delivered on time, and a strenuous pace of testing is maintained. DOT&E reported that the mission capability of the initial production aircraft is unclear, creating planning problems for the

services that depend on those aircraft to meet initial operational capabilities. These actions, coupled with plans to reduce procurement in the near term and to utilize some production aircraft in testing, could impinge on concurrent efforts to begin training pilots and maintainers and could significantly overlap operational testing. These efforts are important to stand up the first operating units and ensure warfighter capabilities are met. If delays continue, the services may have to reduce, defer, or revise operational requirements and pursue fall-back plans to span capability gaps until JSF full warfighting capabilities are available.

A key tenet of the JSF program from inception— to deliver an affordable, highly common fifth generation aircraft that could be acquired by the warfighters in large numbers—is also at increased risk. The program office currently estimates total life-cycle costs for operating, sustaining, and maintaining JSF fleets at $764 billion, substantially higher than earlier estimates. The cost per flying hour of the CTOL variant is projected to be higher than the F-16, one of the Air Force aircraft it is slated to replace. NAVAIR officials recently projected total life-cycle costs even higher, at more than $1 trillion. Service officials are concerned whether future budgets will be able to afford the higher costs expected. Compared to the up-front costs of developing and procuring aircraft, the long-term costs for operating, maintaining, and sustaining JSF fleets over an aircraft's useful life represent the much larger portion of total ownership costs. Escalating life-cycle costs represent major future funding requirements that could significantly affect how many aircraft we and our allies can afford to buy.

Because the JSF is the linchpin of our plans to recapitalize tactical aircraft, delays and affordability concerns about the JSF directly affect funding needs and retirement plans for the legacy aircraft it is slated to replace. Legacy systems must be sustained and kept operationally relevant until JSFs replace them. If JSF quantities are reduced or deliveries slip into future years, billions of dollars more in as yet unbudgeted funding may be required to sustain, modernize, and extend the life of legacy aircraft. Both the Departments of the Air Force and Navy have cited looming shortfalls in the tactical aircraft inventory based on last year's JSF plans and legacy retirements; further delays would exacerbate calculated shortfalls. JSF concerns are especially troublesome for the Marine Corps, which has based its entire future strike force structure on acquiring a capable STOVL in large quantities. Uncertainty about JSF costs and deliveries makes it challenging for all the services to effectively plan and efficiently implement modernization efforts and retirement schedules. During our ongoing work on tactical aircraft recapitalization for the House Armed Services Committee, service officials and legacy aircraft managers

indicated that they are largely in a reactive mode to unfolding JSF events and may have to put forward unfunded contingency plans to modernize and extend the life of some legacy aircraft.

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

Manufacturing JSF test aircraft continues to take more time, money, and effort than budgeted, delaying development tests and affecting the prospects for the significant ramp-up in annual production rates planned. While some improvement is noted, continuing manufacturing inefficiencies, parts problems, and engineering technical changes indicate that design and production processes may lack the maturity needed to efficiently produce aircraft at planned rates. This is confirmed by the recent results of intensive studies conducted by the IMRT and the JET that resulted in the reduction of near-term procurement quantities.

Manufacturing Test Aircraft Continues to Take Longer and Cost More Than Planned

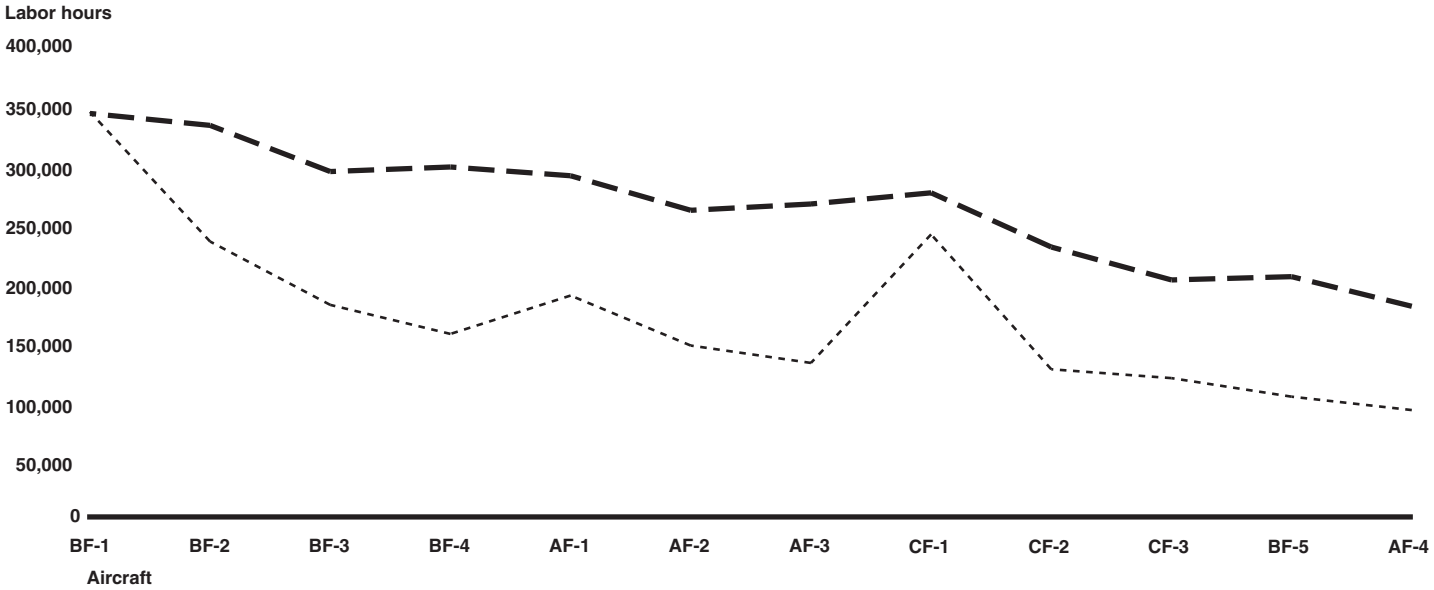
The JSF program is still recovering from earlier problems—extensive design changes, late parts deliveries, and inefficient manufacturing practices—that continue to delay aircraft deliveries. The prime contractor has restructured the manufacturing schedule three times since 2007 and a fourth revision is under way. Each revision has lengthened the time to deliver aircraft to the test program. As of December 2009, the contractor had delivered only 4 of 13 development test aircraft, 2 CTOL aircraft (including the original non-production representative model) and 2 STOVL aircraft. Delivery of the first CV test aircraft is now expected in March 2010. Contractor and program officials now expect to complete delivery of all test aircraft at the end of 2010. Prior plans had expected delivery of almost all aircraft by 2009.

The total labor hours budgeted to produce the test aircraft have steadily increased over time, suggesting the need to mature production processes and improve supply chain performance. In the aggregate, the 2009 revised schedule estimates total labor hours at 3.2 million, exceeding the 2007 schedule estimate by more than 1 million hours, a 54 percent increase.

Expected improvements in labor productivity did not occur to the degree expected. Figure 1 shows that the 2007 schedule assumed a steep drop in labor hours as more units were produced, manufacturing processes matured, and worker knowledge increased. The expected increase in efficiency due to learning is typical of manufacturing programs and is important to JSF achieving its future procurement rate as planned while keeping costs in line. The current 2009 schedule, informed by actual

performance, demonstrates that some learning is occurring, but to a lesser degree than projected by the 2007 schedule. Higher than expected labor costs for the manufacturing of test aircraft increases the risk that future procurement costs for building operational aircraft may also be higher than budgeted. This, in addition to other program problems, may result in reduced buying power where the services may not be able to purchase the number of aircraft currently planned.

Figure 1: JSF Labor Hours for Manufacturing Test Aircraft



Source: GAO analysis of DOD data.

