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F-35 JOINT STRIKE FIGHTER

Program Has Improved in Some Areas, but Affordability Challenges and Other Risks Remain

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April 17, 2013

F-35 JOINT STRIKE FIGHTER

Program Performance Has Improved in Some Areas, but Affordability Challenges and Other Risks Remain

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Highlights

Highlights of GAO-13-500T, a testimony before the Subcommittee on Tactical Air and Land Forces, Committee on Armed Services, House of Representatives

Why GAO Did This Study

The F-35 Lightning II, the Joint Strike Fighter, is DOD's most costly and ambitious aircraft acquisition. The program is developing and fielding three aircraft variants for the Air Force, Navy, Marine Corps, and eight international partners. The F-35 is critical to long-term recapitalization plans as it is intended to replace hundreds of existing aircraft. This will require a long-term sustained funding commitment. Total U.S. investment is nearing $400 billion to develop and procure 2,457 aircraft through 2037. Fifty-two aircraft have been delivered through 2012. The F-35 program has been extensively restructured over the last 3 years to address prior cost, schedule, and performance problems. DOD approved a new acquisition program baseline in March 2012. GAO's prior reviews of the F-35 made numerous recommendations to improve outcomes, such as increasing test resources and reducing annual procurement quantities.

This testimony is largely based on GAO's recently released report, GAO-13-309. This testimony discusses (1) progress the F-35 program made in 2012, and (2) major risks that program faces going forward. GAO's work included analyses of a wide range of program documents and interviews with defense and contractor officials.

What GAO Recommends

GAO has made prior recommendations to help reduce risk and improve outcomes, which DOD has implemented to varying degrees.

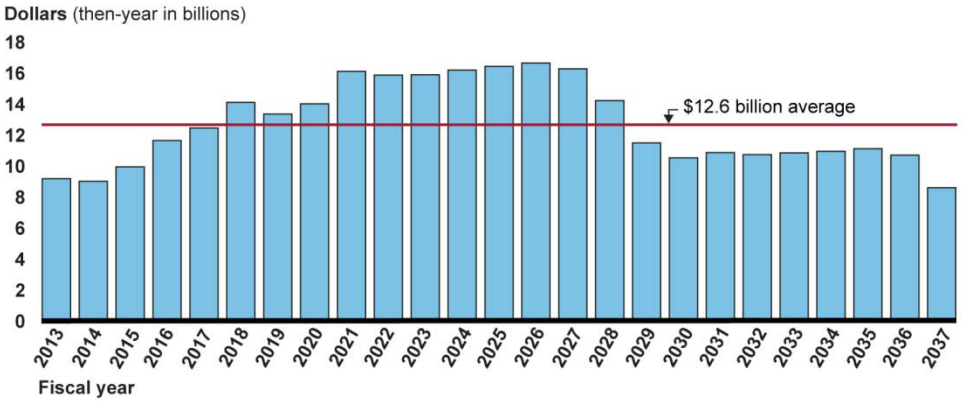
View GAO-13-500T. For more information, contact Michael J. Sullivan at (202) 512-4841 or sullivanm@gao.gov.

What GAO Found

The new F-35 acquisition baseline reflects positive restructuring actions taken by the Department of Defense (DOD) since 2010, including more time and funding for development and deferred procurement of more than 400 aircraft to future years. Overall, the program progressed on several fronts during 2012 to further improve the current outlook. The program achieved 7 of 10 key management objectives and made substantial progress on one other. Two objectives on aircraft deliveries and a corrective management plan were not met. The F-35 development test program substantially met expectations with some revisions to flight test plans and made considerable progress addressing key technical risks. Software management practices and some output measures improved, although deliveries to test continued to lag behind plans. Manufacturing and supply processes also improved—indicators such as factory throughput, labor efficiency, and quality measures were positive. While initial F-35 production overran target costs and delivered aircraft late, the latest data shows labor hours decreasing and deliveries accelerating.

