United States Government Accountability Office
Report to Congressional Committees

April 2015

F-35 JOINT STRIKE FIGHTER

Assessment Needed to Address Affordability Challenges

Accessible Version

GAO-15-364

GAO Highlights

Highlights of GAO-15-364, a report to congressional committees

Why GAO Did This Study

With estimated acquisition costs of nearly $400 billion, the F-35 Lightning II—also known as the Joint Strike Fighter—is DOD's most costly and ambitious acquisition program. The U.S. portion of the program will require annual acquisition funding of $12.4 billion on average through 2038 to complete development and procure a total of 2,457 aircraft. GAO's prior work has found that the program has experienced significant cost, schedule, and performance problems.

In 2009, Congress mandated that GAO review the F-35 acquisition program annually for 6 years. This report, GAO's sixth, assesses the program's (1) development and testing progress, (2) cost and affordability, and (3) manufacturing and supply chain performance.

GAO reviewed and analyzed the latest available manufacturing, cost, testing, and performance data through December 2014; program test plans; and internal DOD analyses; and interviewed DOD, program, engine and aircraft contractor officials.

What GAO Recommends

GAO recommends that DOD assess the affordability of F-35's current procurement plan that reflects various assumptions about technical progress and future funding.

View GAO-15-364. For more information, contact Michael J. Sullivan at (202) 512-4841 or sullivanm@gao.gov.

April 2015

F-35 JOINT STRIKE FIGHTER

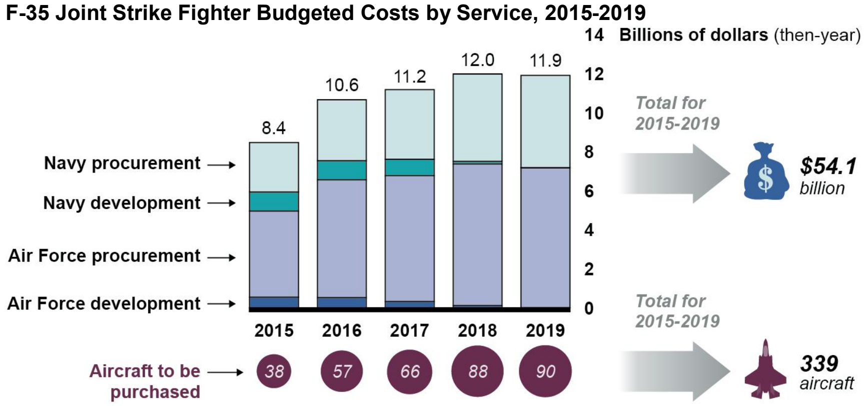
Assessment Needed to Address Affordability Challenges

What GAO Found

The F-35 Joint Strike Fighter program had to make unexpected changes to its development and test plans over the last year, largely in response to a structural failure on a durability test aircraft, an engine failure, and software challenges. At the same time, engine reliability is poor and has a long way to go to meet program goals. With nearly 2 years and 40 percent of developmental testing to go, more technical problems are likely. Addressing new problems and improving engine reliability may require additional design changes and retrofits. Meanwhile, the Department of Defense (DOD) has plans to increase annual aircraft procurement from 38 to 90 over the next 5 years. As GAO has previously reported, increasing production while concurrently developing and testing creates risk and could result in additional cost growth and schedule delays in the future.

Cost and affordability challenges remain. DOD plans to significantly increase annual F-35 funding from around $8 billion to nearly $12 billion over the next 5 years (see figure) reaching $14 billion in 2022 and remaining between $14 and $15 billion for nearly a decade. Over the last year, DOD reduced near-term aircraft procurement by 4 aircraft, largely due to budget constraints. While these deferrals may lower annual near-term funding needs, they will likely increase the cost of aircraft procured in that time frame and may increase funding liability in the future. It is unlikely the program will be able to sustain such a high level of annual funding and if required funding levels are not reached, the program's procurement plan may not be affordable. DOD policy requires affordability analyses to inform long-term investment decisions. The consistent changes in F-35 procurement plans indicate that DOD's prior analyses did not adequately account for future technical and funding uncertainty.

F-35 Joint Strike Fighter Budgeted Costs by Service, 2015-2019



Source: GAO analysis of Department of Defense data. | GAO-15-364

Manufacturing progress continued despite mixed supplier performance. The aircraft contractor delivered 36 aircraft as planned in 2014, despite a fleet grounding, added inspections, and software delays. In contrast, the labor hours needed to manufacture an aircraft and the number of major design changes have continued to decline over time. Because supplier performance has been mixed, late aircraft and engine part deliveries could pose a risk to the program's plans to increase production. The contractors are taking steps to address these issues.

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Congressional Committees

With estimated acquisition costs of nearly $400 billion, the F-35 Lightning II—also known as the Joint Strike Fighter—is the Department of Defense's (DOD) most costly and ambitious acquisition program. Through this program, DOD is developing and fielding a family of next generation strike fighter aircraft, integrating low observable (stealth) technologies with advanced sensors and computer networking capabilities for the United States Air Force, Navy, and Marine Corps, as well as eight international partners.[1] The F-35 family is comprised of the F-35A conventional takeoff and landing variant, the F-35B short takeoff and vertical landing variant, and the F-35C carrier-suitable variant. According to current projections, the U.S. portion of the program will require acquisition funding of $12.4 billion a year, on average, through 2038 to complete development and procure a total of 2,457 aircraft. In addition, DOD and program office estimates indicate that the F-35 fleet could cost around $1 trillion to operate and support over its lifetime, which will pose significant affordability challenges.