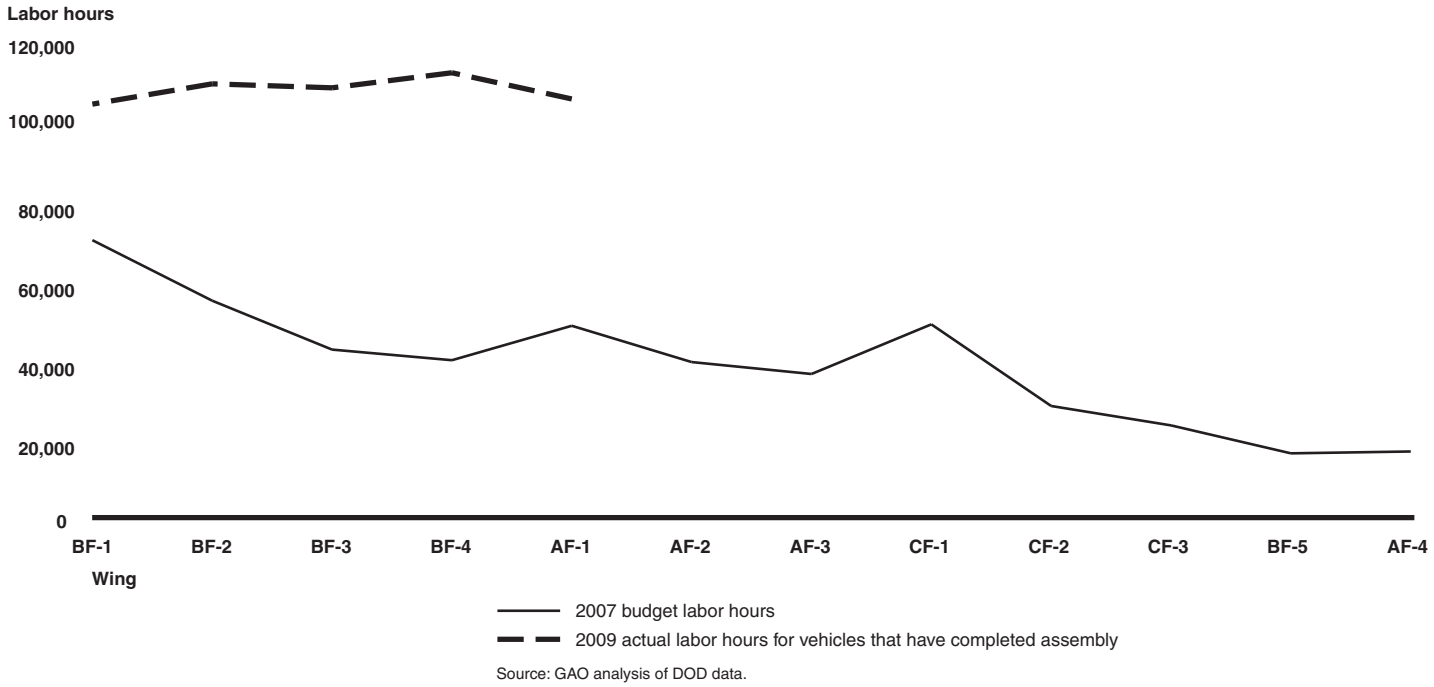
BF= Short take-off and vertical landing aircraft for the Marine Corps
AF= Conventional take-off and landing aircraft for the Air Force
CF= Carrier variant for the Navy

As we reported last year,[15] labor hour performance in two major cost areas—wing assembly and the mate and delivery stations—have been particularly troublesome. According to officials, the prime contractor is taking steps to improve both areas, but only modest improvement has been demonstrated to date. Figure 2 shows the actual number of labor

[15] GAO-09-303.

hours required to complete wing assembly on the first five production-representative test aircraft. The total actual hours are more than twice that predicted in the 2007 manufacturing schedule for the same aircraft.

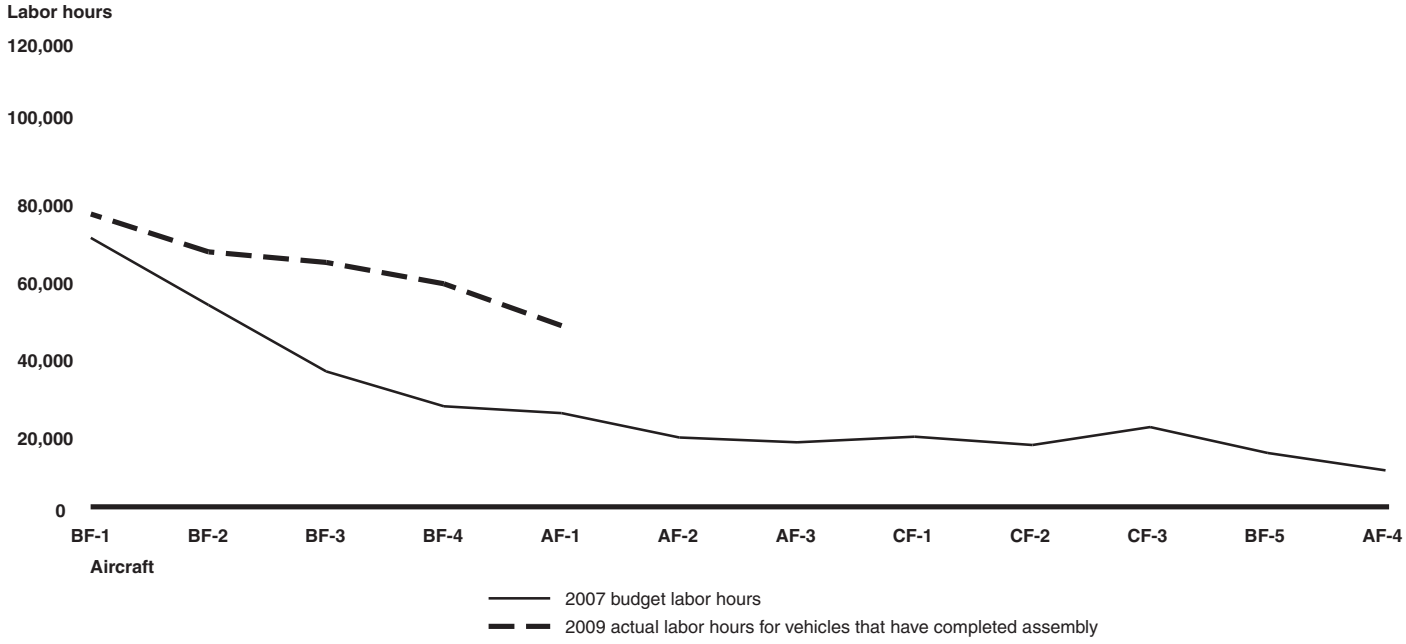
Figure 2: Wing Station Labor Hours



Source: GAO analysis of DOD data.

Similarly, figure 3 shows that the actual time required for completing the mate and delivery phase for the first five test aircraft was 49 percent higher than predicted in 2007.

Figure 3: Mate and Delivery Labor Hours



Source: GAO analysis of DOD data.

One of the prime reasons for increased labor hours is the continued prevalence of out-of-station work. This is work not finished at its designated station that needs to be carried forward and completed at a different station down the production line.[16] Out-of-station work is highly inefficient, increasing labor hours, causing delays, and possibly resulting in quality problems, according to program officials. The amount of out-of-station work has been decreasing and officials hope it will be fully corrected by the end of 2010.

Program officials noted that major contributors to out-of-station workload have been parts shortages caused by design changes and an immature supplier base. In some cases, design changes from the prime contractor necessitated subcontractors to adjust their manufacturing processes to

[16]An efficient production line establishes an orderly flow of work as a product moves from workstation to workstation and on to final assembly. Out-of-station work, sometimes referred to as traveled work, refers to completing unfinished work on major components, for example, the wings, after they have left the wing workstation and moved down the production line to another station, such as mate and final assembly.

new designs resulting in late parts deliveries. In other cases, some subcontractors have been slower than expected in developing their capacity to manufacture and deliver both routine and complex parts on time. According to prime contract officials, efforts are under way to address parts problems and supplier performance. In particular, the contractor has (1) increased its oversight of key subcontractors that are having problems, (2) secured long-term raw material purchase price agreements for the prime and key subcontractors, and (3) improved internal production capabilities.