The F-35 program still faces considerable challenges and risks. Ensuring that the F-35 is affordable and can be bought in the quantities and time required by the warfighter will be a paramount concern to the Congress, DOD, and international partners. With more austere budgets looming, F-35 acquisition funding requirements average $12.6 billion annually through 2037 (see below). Once fielded, the projected costs of sustaining the F-35 fleet have been deemed unaffordable by DOD officials; efforts to reduce these costs are underway. Software integration and test will be challenging as many complex tasks remain to enable full warfighting capability. The program is also incurring substantial costs for rework–currently projected at $1.7 billion over 10 years of production–to fix problems discovered during testing. With two-thirds of development testing still to go, additional changes to design and manufacturing are likely. The program continues to incur financial risk from its plan to procure 289 aircraft for $57.8 billion before completing development flight testing.

F-35 Joint Strike Fighter Acquisition Funding Requirements



Source: GAO analysis of DOD data.

Chairman Turner, Ranking Member Sanchez, and Members of the Subcommittee:

Thank you for the opportunity to discuss our work on the F-35 Lightning II, also known as the Joint Strike Fighter (JSF). At a cost approaching $400 billion, the F-35 is the Department of Defense's (DOD) most costly and ambitious acquisition program. The program is developing and fielding three aircraft variants for the Air Force, Navy, and Marine Corps and eight international partners. The F-35 is the linchpin of U.S. and partner plans to replace existing fighters and support future combat operations. In a time of austere federal budgets, DOD continues to project significant long-term sustained funding requirements for the F-35 while, at the same time, pursuing several other expensive systems. Over the past 3 years, DOD has extensively restructured the F-35 program to address poor cost, schedule, and performance outcomes. Most recently, in March 2012, DOD established a new, more realistic, F-35 acquisition program baseline that reflects increased costs, longer schedule times, and deferred procurement of 410 aircraft to the future. Appendix I tracks program baseline changes since the start of system development in 2001.

We have reported annually on F-35 issues since 2005.[1] My testimony today is largely based on the results of our latest review,[2] and addresses (1) the progress the F-35 program made in 2012 and (2) the major risks that the program faces going forward. To conduct our work, we reviewed program status reports and briefings, management objectives, test plans and results, and internal DOD analyses with a focus on accomplishments in calendar year 2012 compared to original plans for that year. We obtained manufacturing data and cumulative outputs from the start of production in 2007 through the end of 2012, and discussed development and production issues and results to date, future expansion plans, and improvement efforts with DOD, F-35 program, and contractor officials. We toured the aircraft manufacturing plant, obtained production and supply performance indicators, identified cumulative and projected engineering changes, and discussed factory improvements and management controls with members of the contractor's work force and DOD plant representatives. We evaluated DOD's restructuring actions and impacts

[1]See related GAO products at the end of this statement.

[2]GAO, *F-35 Joint Strike Fighter: Current Outlook Is Improved, but Long-Term Affordability Is a Major Concern*, GAO-13-309 (Washington, D.C.: Mar. 11, 2013).

on the program, tracked cost and schedule changes from program start to the March 2012 baseline, and determined factors driving the changes. We obtained current projections of acquisition funding needs through 2037 and estimated life cycle sustainment funding requirements. We conducted this work in accordance with generally accepted government auditing standards.

F-35 Program Performance Improved in 2012

The F-35 program made progress in 2012 on several fronts. The program met or substantially met most of its key management and development testing objectives for the year. We also found that the program made progress in addressing key technical risks, as well as improving software management, manufacturing, and supply processes.

Most Management and Development Testing Objectives Were Achieved

The F-35 program met or substantially met most of its key management objectives established for calendar year 2012. The program office annually establishes major management objectives that it wants to achieve in the upcoming year. The F-35 program achieved 7 of its 10 primary objectives in 2012. Those included, among other things, the completion of development testing on early increments of software, the beginning of lab testing for both variations of the helmet mounted display, the beginning of pilot training for two aircraft variants, and the completion of negotiations on the restructured development contract. Although the program did not complete its software block 3[3] critical design review as planned in 2012, it did successfully complete its block 3 preliminary design review in November 2012 and the critical design review in late January 2013. The program did not meet its objectives to (1) deliver 40 production aircraft in 2012 and (2) receive approval from the Defense Contract Management Agency of the contractor's plan for correcting deficiencies in its system for tracking and reporting cost and schedule progress.[4]

[3] Software capabilities are developed, tested, and delivered in three major blocks. Block 3 is to provide the F-35 its full warfighting capability.