We have reported on F-35 issues for many years. Over time, we have reported significant cost, schedule, and performance problems and have found those problems, in part, can be traced to (1) decisions made at key junctures without adequate product knowledge and (2) a highly concurrent acquisition strategy with significant overlap among development, testing, and manufacturing activities. We have made numerous recommendations for improvement in our previous reports. DOD has taken action to address many of our recommendations to varying degrees.[2]

[1]The international partners are the United Kingdom, Italy, the Netherlands, Turkey, Canada, Australia, Denmark, and Norway. These nations contributed funds for system development and signed agreements to procure aircraft. In addition, Israel, Japan, and South Korea have signed on as foreign military sales customers.

[2]See app. I for a matrix of prior GAO reports, recommendations, and DOD actions.

The National Defense Authorization Act for Fiscal Year 2010 requires GAO to review the F-35 acquisition program annually for 6 years.[3] This is the sixth and final report under that mandate, and in this report we assess program (1) development and testing progress, (2) cost and affordability and (3) manufacturing and supply chain performance.

To conduct our work, we reviewed and analyzed program briefings, management reports, test data and results, and internal DOD program analyses. We collected data on and discussed key aspects of F-35 development and test progress with program management and contractor officials as well as DOD test officials and program test pilots. We collected and analyzed program acquisition cost estimates and reviewed total program funding requirements to project annual funding requirements through 2038. To assess the reliability of the cost data, we reviewed the supporting documentation and discussed the development of those estimates with DOD officials instrumental in producing them. We collected and analyzed production and supply chain performance data from DOD, Lockheed Martin, and Pratt & Whitney. We assessed the reliability of the data by reviewing supporting documentation and interviewing knowledgeable agency officials. We determined that all of the data we used were sufficiently reliable for the purposes of this report. We also discussed ongoing manufacturing process improvements with contracting and Defense Contract Management Agency officials. Appendix II contains a more detailed description of our scope and methodology.

We conducted this performance audit from July 2014 to April 2015 in accordance with generally accepted government auditing standards. Those standards required 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.

Background

DOD began the F-35 acquisition program in October 2001 without adequate knowledge about the aircraft's critical technologies or design. In addition, DOD's acquisition strategy called for high levels of concurrency

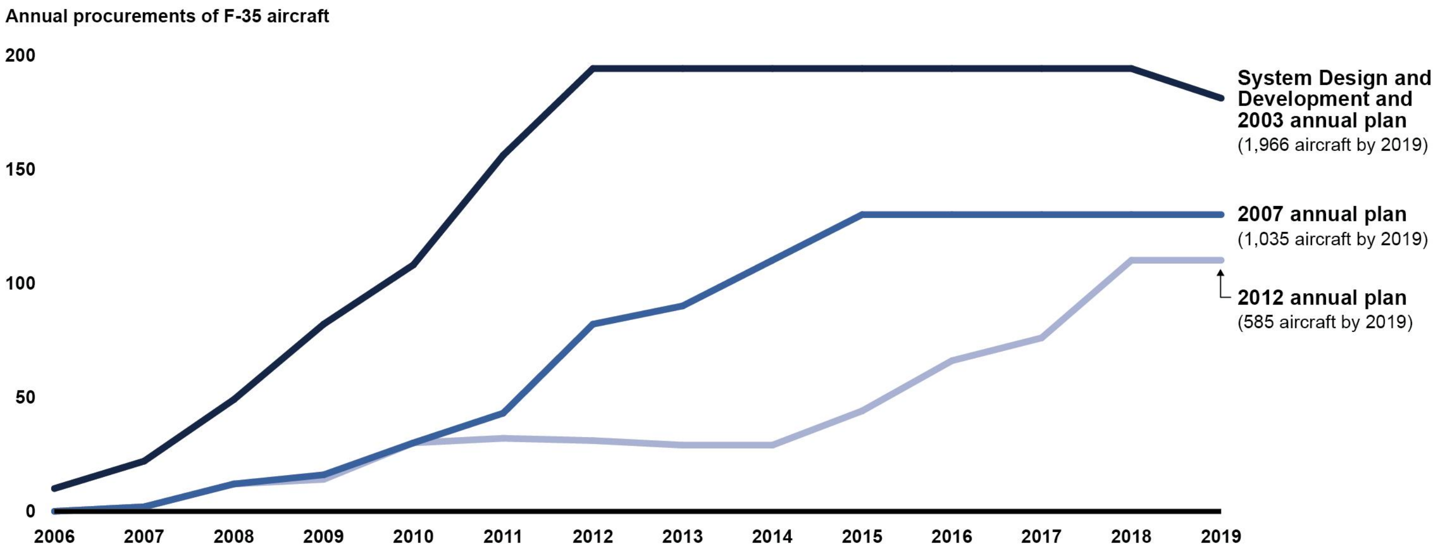
[3]Pub. L. No. 111-84, § 244 (2009).