Recent evidence suggests mixed results. Officials from the Defense Contract Management Agency (DCMA) noted that while late parts deliveries continue, the response time to deliver the parts has improved. The scrap, rework, and repair rate—a good indicator of parts quality—has improved. Program office and prime contractor officials state that the effects from previous design changes and parts shortages are lessening, but will persist over the near term. Officials also noted that JSF quality performance compares favorably with prior acquisitions at similar stages of development, including the F-16 and F-22A. Nonetheless, supplier costs are expected to make up a substantial share of total expenses as the program moves further into production.

The F135 engine contractor has experienced manufacturing challenges similar to those of the aircraft contractor, including part shortages, late deliveries, subcontractor management issues, and test failures. Engine redesigns and manufacturing problems caused slips in engine deliveries, according to program officials. Officials note that these late engine deliveries have not yet critically affected the delivery of test aircraft because airframe production lagged even further behind. However, the prime contractor has been forced to perform out-of-station engine installations and other workarounds as a result of engine issues. As of January 2010, 17 of 18 F135 development flight test engines have been delivered, 7 of which have flown.

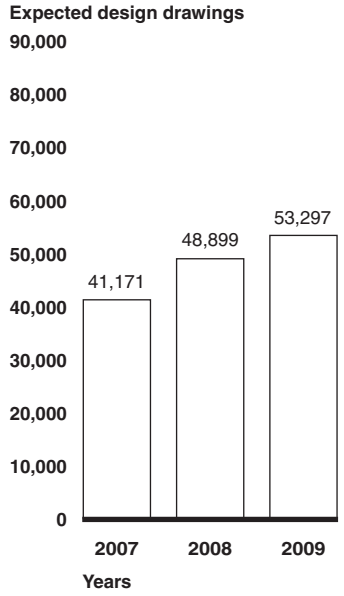
Future Design Changes May Drive Additional Costs

Continuing changes and additions to engineering drawings may cause further manufacturing delays and increased cost. Although the program did not achieve this at the time of the critical design reviews, officials are reporting that 100 percent of expected engineering drawings have now been released for each of the three variants, a level typically associated

with a stable design.[17] However, despite being well beyond the design reviews for each variant, the total number of engineering drawings continues to grow due to design changes and other revisions to drawings (see fig. 4). Contractor officials estimated in 2007 that change traffic—additions and revisions to drawings—would decline to less than 200 per month by the end of fiscal year 2009; however, current change traffic is considerably higher, averaging about 500 changes per month. While many recent drawing additions and revisions are classified as minor in nature, acquisition programs typically encounter higher and more substantive design changes as a result of discovery and rework during development testing. With most of development testing for JSF still ahead, the risk and impact from required design changes are significant. Future changes may require alterations to the production process; changes to the supply base; increases in the amount of on- and out-of-station work required on aircraft in production; and require costly retrofitting of aircraft already produced and fielded.

[17]A best practice is to achieve design stability at the system-level critical design review, usually held midway through system development. Completion of at least 90 percent of engineering drawings at this point provides tangible evidence that the product's design is stable, and a prototype demonstration shows that the design is capable of meeting performance requirements.

Figure 4: Growth in the Number of Engineering Design Drawings



Source: GAO analysis of DOD data.

Critical Work Ahead to Fix Problems as Annual Production Rates Increase

Given the ongoing engineering and manufacturing challenges, the program will have difficulty meeting its current procurement plans. To the point, the IMRT reported that the prime contractor would need to address a large number of conditions in order to achieve its planned full-rate production ramp-up. These conditions focused on, among other things, improving management of the supply chain, engineering changes, part shortages, tooling, unit costs, schedule, and risk mitigation. In addition, the JET recommended that the program reduce its near-term production quantities given the design complexities of the three variants and the concurrent production of both development and production aircraft. As result, DOD slowed down production by delaying the procurement of 122 aircraft between 2011 and 2015. Table 5 illustrates the current procurement plans for the United States and the international partners.

Table 5: Procurement and Manufacturing Plans as of February 2010

Buy year	2011	2012	2013	2014	2015
Delivery year	**2013**	**2014**	**2015**	**2016**	**2017**
Air Force-CTOL	23	24	33	53	70
Navy-CV	7	7	13	15	19
Marine Corps-STOVL	13	14	25	22	24
International partners	0	8	33	67	94
Total (564)	**43**	**53**	**104**	**157**	**207**

Source: GAO analysis of DOD data.

Even after decreasing near-term quantities, the annual procurement rate is still expected to ramp up rapidly, increasing from 43 to 207 during the 5-year period 2011 through 2015. Total procurement during this period is 564 aircraft: 362 for the United States and 202 for the international partners. If the improvements recommended by the IMRT are not implemented, there is greater risk that the prime contractor will not be able to produce planes according to plan, and a backlog of aircraft on order but waiting to be produced will develop.

As we reported last year, the JSF program is procuring a substantial number of production aircraft using cost-reimbursement contracts which place most of the risk on the buyer (DOD), with the government potentially paying more than budgeted should labor, material, or other incurred costs be more than expected when the contract was signed. According to the Federal Acquisition Regulation, cost reimbursement contracts are suitable for use only when uncertainties involved in contract performance do not permit costs to be estimated with sufficient accuracy to use any type of fixed-price contract. [18] While the use of cost reimbursement contracts is permissible for buying initial low-rate procurement quantities, continued use further into production indicates acknowledgement by DOD and the contractor that knowledge on JSF design, production processes, and costs for labor and material is not yet sufficiently mature and that pricing information is not exact enough for the contractor to assume the risk under a fixed-price contract.

We are encouraged by the Secretary's statement in the February 2010 restructuring acquisition decision memorandum that future aircraft and

[18] Federal Acquisition Regulation § 16.301-2.

engine production contracts should move to fixed-price incentive fee structures as soon as possible. According to DOD, the restructuring further established critical business measures to monitor in 2010, including the possible negotiation of a fixed-price low-rate production contract for the 2010 lot buy and completion of a cost study to inform a fixed price for the 2011 lot buy.

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

Steadily lengthening schedules to complete key system development efforts further exacerbates the already extreme overlap among development, test, and production activities. Late deliveries of development test aircraft and less productivity than planned have slowed development flight testing and resulted in the program missing important milestones. The restructuring directive to add four aircraft to supplement the development flight test program, if implemented, should significantly increase test capacity and lessen concurrency with operational testing, but officials agree that flight plans are still aggressive. Other technical challenges abound, including (1) relying on an extensive but largely unproven and unaccredited network of ground test laboratories and simulation models to evaluate system performance, (2) continuing challenges in developing and integrating very large and complex software requirements essential to JSF capabilities, and (3) maturing several technologies that are essential to meet operational performance and logistical support requirements. Collectively, these testing and developmental challenges can be expected to lead to additional delays and increased program costs, while hampering delivery of warfighter requirements, the planned start-up of initial operational testing, and pilot and maintainer training. While technical problems and some delays are to be expected in any major defense acquisition, the JSF is especially challenged because of its size, scope, and complexity and exerts a correspondingly larger impact on future defense budgets and force structure. While all this is still before the program, DOD continues to push ahead and invest in large quantities of aircraft before variant designs are proven and system performance verified.

Development Flight Testing Is Behind Schedule and Entering Its Most Stressing Years

For several years, DOD and the contractors have made annual adjustments to the schedules for key system development activities, each time lengthening the time needed to complete work. Flowing more work to the future further compresses the time available for verifying design and performance and for finding and fixing problems in advance of investing in new aircraft in time to meet capability requirement dates established by the warfighters. Table 6 summarizes recent delays to key JSF test activities

and related development events. In particular, it shows the rippling effects from manufacturing delays and diminished test assets on the program's ability to meet development flight plans.