[4]This specifically refers to the contractor's Earned Value Management System, which has been found to be deficient. Earned value management is a disciplined process for tracking, controlling, and reporting contract costs and schedule. DOD requires its use by major defense suppliers to facilitate good insight and oversight of the expenditure of government dollars.

The F-35 development flight test program also substantially met 2012 expectations with some revisions to original plans. The program exceeded its planned number of flights by 18 percent, although it fell short of its plan in terms of test points[5] flown by about 3 percent, suggesting that the flights flown were not as productive as expected. Test officials had to make several adjustments to plans during the year due to operating and performance limitations with aircraft and late releases of software to test. As a result, none of the three variants completed all of their planned 2012 baseline points, but the test team was able to add and complete some test points that had been planned for future years. Testing accomplished on each of the aircraft variants in 2012 included:

- Conventional takeoff and landing variant (F-35A)—accomplished high angle of attack testing, initial weapons separation, engine air start, expansion of the airspeed and altitude envelopes, and evaluated flying qualities with internal and external weapons.[6]
- Short takeoff and vertical landing variant (F-35B)—accomplished the first weapons release, engine air start tests, fuel dump operations, flight envelope expansion with weapons loaded, radar signature testing, and tested re-design air inlet doors for vertical lift operations.
- Carrier suitable variant (F-35C)—conducted speed and altitude range verification and flights with external weapons, prepared for simulated carrier landings, and conducted shore-based tests of a redesigned arresting hook.

Progress Made in Addressing Key Technical Risks

In 2012, the F-35 program also made considerable progress in addressing four areas of technical risk that could substantially degrade the F-35's capabilities and mission effectiveness. However, additional work remains to fully address those risks. These risk areas and the actions taken in 2012 are discussed below:

1. Helmet mounted display (HMD)—DOD continued to address technical issues with the HMD system. The original helmet mounted display, integral to mission systems, encountered significant technical

[5]Flight test points are specific, quantifiable objectives in flight plans that are needed to verify aircraft design and performance.

[6]Due primarily to operating restrictions and deficiencies in the air refueling system, the F-35A did not accomplish as many flights as planned and fell short of planned test points by about 15 percent.

deficiencies and did not meet warfighter requirements. The program is pursuing a dual path by developing a second, less capable helmet while working to fix the first helmet design. In 2012, DOD began dedicated ground and flight testing to address these issues. Both variations of the helmet mounted display are being evaluated and program and contractor officials told us that they have increased confidence that the helmet deficiencies will be fixed. DOD may make a decision in 2013 as to which helmet to procure.

2. Autonomic Logistics Information System (ALIS)—ALIS is an important tool to predict and diagnose aircraft maintenance and supply issues. ALIS systems with limited capability are in use at training and testing locations. More capable versions of ALIS are being developed and program and contractor officials believe that the program is on track to fix identified shortcomings and field the fully capable system in 2015. Limited progress was made in 2012 on developing a smaller, transportable version needed to support unit level deployments to operating locations.
3. Arresting hook system—The carrier variant arresting hook system was redesigned after the original hook was found to be deficient, which prevented active carrier trials. The program accomplished risk reduction testing of a redesigned hook point to inform this new design. The preliminary design review was conducted in August 2012 and the critical design review in February 2013. Flight testing of the redesigned system is slated for late 2013.
4. Structural durability—Over time, testing has discovered bulkhead and rib cracks on the aircraft. Structural and durability testing to verify that all three variants can achieve expected life and identify life-limited parts was completed in 2012. The program is testing some redesigned structures and planning other modifications. Officials plan to retrofit and test a production aircraft already built and make changes to the production line for subsequent aircraft. Current projections show the aircraft and modifications remain within weight targets.