between development, testing, and production.[4] In our prior work, we have identified the lack of knowledge and high levels of concurrency as major drivers in the significant cost and schedule growth as well as performance shortfalls that the program has experienced since 2001. The program has been restructured three times since it began: first in December 2003, again in March 2007, and most recently in March 2012. The most recent restructuring was initiated in early 2010 when the program's unit cost estimates exceeded critical thresholds established by statute—a condition known as a Nunn-McCurdy breach.[5] DOD subsequently certified to Congress in June 2010 that the program was essential to national security and needed to continue. DOD then began efforts to significantly restructure the program and establish a new acquisition program baseline. These restructuring efforts continued through 2011 and into 2012, during which time the department increased the program's cost estimates, extended its testing and delivery schedules, and reduced near-term aircraft procurement quantities by deferring the procurement of 450 aircraft into the future—total procurement quantities did not change. Figure 1 shows how planned quantities in the near-term have steadily declined over time.

[4]Concurrency is broadly defined as the overlap between technology development and product development or between product development and production.

[5]Section 2433 of title 10 of the United States Code, commonly referred to as Nunn-McCurdy, requires DOD to notify Congress whenever a major defense acquisition program's unit cost experiences cost growth that exceeds certain thresholds. This is commonly referred to as a Nunn-McCurdy breach. Significant breaches occur when the program acquisition unit cost or procurement unit cost increases by at least 15 percent over the current baseline estimate or at least 30 percent over the original estimate. For critical breaches, when these unit costs increase at least 25 percent over the current baseline estimate or at least 50 percent over the original, DOD is required to take additional steps, including conducting an in-depth review of the program. Programs with critical breaches must be terminated unless the Secretary of Defense certifies to certain facts related to the program and takes other actions, including restructuring the program. 10 U.S.C. § 2433a.

Figure 1: Changes in F-35 Joint Strike Fighter Near-Term Procurements



Source: GAO analysis of Department of Defense data. | GAO-15-364

The new F-35 acquisition program baseline was finalized in March 2012, and since that time costs have remained relatively stable. Table 1 shows the significant cost, quantity, and schedule changes from the initial program baseline and the relative stability since the new baseline was established.

Table 1: Changes in Reported F-35 Joint Strike Fighter Program Cost, Quantity, and Deliveries, 2001-2014

	October 2001 Initial Baseline	March 2012 Latest Baseline	December 2014 Estimates	Change from 2001 to 2012	Change from 2012 to 2014
Expected quantities (number of aircraft)					
Developmental quantities	14	14	14	0%	0%
Procurement quantities	2,852	2,443	2,443	-14	0
Total quantities	2,866	2,457	2,457	-14	0
Cost estimates (then-year dollars in billions)[a]					
Development	$34.4	$55.2	$54.9	60%	-0.5%
Procurement	196.6	335.7	331.6	71	-1.2
Military construction	2.0	4.8	4.6	140	-4.2
Total program acquisition	233.0	395.7	391.1	70	-1.2
Unit cost estimates (then-year dollars in millions)[a]					
Program acquisition	$81	$161	$159	99%	-1.2%
Average procurement	69	137	136	99	-0.7
Estimated delivery and production dates					
Initial operational capability	2010-2012	Undetermined	2015-2018	Undetermined	5-6 years
Full-rate production	2012	2019	2019	7 years	0 years

Source: GAO analysis of DOD data | GAO-15-364

aAnnual projected cost estimates expressed in then-year dollars reflect inflation assumptions made by a program

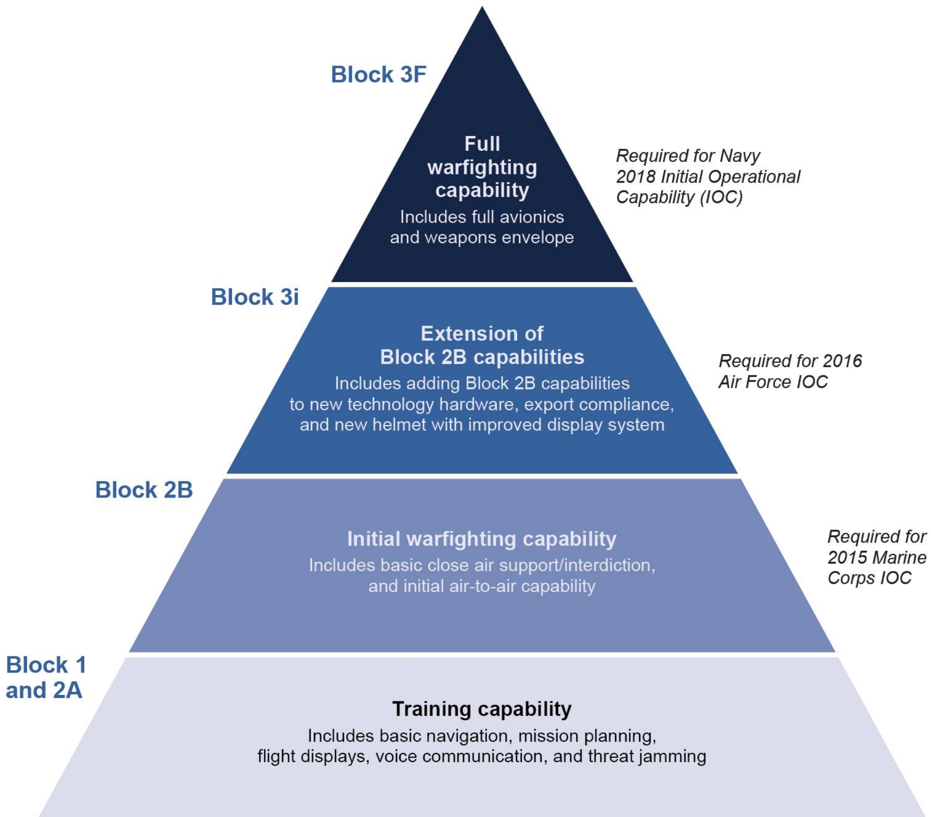
In March 2012, when the new acquisition program baseline was finalized, DOD had not yet identified new initial operating capability dates for the military services.[6] The following year, DOD issued a memorandum stating that the Marine Corps and Air Force were planning to field initial operating capabilities in 2015 and 2016 respectively, and that the Navy planned to field its initial operating capability in 2018, which represented a delay of 5 to 6 years since the program's initial baseline.