Table 6: Progress in Meeting Planned Development and Test Activities

Development activity	2007 Plan	2008 Plan	2009 Plan[a]
Manufacturing			
Flight test aircraft delivered by 2010	14 aircraft	13 aircraft	4 aircraft
Testing activities			
Complete Development Testing	October 2012	October 2013	March 2015
Flight tests expected by September 2009	700	310	120
Flight test hours expected (by September 2009)	1431	532	160
Testing events			
STOVL vertical landing	First Quarter 2009	Third Quarter 2009	Second Quarter 2010 [a]
First CTOL (optimized) flight test	January 2009	May 2009	October 2009
First CV flight test	May 2009	October 2009	January 2010 [a]
First mission system aircraft flight test	January 2009	March 2009	January 2010 [a]
Start of Block 1 flight tests (basic warfighting capability)	Third quarter 2009	Fourth quarter 2009	Third quarter 2010
Engine deliveries			
Engine initial service release (CTOL/CV)	Second quarter 2008	Fourth quarter 2008	Fourth quarter 2009
Engine initial service release (STOVL)	Fourth quarter 2008	First quarter 2009	Third quarter 2010
Software Integration			
Development and integration of software providing full warfighting capability	2012	2013	2015

Source: GAO analysis of DOD data.

[a]Not achieved as of January 2010.

The JSF development flight test program currently has few assets available, has not been as productive as expected, and has missed key test events. By the end of December 2009, only 4 of the planned 13 flight test aircraft had been delivered. Overall, only about 3 percent of total planned flight tests had been completed by the end of 2009. According to the 2007 test plan, 13 percent were to be completed at this time. Productivity during 2009 remained low as only 10 percent of the planned test flights were accomplished, according to DOT&E. Important test events, including the first flight demonstrating full-STOVL characteristics, the first flight of the carrier variant, and initial demonstration of basic warfighting capabilities, have not yet occurred and each has been delayed more than 1 year compared to the schedule in 2007. Our analysis of DOD schedule data determined that the test fleet averaged 13 month delays from initial

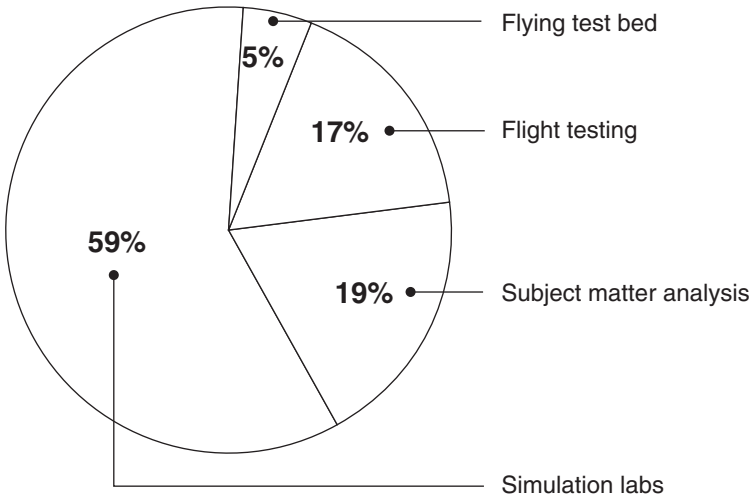
projections in actual or planned first flights. Program officials noted that some of the recent flight test delays are the result of decisions to hold aircraft at the manufacturing location until manufacturing is completed so that aircraft delivered to the developmental test locations better meet requirements and are fully prepared for testing.

Program officials expect to aggressively step up the program's flight testing over the next couple of years. The restructuring directive to add four aircraft to supplement the development flight test program, if implemented, should significantly increase test capacity. Accordingly, DOD officials reduced the JET's projection of a 30-month extension needed for flight testing to a 13-month extension. DOD officials agreed that the new plan reduces risk and is more achievable given the additional aircraft but is still challenging. The new plan has little schedule margin for error and will still be under pressure to accommodate the inevitable discovery of issues and retests that occur over the course of every flight test program. We further note that the new test aircraft to be ordered, a carrier variant, will not be available until mid-2013. In addition, an operational test official said the program may have insufficient logistical support to sustain the increased number of test sorties per day.

Most Simulation Labs Are Not Yet Accredited and Progress in Reducing Program Risks Is Unclear

The JSF test program relies much more heavily than previous weapon systems on its modeling and simulation labs to verify aircraft and subsystem performance. As figure 5 depicts, the program plans to verify 83 percent of JSF capabilities (as measured by individual test points) in its ground labs, the flying test bed, and through desk studies, and only 17 percent through flight testing. Contractor officials believe this breakdown by venues is misleading. If instead quantified by the venue where the final sign-off of requirements is expected to occur, the program plans to complete 55 percent in off-aircraft venues and 45 percent in flight tests. By either method, the reliance on ground labs and simulations is substantial. Program and contractor officials believe that the up-front investment of $5 billion in the simulation labs will allow for early risk reduction, reduce the need for additional flight testing, control costs, and meet key milestones of the program's aggressive test plan.

Figure 5: Breakdown of Verification Venues



Source: GAO analysis of DOD data.

The JSF program's simulation labs appear more prolific, integrated, and capable than the labs used in past aircraft programs; the program utilizes 18 labs for development testing compared to 9 for the F-22A, 7 for the F-18, and 5 for the F-16. According to program officials, the greater number of labs allows engineers to work simultaneously on different development blocks, reducing bottlenecks that may occur in testing. In contrast, engineers for the F-18 and F-22A programs had to interrupt or shut down work on one development block while they made corrections to another block. Also, key JSF simulation labs are co-located at the Lockheed Martin plant in Fort Worth, Texas, whereas the F-22A program utilized three locations and two different companies. The co-location of labs should facilitate more seamless integration for more realistic subsystem tests. Further, the JSF utilizes the first fully integrated airborne test bed for mission system testing. According to program officials, the test bed's design is geospatially proportionate to an actual F-35 aircraft, enhancing its ability to accurately verify aircraft performance.

Despite the extensive network of simulation labs, their ability to substitute for flight testing is unproven and their progress in reducing program risk is difficult to assess. Lab use did increase substantially in 2009; mission systems lab use, for example, increased 81 percent from 2008. According to program officials, early flight test results have tended to corroborate lab results. However, most labs and models have yet to be accredited, a lengthy and involved technical evaluation to ensure fidelity of results. Labs

and models must be fully accredited prior to using them to verify JSF requirements. The prime contractor identified 11 physical labs and 23 models and simulations needing accreditation. At the time of our review, no physical labs and only two models were accredited. Although officials told us that current requirements verification plans are on track, it is difficult to assess performance until more labs and models are accredited and more flight testing is done to corroborate fidelity of results. Accordingly, although the contractor seems to be utilizing its labs well, the true measure of progress will be when all these venues are accredited and officials are completing the test plan by successfully verifying required capabilities. To date, only 62 of 2,879 capabilities have been verified through labs, flight tests, or both.

Delays in accreditation add substantial risk to future software block completion and defect discovery later in the program and could lead to more flight testing, which is generally more expensive. Moreover, it is unclear how the ongoing delays in flight testing will affect the accreditation process. Validating that the models accurately reflect aircraft performance is crucial to the accreditation process. In this way, model validation relies to a certain extent on the progress of flight testing. As such, continued delays to flight testing increase the risk that simulation labs may not be accredited when expected.

Software Development and Other Technical Risks Increase the Likelihood of Further Testing Delays and Cost Increases

While technical challenges are part of any major defense acquisition, the JSF program has particularly daunting tasks ahead. The JSF software development effort is one of the largest and most complex in DOD history, essential to providing capabilities for sensor fusion, weapons and fire control, diagnostics, and propulsion. The program estimates that the systems will require 11.6 million effective software lines of code.[19] By comparison, the F/A-18/E/F has only 1.1 million and the F-22A has 2.2 million lines of code on board. Progress on software is noted by several measures. Currently, JSF engineers have written about three-fourths of the total lines of aircraft code expected and about 40 percent of the written code has been integrated and tested. This is typically the most challenging phase of software development. The program, however, also continues