Software Management and Output Improved

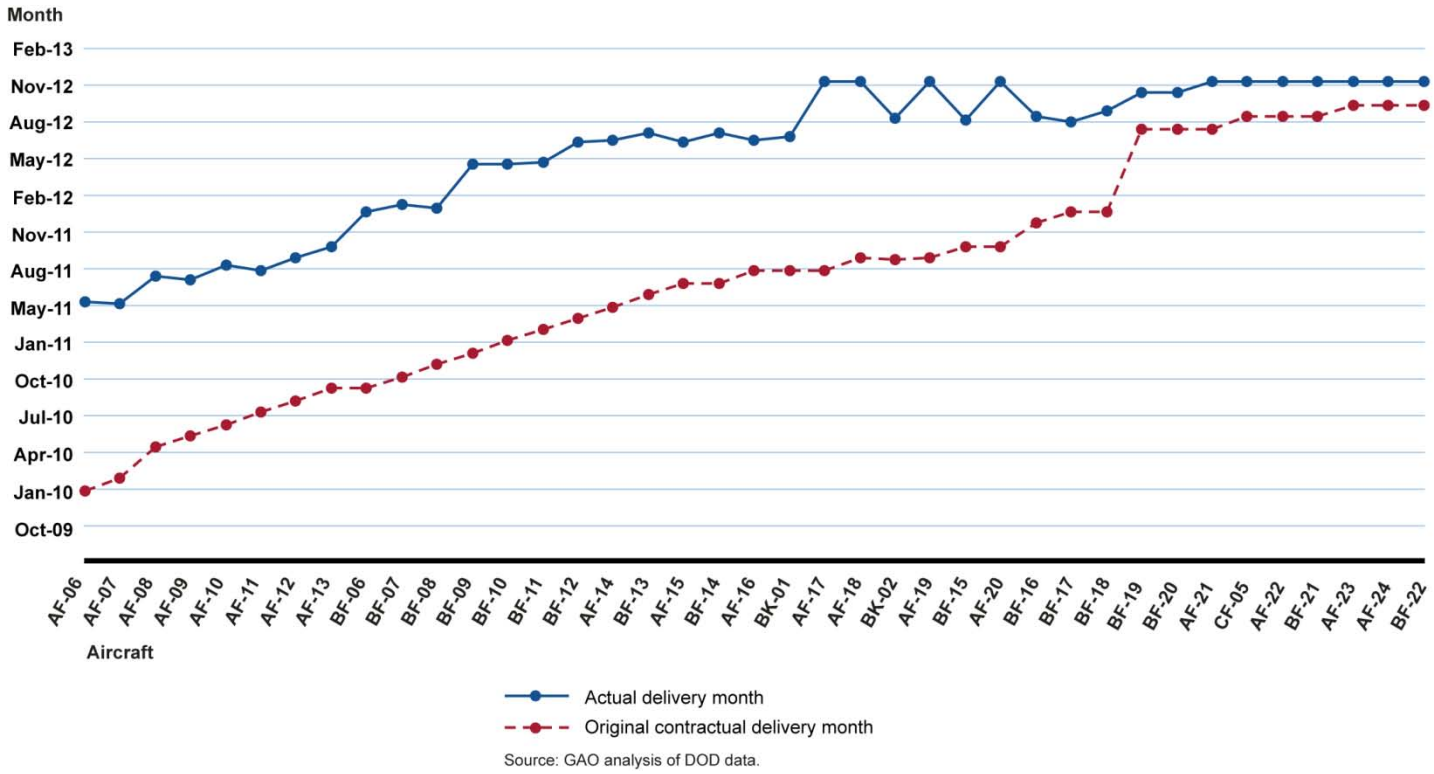
In 2012, the F-35 aircraft contractor and program office took steps to improve the program's software management and output. The program began the process of establishing a second system integration laboratory, adding substantial testing and development capacity. The program also began prioritizing and focusing its resources on incremental software development as opposed to the much riskier concurrent development approach. In addition, the program began implementing improvement initiatives recommended by an independent software review, and

evaluated the possible deferral of some of the aircraft's capabilities to later blocks or moving them outside of the current F-35 program altogether. At the same time, program data regarding software output showed improvement. For example, program officials reported that the time it took to fix software defects decreased from180 days to 55 days, and the time it took to build and release software for testing decreased from 187 hours to 30 hours.