DOD is currently conducting developmental flight testing to verify that the F-35 system's design works as intended and can reliably provide the capabilities needed for the services to field their respective initial

[6]Initial operating capability is generally obtained when organizations or units have received a specified number of systems and have the ability to employ and maintain those systems.

operational capabilities. The program’s flight testing is separated into two key areas referred to as mission systems and flight sciences. Mission systems testing is done to verify that the software and systems that provide warfighting capabilities function properly and meet requirements, while flight science testing is done to verify the aircraft’s basic flying capabilities. For the F-35 program, DOD is developing and fielding mission systems capabilities in software blocks: (1) Block 1, (2) Block 2A, (3) Block 2B, (4) Block 3i, and (5) Block 3F. Each subsequent block builds on the capabilities of the preceding blocks. Blocks 1 and 2A are essentially complete. The program is now focused on completing Block 2B testing to support Marine Corps initial operating capability, but some testing of specific Block 3i and Block 3F capabilities is also being conducted. Blocks 2B and 3i will provide initial warfighting capabilities while Block 3F is expected to provide the full suite of warfighting capabilities. Figure 2 identifies the sequence of software blocks and capabilities expected to be delivered in each.

Figure 2: Subsequent Development of F-35 Joint Strike Fighter Software Blocks



Source: GAO analysis of Department of Defense data. | GAO-15-364

As developmental flight testing continues, DOD is concurrently purchasing and fielding aircraft. The F-35 airframe and engine are managed as one program, but they are manufactured in separate facilities by different contractors. The airframe is being manufactured by Lockheed Martin, the prime contractor, in Fort Worth, Texas, while the engine—which is designated the F135—is manufactured by Pratt & Whitney in Middletown, Connecticut. The engines are purchased by the government directly from Pratt & Whitney and delivered as government furnished equipment to Lockheed Martin for integration into the airframes during production. As a result, engine development and testing activities are managed by Pratt & Whitney and not Lockheed Martin.

Recent Technical Challenges Will Likely Result in Cost Growth and Schedule Delays

The F-35 program continued to experience development and testing discoveries over the past year, largely due to a structural failure on the F-35B durability test aircraft, an engine failure, and more mission system test growth than expected. Together, these factors led to adjustments in the program's test schedule. Test resources and some aircraft capabilities were reprioritized, and test points were deferred or eliminated. While these actions mitigated some of the schedule risk, ultimately the completion of key developmental test activities had to be delayed. Decisions were also made to restructure an early operational test event that likely would have reduced operational risk for the Marine Corps. The event will now be conducted over time and will not be completed as originally scheduled. Instability in the development program is likely to continue with more complex and demanding development testing still to go. As the program continues to discover problems in development and testing, it also faces a significant challenge to improve the reliability of the engine. Program data show that the reliability of the engine is very poor (less than half of where it should be) and has limited the program's progress toward its overall reliability targets. The engine contractor, Pratt & Whitney, has identified a number of design changes that it believes will help improve engine reliability, but some of those changes have not yet been implemented. With complex and challenging developmental testing remaining and engine reliability challenges ahead, DOD still plans to increase procurement rates by nearly threefold over the next 5 years. This same highly concurrent strategy has already proven to have negatively impacted the program. According to program reports, $1.7 billion could be incurred in costs associated with retrofits to already delivered aircraft. This cost will likely increase, as more aircraft are purchased and delivered before development ends.

Test Failures and Software Challenges Forced Program Changes

A significant structural failure on the F-35B durability test aircraft, an engine failure, and a higher than expected amount of test point growth largely to address software rework, over the past year, delayed key test activities and forced unexpected adjustments to the program's development schedule and test plans. Each of these three factors is discussed in more detail below.

- At around 9,000 hours of durability testing—about half of the 16,000 hours required—a major airframe segment, known as a bulkhead, on the F-35B durability test aircraft severed, and one other bulkhead was fractured as a result.[7] Durability testing on the F-35B was halted for more than a year as program officials conducted a root cause analysis and Lockheed Martin worked to repair the durability test aircraft. The root cause analysis determined that the bulkhead severed because its design did not take into account appropriate factors in the manufacturing processes, resulting in a bulkhead that had less durability life than expected. According to officials, the fracture in the other bulkhead was caused by the added weight it had to bear after the first bulkhead severed. Lockheed Martin is currently redesigning the bulkheads to strengthen the aluminum and plans to incorporate the updated designs into the ninth low-rate initial production lot. A total of 50 aircraft will have to be modified using additional structural reinforcement techniques. According to program and contractor officials, because the incident occurred halfway through durability testing, retrofits will not be required until the aircraft reach about half of their expected service life, or about 10 years. According to officials, the total costs of related modifications are yet to be determined at this time.