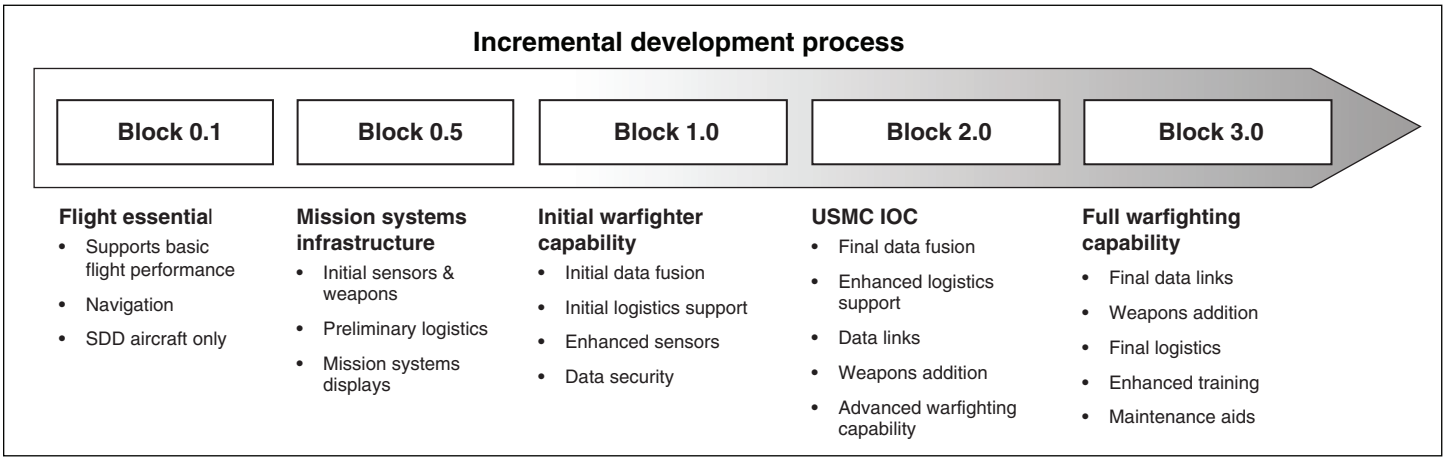
[19] The program estimates it will have 11.6 million effective software lines of code (ESLOC). ESLOC measures the effective size of reused and adapted code, and is adjusted to its equivalent size in new lines of code. This is not a deliverable product. The program will have over 18 million software lines of code (SLOC), which is a measure of the total raw size of software.

moving some capabilities to future blocks in order to keep on schedule. This adds pressure and costs to future efforts and increases the probability of defects being realized later in the program.

Software is developed, integrated, and released in five increments (see fig. 6). The first increment, needed to enable basic aircraft flying characteristics, is the only one completed. All other software increments are behind schedule. Mission system software, in particular, is behind schedule, poses significant integration challenges, and its progress is difficult to assess.[20] Further delays may affect the already delayed first mission system flight test. Naval Air Systems Command officials predict further delays in providing software capability to flight tests due to competing scarce resources from upcoming blocks to complete or rework current blocks. The joint estimating team projects more time and effort will be needed to complete the fifth software increment, the development and integration of software for achieving full warfighting capability. Team officials project 2015 for completing this work, 2 years later than currently reported by the program office. They also believe that the most complex and troublesome work is still ahead, that dedicated resources to complete software development and integration are inadequate, and that the contractor will not be able to write code as fast and productively as earlier releases. The joint team also predicts that software requirements will continue to grow. Recent prior acquisitions have experienced 30 to 100 percent growth in software requirements over time, whereas the JSF program office current estimate assumed no growth. We note that JSF software has grown 40 percent since the preliminary design review and 13 percent since the critical design review over initial program estimates. Given the resource shortages and the complexity of the work ahead, DOD directed the program to expand software integration capabilities by adding an additional software integration line as part of the recent restructuring. If properly resourced, the extra line should significantly increase throughput.

[20]Mission systems are critical to realizing increased warfighter capability in combat effectiveness through next- generation sensors with fused information from on-board and off-board systems (i.e., Electronic Warfare, Communication Navigation Identification, Electro-Optical Target System, Electro-Optical Distributed Aperture System, Radar, and Data Links).

Figure 6: Software Increments



Source: GAO analysis of DOD data.

In addition to ongoing software challenges, the program continues to address several technical issues. We spoke with several defense organizations, as well as the JSF program office and contractors, who identified technical hardware and software challenges that could have significant operational impacts if not resolved. Several challenges cited by more than one office and considered critical to meeting requirements include the following:

- **Design changes to carrier variant**. The carrier variant requires significant design modifications to the keel web, a key structural joint to enable catapult takeoffs. Proposed design changes are still being reviewed and cost and schedule impacts are unknown at this time. Design modifications will be needed for any test aircraft planned for carrier suitability testing. It is not clear at this point which aircraft are expected to receive design modifications on the manufacturing line and which will be modified after their first flight. Nonetheless, completing the design modifications will likely result in carrier suitability test delays of at least 4 months, according to an official from DOT&E.

- **JSF engine**. The program continues to address significant technical and design challenges with the F135 engine. The STOVL engine's lift fan has required design changes in response to damages incurred during testing which will limit flight test efficiency and will likely require additional modifications, time, and resources. In addition, other key engine components, such as the turbine blades, electric de-icing system, and dual vane fuel pump, have required reengineering after failing initial tests.

- **Logistics support**. The advanced integrated support system aims to improve and streamline aircraft logistics and maintenance functions in order to reduce life-cycle costs. NAVAIR reported that the software to support the system's communication with legacy information systems is currently not planned and may affect interoperability. In addition, the Air Force Operational Test and Evaluation Center (AFOTEC) reported that the current integrated support system for the JSF prohibits operating two detachments from one squadron simultaneously. This limitation will severely affect current operating practices. The JSF program has proposed interim solutions, but full support system deployability will not be available by the Marine Corp's and Air Force's initial operational capability dates.

- **Helmet Mounted Display**. Critical to information integration and situational awareness, issues with the helmet mounted display continue to impact system effectiveness and air system integration. These include night operations, system latency for information displayed, weapon systems aiming and accuracy, and laser eye protection. These shortfalls may lead to workarounds or omissions during flight tests, according to NAVAIR. Further, the lack of a production helmet mounted display configuration at this time could result in a major system redesign or change in concept of operations.

- **Damage to flight deck and runways**. The F-35 engine and integrated power package exhaust may cause excessive damage to the flight deck environment and runway surfaces that may result in operating limits or drive costly upgrades and repairs of JSF basing options. The program office and DOD are still evaluating the problem and plan to conduct further studies when full-scale models or actual aircraft are available. In addition, the Defense Advanced Research Projects Agency is soliciting research proposals in the area of thermal management systems for aircraft landing decks.

- **Thermal management**. Heat build-up and exhaust impedes the aircraft's ability to conduct missions in hot environments. The program has made design changes to address this issue, but those changes are not expected to go into effect until the third low-rate procurement lot and are likely to affect operational testing. The development of a fuel pump to mitigate excessive heat is not expected to fully achieve requirements. As a result, the program has instituted restrictions on how the aircraft can be used. These restrictions will limit flight test efficiency and may not be feasible for operational deployment.

While DOD officials acknowledge that the program continues to address technical risks, they note that discovering and working through technical problems are to be expected in any development program especially a program as complex as JSF. They further note that the Department has not uncovered any technology or manufacturing issues as a result of the restructuring that would prevent the aircraft from meeting requirements.

Significant Investments in Aircraft Are Planned Before Flight Testing Is Completed

Although officials recently reduced near-term procurement plans and added test aircraft, DOD is still planning significant investments in procuring large quantities of JSF aircraft before flight testing proves they will perform as required. The intent of development flight testing is to discover and fix design and performance deficiencies during development when it is cheaper to do so than discovering problems and shortfalls during follow-on operational testing and after initial fielding. Purchasing aircraft before testing successfully demonstrates that the designs are mature and that the weapon system will work as intended increases the likelihood and impact of design, manufacturing, and requirements changes resulting in subsequent cost growth, schedule delays, and performance shortfalls. Systems already built and fielded may require substantial modifications, driving further costs. Figure 7 shows DOD's planned investment in dollars and aircraft prior to the completion of development flight testing. DOD has already bought 28 production aircraft through fiscal year 2009. Under the current plan, DOD may procure as many as 307 aircraft at a total estimated cost of $58.2 billion before development flight testing is completed.

Figure 7: JSF Procurement Investments and Progress of Flight Testing

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

Source: GAO analysis of DOD data.