Manufacturing Process Metrics Improved

Key manufacturing metrics and discussions with defense and contracting officials indicate that F-35 manufacturing and supply processes improved during 2012. While initial F-35 production overran target costs and delivered aircraft late, the latest data through the end of 2012 shows labor hours decreasing and deliveries accelerating. The aircraft contractor's work force is gaining important experience and processes are maturing as more aircraft are built. The labor hours needed to complete aircraft at the prime contractor's plant decreased, labor efficiency since the first production aircraft improved, time to manufacture aircraft in the final assembly area declined, factory throughput increased, and the amount of traveled work declined. In addition, program data show that the reliability and predictability of the manufacturing processes increased while at the same time aircraft delivery rates improved considerably. Figure 1 illustrates the improvement in production aircraft delivery time frames by comparing actual delivery dates against the dates specified in the contracts.

Figure 1: F-35 Production Aircraft Deliveries Compared to Contract Dates



Source: GAO analysis of DOD data.

Note: The numbered aircraft are in order of delivery. AF= U.S. Air Force F-35A, BF = U.S. Marine Corps F-35B, CF = U.S. Department of the Navy F-35C; and BK = United Kingdom F-35B.

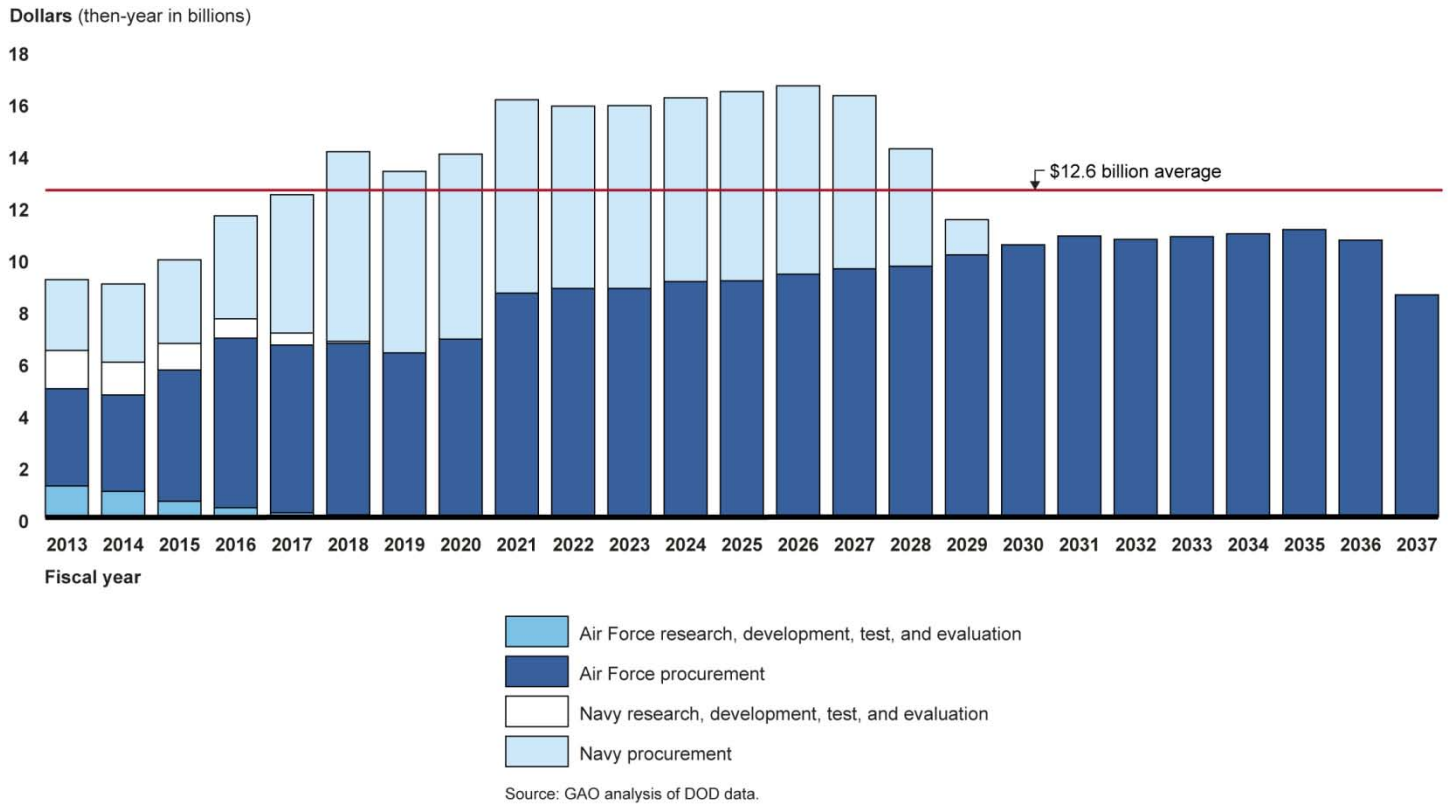
F-35 Program Still Faces Risks

Ensuring that the F-35 is affordable and can be bought in the quantities and time frames required by the warfighter will be of paramount concern to the Congress, U.S. military and international partners. The acquisition funding requirements for the United States alone are currently expected to average $12.6 billion per year through 2037, and the projected costs of operating and sustaining the F-35 fleet, once fielded, have been deemed unaffordable by DOD officials. In addition, the program faces challenges with software development and continues to incur substantial costs for rework to fix deficiencies discovered during testing. As testing continues additional changes to design and manufacturing processes will likely be required, while production rates continue to increase.

Long-Term Affordability Remains a Concern