- In June 2014, an F-35A engine caught fire during take-off. As a result, the entire F-35 fleet was grounded for nearly one month and then placed under flight restrictions for several additional months. A root cause analysis conducted by Pratt & Whitney determined that excessive heat caused by rubbing between engine fan components ultimately led to parts of the engine breaking free at a high rate of speed, resulting in a fire. The program could not execute any planned flight test points while the fleet was grounded. After flying resumed there were still hundreds of planned test points that could not be executed because the fleet was restricted from flying at the speeds and conducting the maneuvers necessary to execute those points. Despite these obstacles, the program was able to keep its test aircraft productive and accomplished some test points that had been planned to be done in the future. Follow-up inspections conducted by the contractor identified 22 engines with evidence of overheating. Officials have identified a short-term fix that they believe will allow the fleet to return to normal flight test operations. As of January 31, 2015, 18 of 22 engines had received the short-term fix and were cleared to return

[7] The F-35B is the only aircraft affected as its bulkhead is made of aluminum material. The other F-35 variants have titanium bulkheads that are not as vulnerable to these cracks.

to normal flight operations. Pratt & Whitney has identified several potential long-term fixes but no final determination has been made.

- While the program's test plan for 2014 reflected an allowance of 45 percent growth in mission system software test points for the year—largely to address software rework that might be needed—officials from the Office of the Secretary of Defense noted that the program experienced around 90 percent growth, or nearly twice the planned amount. As of January 2015, 56 percent of the Block 2B functionality had been verified by program officials, which was about 10 percent short of its goal. According to DOD and contractor officials, the higher than anticipated amount of rework was largely due to the fact that portions of the Block 2B software did not function as expected during flight testing. To address these deficiencies, changes were made to the software and this extended the Block 2B test schedule by approximately 3 months. As of January 2015, all of the updated software was in flight testing.

DOD continued to address other key technical risks that we have highlighted in the past including the Helmet Mounted Display, Arresting Hook System, and the Autonomic Logistics Information System (ALIS).[8] A new helmet design was developed and integrated that includes previously developed updates and addresses shortfalls in night vision capability. Test pilots we spoke with noted that while testing of the new helmet design has just begun, some improvements over the previous design are evident, but more testing is needed. A redesigned Arresting Hook System was also integrated on the aircraft. While sea trial testing of the redesigned system was slightly delayed, the testing took place in November 2014 and the system performed very well with a 100 percent arrestment rate. Lastly, program officials began testing a more capable version of ALIS in September 2014 and expect to begin testing a deployable version in February 2015. Although DOD plans to release the deployable version in time for Marine Corps initial operational capability, it faces tight timeframes. A portion of the system's capabilities, Prognostics Health Management downlink, has been deferred to follow-on development.

[8] GAO-14-322

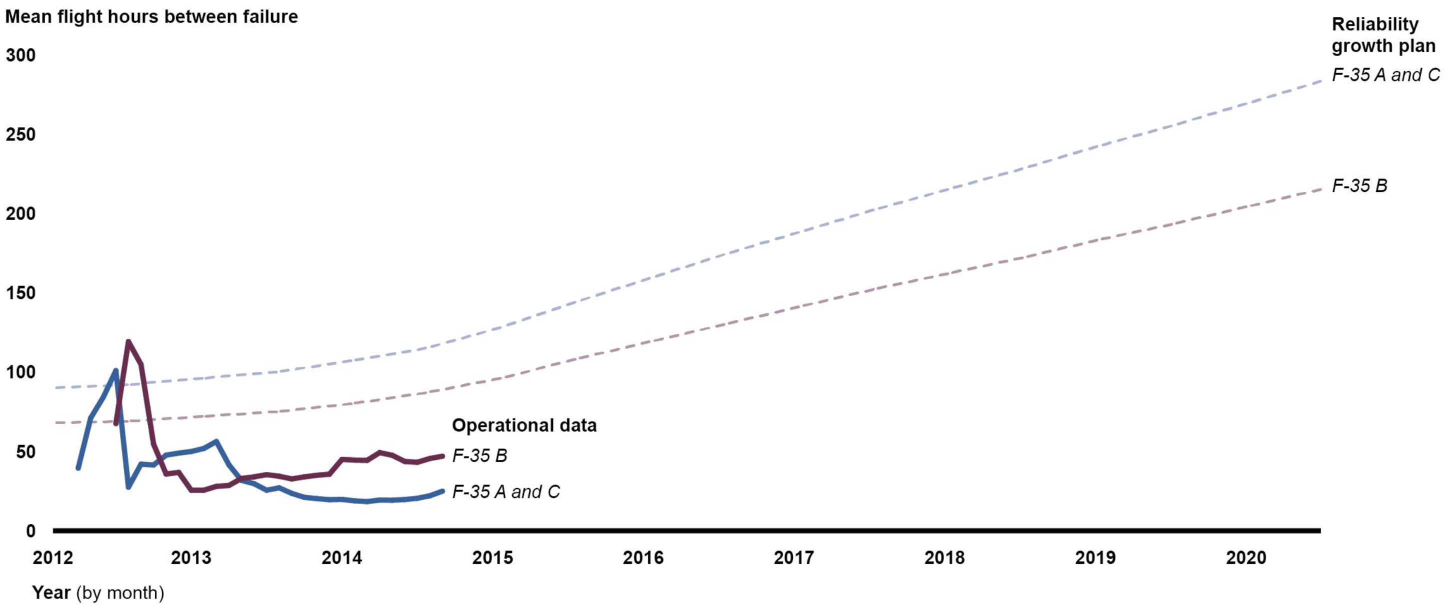
In response to the challenges faced in 2014, program officials reprioritized test resources and aircraft capabilities, deferred or eliminated test points, and ultimately delayed completion of some developmental test activities. Personnel and facilities that had been dedicated to developing and testing Block 3i and Block 3F—software blocks required by the Air Force and the Navy to field initial operational capabilities in 2016 and 2018 respectively—were reassigned to focus on delivering Block 2B to support the Marine Corps' initial operational capability in 2015. In addition, program officials eliminated over 1,500 test points from the overall Block 2B developmental test plan, and deferred some Block 2B capabilities. According to program officials, they chose to delay some test points that had been scheduled to be accomplished in 2014, and accomplish other test points that they had scheduled to be done in the future. In addition, program officials, in conjunction with officials from the Director, Operational Test and Evaluation, restructured a Block 2B early operational test event that had been planned for 2015. The restructured event will now be conducted over time as resources allow but will not be completed as originally scheduled. While these changes allowed the program to accomplish nearly the same number of test points it had planned for the year, officials stated that not all of the specific test activities scheduled were completed. In the end, the completion of Block 2B developmental testing is 3 months behind schedule, Block 3i testing is about 3 months behind schedule, and Block 3F could be as much as 6 months behind schedule.