We have reported on several occasions about the risks of procuring aircraft before testing demonstrates the design is mature, costs are well understood, and manufacturing activities can support the ramp up in production.[21] The JSF program has entered production and has laid out an

[21] GAO-09-303, GAO-08-388, GAO-07-360, and GAO-06-356.

investment schedule that significantly increases procurement rates by 163 percent from fiscal year 2011 to 2015. However, at the same time, it has not been successful in meeting demonstration goals and testing schedules to support increases in production investments, placing billions of dollars at risk as it develops and produces aircraft concurrently. As the JSF program development and test program slips, it further increases the chances that costly design changes will surface in the later years of flight testing.

The risk of further concurrency could be managed if the program outlines a plan that illustrates what minimum conditions should be met before increases in investments are made. Such a plan would allow decision makers to gauge a program's progress and to determine whether a program has demonstrated a sufficient amount of knowledge that would justify such an increase in investment levels. To date, the JSF program has not outlined such a plan. Also, given the several changes to schedules, test program, and procurement profiles, and continued program uncertainty, it has been difficult to baseline the program and measure its progress.

Congress had similar concerns about the concurrency planned for the advanced technology bomber B-2 program, and the planned investment in procurement aircraft prior to fully testing the aircraft. Congress enacted legislation requiring DOD to establish an initiative for maintaining discipline in cost, contractor performance, and management within the program. The initiative was required to include creation of a management plan under which decisions to commit to specified levels of production are linked to progress in meeting specified program milestones, including testing milestones. The initiative was also required to include creation of a "full performance matrix," a tool used by DOD to identify minimum conditions that would be met before making annual procurements. The full performance matrix laid out over time how different capabilities for the B-2 would be demonstrated in relationship to procurement decisions. Such a tool helps provide visibility for decision makers into a program's progress in ensuring the maturity of the weapon system based on expected, demonstrated knowledge compared to a baseline plan thus allowing for more informed investment decisions, and better managed risks inherit in a highly concurrent development and production program.

Conclusions

The JSF is DOD's largest and most complex acquisition program and the linchpin of the United States and its allies' long-term plans to modernize tactical air forces. It will require exceptional levels of funding for a sustained period through 2034, competing against other defense and

nondefense priorities for the federal discretionary dollar. As such, it is critical to maintain affordability while moving forward, prudently balancing program, technical, and funding risks with the achievement of warfighter performance requirements. Risks are manifold—mounting cost and schedule pressures; complex, extensive, and unproven software requirements; and a nascent, very aggressive test program that continues to experience significant delays. Since our last report, development costs have again increased and the schedule for completing development and operational testing has been extended. Further acquisition cost increases and delays are expected. Impacts on production are uncertain, but increased manufacturing labor hours and late deliveries of development aircraft indicate that learning curve efficiencies are not meeting expectations and will likely result in higher future procurement unit prices than those currently reported to Congress. Given all these challenges, moving forward with the current plan for ramping up production does not seem prudent.

JSF cost increases, schedule delays, and continuing technical problems also increase the risk that the program will not be able to deliver the aircraft quantities and capabilities in the time required by the warfighter. Because of the significance that JSF is expected to have on the overall composition of the future tactical aircraft fleet, the services' ability to meet their initial operational capability requirements and to acquire JSFs in quantity should have a high degree of confidence so that DOD can effectively plan its overall tactical aircraft force structure strategy. DOD leadership is now taking some positive steps that, if effectively implemented, should improve outcomes and provide more realistic cost and schedule estimates. Nonetheless, there is still substantial overlap of development, test, and production activities while DOD continues to push ahead and invest in large quantities of production aircraft before variant designs are proven and system performance verified. As we have recommended in the past, adopting a more evolutionary, incremental strategy that delivers proven and operationally suitable capabilities when available, but acknowledges that more time is needed to deliver the full capabilities, would increase the likelihood of success in providing timely and affordable capability to the warfighter. Credible cost and schedule estimates are critical because they allow DOD management to make sound trade-off decisions against competing demands and allow Congress to perform oversight and to hold DOD accountable. While the independent cost estimate completed by the Joint Estimating Team is a very good start, it by design focused only on the near term. Until a complete and comprehensive cost estimate that provides cost through completion of procurement and includes a more complete estimate of military

construction funding requirements is formally adopted as the new program of record, JSF program costs will remain unclear. Tying annual investments more directly to demonstrated progress in developing, testing, and manufacturing aircraft would be a prudent fiscal measure.

Recommendations for Executive Action

Given the continuing changes in JSF program plans and future risks going forward and to provide DOD leaders and Congress with accurate and timely data for making decisions and appropriating funds, we recommend that the Secretary of Defense direct appropriate offices within DOD to expeditiously complete a full, independent, comprehensive cost and schedule estimate for the JSF acquisition program through completion and that this new estimate be established as the official program of record for planning, budgeting, and congressional reporting purposes. This effort should build upon the work already accomplished by the Joint Estimating Team, the Independent Manufacturing Review Team, the Joint Assessment Team, and NAVAIR. In addition to development and procurement costs, this effort should also include (1) a robust estimate of military construction costs, (2) identification of JSF-related costs not funded in the JSF program but which are needed to properly base and operate service fleets on the ground and at sea, and (3) a comprehensive evaluation of projected operating and support costs and the implications of higher JSF operating costs compared to legacy aircraft on future defense budgets and force structure.

We also recommend that the Secretary of Defense direct that the military services, with Joint Staff and combatant command participation, conduct a detailed review of each service's initial operational capabilities requirement to determine the minimum warfighter needs (both capabilities and capacity) and reasonable, realistic time frames for achieving the requirement. In conducting this review, the military services should consider trading off desired capabilities in order to more rapidly field JSF aircraft with an initial set of usable capabilities to reduce risks of a future tactical aircraft "gap" created by delays in fielding the JSF. Capabilities that are not needed to meet more immediate warfighter needs should be deferred to a future development increment. If options are not available for deferring capabilities to future increments, DOD needs to extend its IOC dates to better align operating plans with more realistic, higher confidence development and production schedules. In addition, because of remaining JSF development risks and uncertainties—including potential for future delays and possible reductions in JSF quantities—contingency plans for legacy aircraft need to be developed so that a properly resourced strategy is in place to fill the capability and capacity gaps until the JSF can

replace the legacy aircraft. Completing this review before finalizing its ongoing program restructure would ensure that the program's acquisition strategy is in sync with and supports revisions to services' IOC requirements. The Secretary of Defense should report the results of this review to the congressional defense committees.

Matter for Congressional Consideration

In addition to the recommendations for the Secretary above, Congress may wish to consider requiring DOD to provide a JSF "system maturity matrix" as a tool that could help Congress better measure the program's progress in maturing the weapon system. The matrix should provide criteria and conditions for comparing documented results to expected progressive levels of demonstrated weapon system maturity in relationship to planned increases in future procurement quantities. This matrix should explain how increasing levels of demonstrated, quantifiable knowledge about the weapon system maturity at annual procurement decision points justify a ramp up of procurement quantities, and corresponding increasing funding needs, leading up to full-rate procurement. Key areas of the matrix and potential criteria could include:

- manufacturing maturity (including on-time deliveries, manufacturing process control, quality rates, and labor efficiency rates);
- engineering maturity (design traffic and design changes);
- performance and testing progress (test points, hours and flights accomplished, capabilities demonstrated, key performance parameters, and attributes demonstrated);
- mission effectiveness and system reliability (operational effectiveness and reliability growth);
- cost estimate fidelity; and
- training, fielding, and deployment status.

Agency Comments and Our Evaluation

DOD provided written comments on a draft of this report. The Department concurred with our two new recommendations. Its comments are included in appendix 3. DOD also provided some technical comments that we incorporated in the final report.

Our draft report included a third recommendation, reiterated from our 2009 report, concerning plans to transition to fixed-price procurement contracts. In the interim since we submitted the draft for comment, the Department announced its significant restructuring plans, including directions to transition to fixed-price procurement contracts, perhaps as soon as this year, and prescribed other changes to contracting strategy and provisions. In written comments, the Department partially concurred with

our recommendation, stating that they were addressing this topic with the prime contractors, had discussed specific plans with all four defense committees, and will continue to update them on the progress. Accordingly, the Department believes its actions meet the intent of this recommendation, both in this report and in our prior report. We agree and deleted it in the final report. Furthermore, we added more details on elements of the restructuring as it impacted several sections of the report.