The March 2012 acquisition program baseline places the F-35 program on firmer footing, but aircraft are expected to cost more and deliveries to warfighters will take longer than previously projected. The new baseline projects the need for a total of $316 billion in development and procurement funding from 2013 through 2037, or an average of $12.6 billion annually over that period (see figure 2). Maintaining this level of sustained funding will be difficult in a period of declining or flat defense budgets and competition with other "big ticket items" such as the KC-46 tanker and a new bomber program. In addition, the funding projections assume the financial benefits of the international partners purchasing at least 697 aircraft. If fewer aircraft are procured in total or in smaller annual quantities—by the international partners or the United States—unit costs will likely rise according to analysis done by the Office of the Secretary of Defense (OSD) Cost Assessment and Program Evaluation (CAPE) office.

Figure 2: F-35 Program Budgeted Development and Procurement Funding Requirements, Fiscal Years 2013-2037



Source: GAO analysis of DOD data.

Note: Development and procurement of the Marine Corps variant is included in the Department of the Navy budget accounts.

In addition to the costs for acquiring aircraft, significant concerns and questions persist regarding the cost to operate and sustain the F-35 fleet over the coming decades. The current sustainment cost projection by CAPE for all U.S. aircraft, based on an estimated 30-year service life, exceeds $1 trillion. Using current program assumptions of aircraft inventory and flight hours, CAPE recently estimated annual operating and support costs of $18.2 billion for all F-35 variants compared to $11.1 billion spent on legacy aircraft in 2010. DOD officials have declared that operating and support costs of this magnitude are unaffordable and the department is actively engaged in evaluating opportunities to reduce those costs, such as basing and infrastructure reductions, competitive sourcing, and reliability improvements.

Because of F-35 delays and uncertainties, the military services have made investments to extend the service lives of legacy F-16 and F-18 aircraft at a cost of $5 billion (in 2013 dollars). The Navy is also buying new F/A-18E/F Super Hornets at a cost of $3.1 billion (in then-year dollars) to bridge the gap in F-35 deliveries and mitigate projected shortfalls in fighter aircraft force requirements. As a result, the services will incur additional future sustainment costs to support these new and extended-life aircraft, and will have a difficult time establishing and implementing retirement schedules for existing fleets.