Need to Improve Engine Reliability Presents Additional Challenges

The program has a long way to go to achieve its engine reliability goals. Reliability is a function of how well a system design performs over a specified period of time without failure, degradation, or need of repair. During system acquisition, reliability growth should occur over time through a process of testing, analyzing, and fixing deficiencies through design changes or manufacturing process improvements. Once fielded, there are limited opportunities to improve a system's reliability without additional cost increases and schedule delays. Currently, the F-35 engine's reliability is very poor and overall aircraft reliability growth has been limited. Improving engine reliability will likely require additional design changes and retrofits.

The program uses various measures to track and improve reliability, including the mean flying hours between failures (design controlled).[9] Data provided by Pratt & Whitney indicate that the mean flight hours between failure for the F-35A engine is about 21 percent of where the engine was expected to be at this point in the program. The F-35B engine is about 52 percent of where the engine was expected to be at this point. This means that the engine is failing at a much greater rate and requiring more maintenance than expected. Pratt & Whitney has identified a number of design changes that officials believe will improve the engine's reliability and is in the process of incorporating some of those changes into the engine design, production, and retrofitted to already built aircraft; however, other design changes that Pratt & Whitney officials believe are needed, such as changes to engine hoses and sensors, are not currently funded. Figure 3 shows the trend in the engine's mean flight hours between failures (design controlled).

Figure 3: Measured Mean Flight Hours between Failure-(design controlled) for the F-35 Joint Strike Fighter Engine Only



Source: GAO analysis of Department of Defense and contractor data. | GAO-15-364

[9]This specific metric tracks failures that are directly attributed to design and are considered fixable with design changes.

Poor engine reliability has limited the F-35's overall reliability progress. The overall reliability of the aircraft, which includes engine reliability data, has been improving over the past year. Contractor officials attribute the improvements in reliability to having an increasing number of aircraft in flight operations that have received design changes to address previously identified problems. For example, design changes in the way certain metal plates—known as nut plates—are bonded to the aircraft, and changes to fix problems with contamination of the On-board Oxygen Generating System have been incorporated into 62 aircraft that were delivered and began flying throughout 2013 and 2014. While overall reliability has increased, engine reliability over the last year has remained well below expected levels. Improving the F-35 engine reliability to achieve established goals will likely require more time and resources than originally planned.

In addition, in September 2014, we reported problems with the F-35 software reliability and maintainability. Specifically, we reported that the program continues to experience both hardware and software reliability issues, but DOD had no processes or metrics that provide sufficient insight into the impact of software reliability and maintainability contributing to the overall aircraft reliability. We recommended that DOD develop a software reliability and maintainability assessment process with metrics, and DOD concurred with this recommendation.[10]

Unexpected Technical Issues and Ongoing Reliability Challenges Amplify Concurrency Risk

While DOD has taken steps over the past few years to reduce concurrency, the program's strategy still contains a noteworthy overlap between the completion of flight testing and the increase in aircraft procurement rates. With about 2 years and 40 percent of the developmental test program remaining and significant engine reliability growth needed, DOD plans to continue increasing procurement rates. Over the next 5 years, procurement will increase from 38 aircraft per year to 90 aircraft per year, and by the time developmental testing is finished—currently expected to occur in 2017—DOD expects to have purchased a cumulative total of 340 aircraft. During this time, there are plans to conduct testing to prove that the F-35 can provide full warfighting capabilities—Block 3F—needed to perform in more demanding and

[10]GAO- F-35 *Sustainment: Need for Affordable Strategy, Greater Attention to Risks, and Improved Cost Estimates,* GAO-14-778 (Washington, D.C.: September 23, 2014).