We are sending copies of this report to the Secretary of Defense; the Secretaries of the Air Force, Army, and Navy; and the Director of the Office of Management and Budget. The report also is available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staff have any questions concerning this report, please contact me at (202) 512-4841 or sullivanm@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Staff members making key contributions to this report are listed in appendix IV.

Michael J. Sullivan
Director
Acquisition and Sourcing Management

List of Congressional Committees

The Honorable Carl Levin
Chairman
The Honorable John McCain
Ranking Member
Committee on Armed Services
United States Senate

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

The Honorable Ike Skelton
Chairman
The Honorable Howard P. McKeon
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Norm Dicks
Chairman
The Honorable C.W. Bill Young
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Appendix I: Scope and Methodology

To determine the Joint Strike Fighter (JSF) program's progress in meeting cost, schedule, and performance goals, we received briefings by program and contractor officials and reviewed financial management reports, budget documents, annual Selected Acquisition Reports, monthly status reports, performance indicators, and other data. We compared reported progress with the program of record and previous years' data, identified changes in cost and schedule, and obtained officials' reasons for these changes. We interviewed officials from the JSF program, contractors, and the Department of Defense (DOD) to obtain their views on progress, ongoing concerns and actions taken to address them, and future plans to complete JSF development and accelerate procurement.

At the time of our review, the most recent Selected Acquisition Report available was a limited report from December 31, 2008. The most recent full Selected Acquisition Report was from December 31, 2007. The Office of the Secretary of Defense was still preparing its new cost estimate to be included in the program's Selected Acquisition Report dated December 31, 2009, which will be delivered to Congress in April 2010. Additionally, at the time of our review the JSF program was in the process of developing a new test schedule. We received a draft of the new schedule; however, since it had not yet been approved we continued to use the program of record in our assessment.

In assessing program cost estimates, we compared the official program cost estimate in the 2008 Selected Acquisition Report to estimates developed by the JSF program, Defense Contract Management Agency (DCMA) reports, and independent reviews from the Joint Estimating Team (JET), Naval Air Systems Command (NAVAIR), and the Independent Manufacturing Review Team (IMRT) for fiscal years 2010 through 2017. Because the fiscal year 2011 budget had not been submitted to Congress at the time of the draft report, some of the report's findings are based on preliminary cost projections that existed at the time of our review rather than the official program of record. We interviewed members of NAVAIR, DOD Cost Analysis and Program Evaluation Office (CAPE),[1] and DCMA to understand their methodology, data, and approach in developing their independent cost estimates. To assess the validity and the reliability of

[1]The CAPE serves as the principal advisory body to the milestone decision authority on all matters concerning an acquisition program's life-cycle cost, and is given general responsibilities for establishing DOD policy guidance on a number of matters relating to cost estimating. The independent CAPE cost estimate is designed to assess the program office estimate and ensure realistic cost estimates are considered.

contractors' cost estimates, we reviewed audit reports prepared by DCMA and conducted independent analysis of contractor cost performance reports.

To assess the program's plans and risk in manufacturing and its capacity to accelerate production between fiscal years 2010 and 2015, we analyzed manufacturing cost and work performance data to assess progress against plans. We compared budgeted program labor hours to actual labor hours, identified growth trends, and noted differences between future labor requirements and current plans to release engineering staff. We reviewed data and briefings provided by the program, DCMA, and the JET to assess supplier performance and ability to support accelerated production between fiscal years 2010 and 2015. We also determined reasons for manufacturing delays, discussed program and contractor plans to improve, and projected the impact on development and operational tests. We also reviewed the program's schedule estimates and compared them with relevant best practices[2] to determine the extent to which they reflect key estimating practices that are fundamental to having a reliable schedule. In doing so, we interviewed program officials to discuss their creation of the program's current schedule and interviewed officials from NAVAIR to understand their approach and to obtain results of their independent schedule risk analysis.

To assess plans, progress, and risks in test activities, we examined program documents and interviewed DOD, program office, and contractor officials about current test plans and progress. To assess progress towards test plans, we compared the number of flight tests conducted as of December 2009 to the original test plan established in 2006. We also reviewed documents and interviewed prime contractors about flight testing, the integrated airborne test bed, and ground testing. To assess the ground labs and test bed, we interviewed officials from the Office of the Secretary of Defense, and toured the testing labs at the Lockheed Martin facilities in Fort Worth, Texas. We also reviewed independent assessments conducted by the JET and NAVAIR to obtain their perspective on the program's progress in test activities.

In performing our work, we obtained information and interviewed officials from the JSF Joint Program Office, Arlington, Virginia; Naval Air Systems Command, Patuxent River, Maryland; Defense Contract Management

[2]GAO-09-3SP.

Agency, Fort Worth, Texas; Lockheed Martin Aeronautics, Fort Worth, Texas; Defense Contract Management Agency, East Hartford, Connecticut; Pratt & Whitney, East Hartford, Connecticut; Defense Contract Management Agency, Cincinnati, Ohio; and General Electric Rolls-Royce, Cincinnati, Ohio. We also met with and obtained data from the following offices of the Secretary of Defense in Washington, D.C.: Director, Operational Test and Evaluation; Cost Analysis and Program Evaluation Office; and Systems and Software Engineering. We assessed the reliability of DOD and JSF contractor data by (1) performing electronic testing of required data elements, (2) reviewing existing information about the data, and (3) interviewing agency officials knowledgeable about the data. We determined that the data were sufficiently reliable for the purposes of this report. We conducted this performance audit from June 2009 to February 2010 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Changes in Reported JSF Program Costs, Quantities, and Deliveries

Table 7 shows the evolution of DOD's official estimated cost, quantity, and deliveries from the initiation of system development in October 2001 to the fiscal year 2011 budget request submitted to Congress in February 2010. It depicts quantities reduced in the last major program restructure in 2004, the impacts of increased costs on unit prices, and the slip in delivering initial operational capability to the warfighter.

Table 7: Changes in Reported JSF Program Costs, Quantities, and Deliveries

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

Source: GAO analysis of DOD data.

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

Appendix III: Comments from the Department of Defense

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

ACQUISITION,
TECHNOLOGY
AND LOGISTICS

MAR 18 2010

Mr. Michael Sullivan
Director, Acquisition and Sourcing Management
U.S. Government Accountability Office
441 G Street, N.W.
Washington, DC 20548

Dear Mr. Sullivan:

This is the Department of Defense (DoD) response to the GAO draft report 10-382, "Joint Strike Fighter: Additional Costs and Delays Risk Not Delivering Warfighter Requirements on Time" dated February 12, 2010, (GAO Code 120822). Detailed comments on the report recommendations are enclosed.

The DoD concurs with recommendations one and two and partially concurs with recommendation three. The rationale for our position is included in the enclosure.

We appreciate the opportunity to comment on the draft report. My point of contact for this effort is Col Mike Schmidt, 703-697-3619, Michael.schmidt@osd.mil.

Sincerely,

David G. Ahern
Director
Portfolio Systems Acquisition

Enclosure:
As stated

GAO DRAFT REPORT DATED FEBRUARY 12, 2010
GAO-10-382 (GAO CODE 120822)

"JOINT STRIKE FIGHTER: ADDITIONAL COSTS AND DELAYS RISK NOT MEETING WARFIGHTER REQUIREMENTS ON TIME"

DEPARTMENT OF DEFENSE COMMENTS TO THE GAO RECOMMENDATIONS

The Department recognizes and appreciates the GAO's effort to update their initial draft report to more accurately account for program changes made over the last few months. However, the reporting of some technical and programmatic issues highlighted in the report is unbalanced in terms of the risks going forward.

The Department remains committed to the F-35 program and its Partners. The FY 2011 President's Budget (PB) request reflects the DoD's commitment to the F-35 program as the backbone of the future tactical aircraft inventory for the Air Force, Navy, and Marine Corps, as well as our international partners.