Software Development Challenges Remain

Over time, F-35 software requirements have grown in size and complexity and the contractor has taken more time and effort than expected to write computer code, integrate it on aircraft and subsystems, conduct lab and flight tests to verify it works, and to correct defects found in testing. Although recent management actions to refocus software development activities and implement improvement initiatives appear to be yielding benefits, software continues to be a very challenging and high-risk undertaking, especially for mission systems.[7] While most of the aircraft's software code has been developed, a substantial amount of integration and test work remain before the program can demonstrate full warfighting capability. About 12 percent of mission systems capabilities have now been validated, up from 4 percent about a year ago. However, progress

[7]Mission systems are critical enablers of F-35's combat effectiveness, employing 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).

on mission systems was limited in 2012 by contractor delays in software delivery, limited capability in the software when delivered, and the need to fix problems and retest multiple software versions. Further development and integration of the most complex elements—sensor fusion and helmet mounted display—lie ahead.

F-35 software capabilities are being developed, tested and delivered in three major blocks and two increments—initial and final—within each block. The testing and delivery status of the three blocks is described below:

- Block 1.0, providing initial training capability, was largely completed in 2012, although some final development and testing will continue. Also, the capability delivered did not fully meet expected requirements relating to the helmet, ALIS, and instrument landing capabilities.
- Block 2.0, providing initial warfighting capabilities and limited weapons, fell behind due to integration challenges and the reallocation of resources to fix block 1.0 defects. The initial increment, block 2A, delivered late and was incomplete. Full release of the final increment, block 2B, has been delayed until November 2013 and will not be complete until late 2015.
- Block 3.0 providing full warfighting capability, to include sensor fusion and additional weapons, is the capability required by the Navy and Air Force for declaring their respective initial operational capability dates. Thus far, the program has made little progress on block 3.0 software. The program intends initial block 3.0 to enter flight test in 2013. This is rated as one of the program's highest risks because of its complexity.

Design Changes and Rework Continue to Add Cost and Risk

Although F-35 manufacturing, cost, and schedule metrics have shown improvement, the aircraft contractor continues to make major design and tooling changes and alter manufacturing processes while development testing continues. Engineering design changes from discoveries in manufacturing and testing are declining in number, but are still substantial and higher than expected from a program this far along in production. Further, the critical work to test and verify aircraft design and operational performance is far from complete. Cumulatively, since the start of developmental flight testing, the program has accomplished 34 percent of its planned flights and test points. For development testing as a whole, the program verified 11.3 percent of the development contract specifications through November 2012. As indicated in table 1, DOD continues to incur financial risk from its plan to procure 289 aircraft for $57.8 billion before completing development flight testing.

Table 1: F-35 Procurement Investments and Flight Test Progress

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cumulative procurement (then-year dollars in billions)	$0.8	$3.5	$7.1	$14.3	$21.3	$27.6	$33.8	$40.1	$47.9	$57.8	$69.0
Cumulative aircraft procured	2	14	28	58	90	121	150	179	223	289	365
Percent total flight test points completed	-	<1%	<1%	2%	9%	22%	34%	54%	74%	91%	100%

Source: GAO analysis of DOD data.

Notes: Years listed denote fiscal years. Flight test data reflects the percentage of total flight test points completed in time to inform the next year's procurement decision. For example above, the F-35 program accomplished about 22 percent of total planned flight test points through the end of calendar year 2011 that could help inform the fiscal year 2012 procurement decision. The program intends to complete developmental flight test points in 2016 and would be in a position to fully support the 2017 procurement buy.

This highly concurrent approach to procurement and testing increases the risk that the government will incur substantial costs to retrofit (rework) already produced aircraft to fix deficiencies discovered in testing. In fact, the F-35 program office projects rework costs of about $900 million to fix the aircraft procured on the first four annual procurement contracts. Substantial rework costs are also forecasted to continue through the 10th annual contract (fiscal year 2016 procurement), but at decreasing amounts annually and on each aircraft. The program office projects about $827 million more to rework aircraft procured under the next 6 annual contracts.