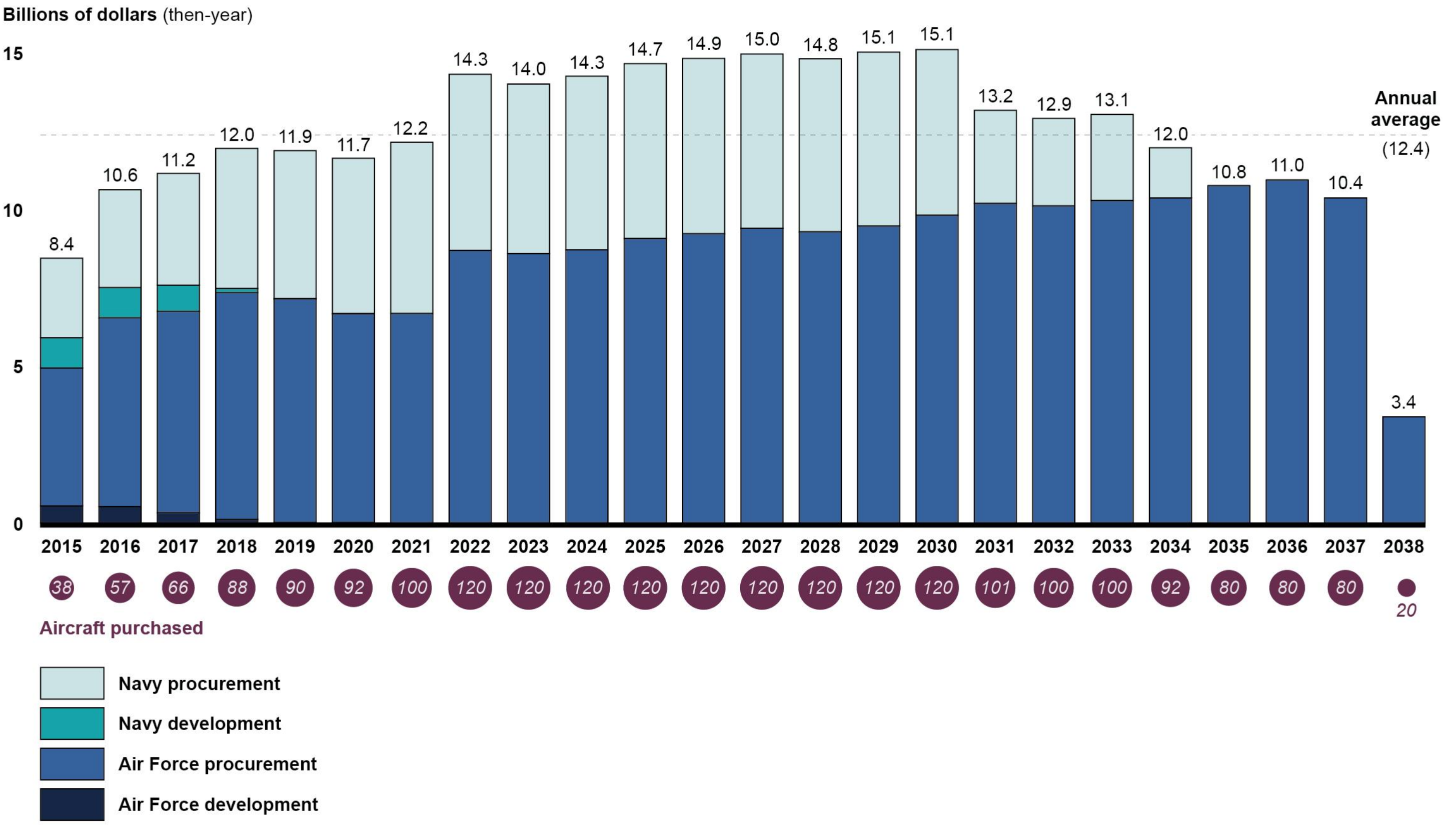
stressing environments. In addition, DOD plans to complete operational testing in early 2019 and at that time will have procured 518 aircraft or 21 percent of its total planned procurement quantities. At the same time, efforts will be ongoing to improve F-35 engine reliability.

As of June 2014, DOD estimated that at that point about $1.7 billion in funding was needed to rework and retrofit aircraft with design changes needed as a result of test discoveries. This concurrency cost estimate does not include any costs related to the most recent failures. According to DOD officials, the estimate takes into account some unexpected costs and they believe that the estimate will not exceed $1.7 billion. However, with more complex and demanding testing ahead and engine reliability improvements needed, it is almost certain that the program will encounter more discoveries. Depending on the nature and significance of the discoveries, the program may need additional time and money, beyond the current $1.7 billion estimate, to incorporate design changes and retrofit aircraft at the same time that it increases procurement.