A constructive tension exists within the Department regarding estimates of F-35 cost. Over the last four years the Department's Cost Analysis Improvement Group (CAIG) and the more recent JSF Joint Estimate Teams (JET) have consistently predicted it will cost more and take longer to finish the F-35 development program than the JSF Program Office and contractor project. The CAIG and JET also predicted the production aircraft will cost more, significantly influenced by assumptions on the benefits of commonality and other production factors. Last year, the Department added $476 million to the FY 2010 RDT&E budget request in accordance with the JET's recommendation, with the intent to re-visit the funding requirement for subsequent years based on program performance.

In 2009 program performance did not meet expectations, and the Department chose to accept and fund to the updated JET estimate in the FY 2011 budget request and related Future Years Defense Plan (FYDP). Despite many important accomplishments, the program is experiencing challenges as it transitions from development to production. Although the challenges are not unusual for this phase of a major acquisition program, the Department is especially disappointed by the contractor's failure to deliver flight test aircraft during the past year as scheduled. The late deliveries will significantly delay the flight test schedule, which was a major factor in the Department's decision to fund the program to the JET estimate in the FY11 budget submission.

While the Department wants more realism in program estimates, we refuse to accept the cost and operational consequences of a longer development program without doing everything possible to minimize them. The Department is adding another carrier variant aircraft to SDD, adding a software integration line, and borrowing three LRIP aircraft for development flight test to help reduce the 30 months of additional JET-projected schedule requirements to 13 months. The Department also added $2.8B

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RDT&E through the FYDP to fully fund to the JET development estimate for this restructured program.

The Department has not uncovered any technology or manufacturing show-stoppers, and did not de-scope performance requirements during this re-structure process. The Department will continue to evaluate opportunities to reduce risk and reduce the time required to field this vital weapon system.

The contractors have made it clear they intend to meet previous commitments and complete SDD sooner and cheaper than the Department projects, and the Department will incentivize them to do so. The remaining award fee tied to the existing Cost Plus Award Fee contract will be withheld. The remaining fee pool on the SDD Air System prime contract ($614M) will be converted to a performance incentive construct. The new fee construct will establish a balanced and objective incentive structure based on the contractor's performance in attaining cost targets and milestone schedule events.

The Department reduced near-term expected procurement quantities to ensure that the budget and ramp rate adequately account for production risk. In March 2009 the Department chartered an Independent Manufacturing Review Team (IMRT) to assess the adequacy of current program plans to achieve the planned production ramp-up and sustain the predicted maximum production rates. In fall 2009, the IMRT made 20 time-phased recommendations some of which, they conclude, must be accomplished in order to achieve the ramp rates required to meet full-rate production goals. They also proposed more achievable ramp rates, which address some identified production program risks yet fully exercise the production system. The revised ramp reflected in the FY 2011 budget submission provides a more realistic production profile, and results from the following: transfer of procurement funding to development to mitigate risk; delay of planned Partner aircraft procurements; higher unit costs; and IMRT recommended limitations on the annual production rate.

Due to F135 propulsion system projected cost growth, the USD(AT&L) chartered a F135 Joint Assessment Team (JAT) to analyze and address F135 cost and affordability. The JAT concluded that the cost growth projections are to a significant degree reversible, there is good confidence that with investment in affordability AND a commitment by the contractor, Pratt and Whitney can realistically achieve their cost goals.

The contractors remain committed to delivering production aircraft and engines at costs in line with previous commitments. We intend to work with the Congress to buy more aircraft within the F-35 budget if the contractors perform at lower cost than the JET predicts.

RECOMMENDATION 1: The GAO recommends that the Secretary of Defense direct appropriate offices within the Department to expeditiously complete a full, independent, comprehensive cost and schedule estimate for the Joint Strike Fighter (JSF) acquisition program through completion and that this new estimate be established as the official program of record for planning, budgeting, and congressional reporting purposes. This effort should build upon the work already accomplished by the Joint Estimating Team, the Independent Manufacturing Review Team, the Joint Assessment Team, and the

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NAVAIR. In addition to development and procurement costs, this effort should also include (a) a robust estimate of military construction costs; (b) identification of JSF-related costs not funded in the JSF program but which are needed to properly base and operate service fleets on the ground and on the sea; and (c) a comprehensive evaluation of projected operating and support costs and the implications of higher JSF operating costs compared to legacy aircraft on future defense budgets and force structure. (See page 28/GAO Draft Report.)

DoD RESPONSE: Concur. The Department will continue to build on the previous work summarized in the above introduction, and the USD(AT&L) will continue to lead a Department-wide review of the JSF program. As part of that review, the Director, Capabilities Assessment and Program Evaluation plans to conduct an Independent Cost Estimate which will include estimates in the areas described in the recommendation.

RECOMMENDATION 2: The GAO recommends that the Secretary of Defense direct that the military services, with Joint Staff and combatant command participation, conduct a detailed review of each service's initial operational capabilities requirement to determine the minimum warfighter needs (both capabilities and capacity) and reasonable, realistic timeframes for achieving the requirement. In conducting this review, the military services should consider trading off desired capabilities in order to more rapidly field JSF aircraft with an initial set of usable capabilities to reduce risks of a future tactical aircraft "gap" created by delays in fielding the JSF. Capabilities that are not needed to meet more immediate warfighter needs should be deferred to a future development increment. If options are not available for deferring capabilities to future increments, DoD needs to extend its initial operation capability (IOC) dates to better align operating plans with more realistic, higher confidence development and production schedules. In addition, because of remaining JSF development risks and uncertainties—including potential for future delays and possible reductions in JSF quantities—contingency plans for legacy aircraft need to be developed so that a properly resourced strategy is in place to fill the capability and capacity gaps until the JSF can replace the legacy aircraft. Completing this review before finalizing its ongoing program restructure would ensure that the program's acquisition strategy is in synch with and supports revisions to Services IOC requirements. The Secretary of Defense should report the results of this review to the congressional defense subcommittees. (See page 28/GAO Draft Report.)

DoD RESPONSE: Concur. In February 2010, the Joint Requirements Oversight Council (JROC) received a status brief from the JSF Program Office and discussed Initial Operational Capability (IOC) requirements with the Service representatives. The determination of IOC is ultimately a Service responsibility. The JSF Program Office will assist the Services' assessment of potential impacts of the re-structure on their respective IOC plans. The Department will continue to balance existing and future operational

requirements against legacy capabilities within a constrained budget. The Department will keep congressional defense committees informed on the progress.

RECOMMENDATION 3: The GAO is reiterating their recommendation in GAO-09-303 that the Secretary of Defense direct that the Under Secretary of Defense for Acquisition, Technology, and Logistics report to the congressional defense committees on (a) an explanation of the cost and other risks associated with a cost-reimbursable contract as compared to a fixed-price contract for JSF's future low-rate production quantities; (b) the program's strategy for managing and mitigating risks associated with the use of cost contracts; and (c) plans for transitioning to fixed-price contracts for production to include time frames and criteria. (See page 28/GAO Draft Report.)

DoD RESPONSE: Partially concur. The Department's use of cost reimbursement contracts for the early Low Rate Initial Production lots provides the best balance of cost and risk. The Department has always planned to transition to fixed-price type contracts when the risk is reduced, costs have been lowered (via learning, production efficiency improvements, and affordability investments), and sufficient data is available for realistic pricing. The Department plans to move to fixed price incentive type contracts as soon as possible and earlier than expected. The Department is currently addressing this topic with the JSF prime contractors. Department officials have recently discussed more specific contracting plans with professional staff members from all four defense committees and will continue to update them on the progress. The Department believes this meets the intent of both this recommendation and the recommendation in GAO-09-303.

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Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

Michael Sullivan (202) 512 4841 or sullivanm@gao.gov

Acknowledgments

In addition to the contact name above, the following staff members made key contributions to this report: Bruce Fairbairn, Assistant Director; Ridge Bowman; Charlie Shivers; David Adams; Lindsay Taylor; W. Kendal Roberts; Matt Lea, Karen Richey; Jason Lee; and Greg Campbell.

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