Concluding Remarks

Restructuring actions place the F-35 program on firmer footing, although aircraft are expected to cost more and deliveries to warfighters will take longer. Going forward, ensuring affordability is of paramount concern as more austere budgets are looming. The program continues to incur financial risk from its plan to procure 289 aircraft for $57.8 billion before completing development flight testing. Meanwhile, the services are making significant investments to extend the life of existing aircraft and to buy new ones to mitigate shortfalls due to F-35 delays. Overall, the F-35 Joint Strike Fighter program is now moving in the right direction after a long, expensive, and arduous learning process. It still has tremendous challenges ahead. The program must fully validate design and operational performance against warfighter requirements, while, at the same time, making the system affordable so that the United States and partners can acquire new capabilities in the quantity needed and can then sustain the force over its life cycle. DOD and the contractor now need to demonstrate that the F-35 program can effectively perform against cost

and schedule targets in the new baseline and deliver on promises. Until then, it will continue to be difficult for the United States and international partners to confidently plan, prioritize, and budget for the future; retire aging aircraft; and establish basing plans with a support infrastructure.

Chairman Turner, Ranking Member Sanchez, and members of the House Armed Services Committee, this completes my prepared statement. I would be pleased to respond to any questions you may have.

GAO Contact and Acknowledgments

For further information on this statement, please contact Michael Sullivan at (202) 512-4841 or sullivanm@gao.gov. Contact points for our Office of Congressional Relations and Public Affairs may be found on the last page of this statement. Individuals making key contributions to this statement are Bruce Fairbairn, Travis Masters, Marvin Bonner, W. Kendal Roberts, Megan Porter, and Erin Stockdale.

Appendix I: Changes in Reported F-35 Program Quantity, Cost, and Deliveries, 2001-2012

	October 2001 (system development start)	December 2003 (approved baseline)	March 2007 (approved baseline)	June 2010 (Nunn-McCurdy)	March 2012 (approved baseline)
Expected quantities					
Development quantities	14	14	15	14	14
Procurement quantities (U.S. only)	2,852	2,443	2,443	2,443	2,443
Total quantities	2,866	2,457	2,458	2,457	2,457
Cost estimates (then-year dollars in billions)					
Development	$34.4	$44.8	$44.8	$51.8	$55.2
Procurement	196.6	199.8	231.7	325.1	335.7
Military construction	2.0	0.2	2.0	5.6	4.8
Total program acquisition	$233.0	$244.8	$278.5	$382.5	$395.7
Unit cost estimates (then-year dollars in millions)					
Program acquisition	$81	$100	$113	$156	$161
Average procurement	69	82	95	133	137
Estimated delivery and production dates					
First production aircraft delivery	2008	2009	2010	2010	2011
Initial operational capability	2010-2012	2012-2013	2012-2015	TBD	TBD
Full-rate production	2012	2013	2013	2016	2019

Source: GAO analysis of DOD data.

Note: TBD means to be determined.

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Related GAO Products

Defense Acquisitions: Assessments of Selected Weapon Programs. GAO-13-294SP. Washington, D.C.: March 28, 2013.

F-35 Joint Strike Fighter: Current Outlook Is Improved, but Long-Term Affordability Is a Major Concern. GAO-13-309. Washington, D.C.: March 11, 2013.

Joint Strike Fighter: DOD Actions Needed to Further Enhance Restructuring and Address Affordability Risks. GAO-12-437. Washington, D.C.: June 14, 2012.

Joint Strike Fighter: Restructuring Added Resources and Reduced Risk, but Concurrency Is Still a Major Concern. GAO-12-525T. Washington, D.C.: March 20, 2012.

Joint Strike Fighter: Implications of Program Restructuring and Other Recent Developments on Key Aspects of DOD's Prior Alternate Engine Analyses. GAO-11-903R. Washington, D.C.: September 14, 2011.

Joint Strike Fighter: Restructuring Places Program on Firmer Footing, but Progress Still Lags. GAO-11-325. Washington, D.C.: April 7, 2011.

Joint Strike Fighter: Additional Costs and Delays Risk Not Meeting Warfighter Requirements on Time. GAO-10-382. Washington, D.C.: March 19, 2010.

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Joint Strike Fighter: DOD Plans to Enter Production before Testing Demonstrates Acceptable Performance. GAO-06-356. Washington, D.C.: March 15, 2006.

Tactical Aircraft: Opportunity to Reduce Risks in the Joint Strike Fighter Program with Different Acquisition Strategy. GAO-05-271. Washington, D.C.: March 15, 2005.