Affordability Challenges Will Likely Continue to Affect Program Plans to Increase F-35 Procurement

As of December 2014, the program office estimated that the total acquisition cost of the F-35 will be $391.1 billion, or $7.4 billion less than DOD reported in December 2013. Our analysis indicates that the program will require an average of $12.4 billion per year, which represents around one-quarter of DOD's annual funding for major defense acquisition programs over the next 5 years. From fiscal years 2015 to 2019, DOD plans to increase annual development and procurement funding for the F-35 from around $8 billion to around $12 billion, an investment of more than $54 billion over that 5-year period, while competing with other large programs for limited acquisition resources. This funding reflects the U. S. military services' plans to significantly increase annual aircraft procurement buys from 38 in 2015 to 90 in 2019. International partners will also increase procurement buys during this time, and the combined purchases will peak at 179 aircraft in 2021, with the United States purchasing 100 aircraft and the international partners purchasing an additional 79 aircraft. DOD projects that the program's acquisition funding needs will increase to around $14 billion in 2022. Funding needs will remain between $14 and $15 billion for nearly a decade and peak at $15.1 billion in 2029 (see figure 4). Given resource limitations and the funding needs of other major acquisition programs such as the KC-46A tanker, the DDG-51 Class Destroyer, the Ohio Class submarine replacement, and a long-range strike bomber, in addition to the high estimated costs of sustaining the fleet over the next several years, we believe funding of this magnitude will pose significant affordability challenges.

Figure 4: Budgeted Development and Procurement Costs by Service, 2015-2038



Source: GAO analysis of Department of Defense data. | GAO-15-364

Note: Annual projected cost estimates expressed in then-year dollars reflect inflation assumptions made by a program.

Since the 2012 re-baselining, DOD has made changes to its F-35 procurement plans on an annual basis. In 2013, DOD reduced the number of aircraft that it planned to purchase between 2015 and 2019 by 37 aircraft and extended the procurement timeline by one year. In 2014, DOD deferred the purchase of 4 more aircraft over that same timeframe. DOD officials attribute this decision to affordability concerns due to budget constraints, among other factors. Although this action may reduce near-term funding requirements as well as concurrency risks, it will likely increase the average unit cost of the aircraft purchased over that time and may increase funding liability in the future. DOD policy requires affordability analyses to inform long-term investment decisions.[11] The consistent changes in F-35 procurement plans, made during the annual DOD budget process, indicate that the analysis done to support the program's 2012 baseline did not accurately account for future technical risks or funding realities. Changes in procurement plans are also impacted by adjustments to military service and DOD priorities.

Program office data indicates that after accounting for quantity changes, the program is unlikely to achieve the affordability unit cost targets set by the Under Secretary of Defense for Acquisition, Technology, and Logistics in 2012.[12] The aircraft deferrals will also reduce the number of F-35s fielded over the next several years, which could force the military services to invest in extending the life of their current aircraft fighter fleets, including the Air Force A-10 Thunderbolt II and the Navy F/A-18 Hornet. We believe maintaining the level of sustained funding required to build an F-35 fleet in addition to incurring costs to extend the life of current aircraft will be difficult in a period of austere defense budgets.

Officials from the Office of Secretary of Defense have stated that the current sustainment strategy is not affordable. Both the program office and the Cost Assessment and Program Evaluation (CAPE) office, within the Office of the Secretary of Defense, estimate sustainment costs will be about $1 trillion over the life of the F-35 fleet. Since 2012, CAPE's sustainment cost estimate has decreased by nearly $100 billion. CAPE attributes the bulk of this decrease to updated cost estimating ground rules and assumptions related to the cost of spare parts, labor rates, and fuel efficiency. The program office has also issued a separate sustainment cost estimate of approximately $859 billion, which is $57.8 billion less than it estimated last year. The CAPE and program estimates differ primarily in assumptions about reliability, depot maintenance, personnel, and fuel consumption. However, as we reported in September 2014, the current estimates are still higher than the current operation and support costs of the existing aircraft the F-35 is expected to replace, and

[11]Department of Defense Instruction 5000.02, *Operation of the Defense Acquisition System* Encl. 8, para. 2 (Jan. 7, 2015).

[12]These targets are based upon planning assumptions reflected in the FY 2013 President's Budget and the 2011 projection for international partner procurement. If there are subsequent changes to either the United States or international partner procurement quantities, the program will isolate the effect that this has on the targets as a factor that is not within its control.

according to officials from the Office of Secretary of Defense, remain unaffordable. In addition, we reported that DOD's sustainment cost estimates may not reflect the most likely costs that the F-35 program will incur.[13]

While the F-35 program office and contractors have initiatives underway to improve affordability, those initiatives have a specific focus on reducing procurement and sustainment costs but do not assess the affordability of the program's overall procurement plan within budget constraints. These initiatives include the "War on Cost," "Cost War Room," and "Blueprint for Affordability" that are intended to identify ways to reduce procurement and sustainment costs of the aircraft and engine. The initiatives are still ongoing and the total cost savings related to these initiatives is yet to be determined.

While Manufacturing Progress Remains Steady, Planned Production Increases Could Be a Challenge

As Lockheed Martin continues to deliver more aircraft, the number of hours needed to build each aircraft has declined and efficiency rates have improved despite increases in the time spent on scrap, rework, and repairs. Supplier performance has been mixed as late deliveries have resulted in increases to part shortages. Supplier quality defects have also increased while scrap, rework, and repair attributable to suppliers have remained steady. Pratt & Whitney is experiencing problems with quality and late deliveries from its suppliers.

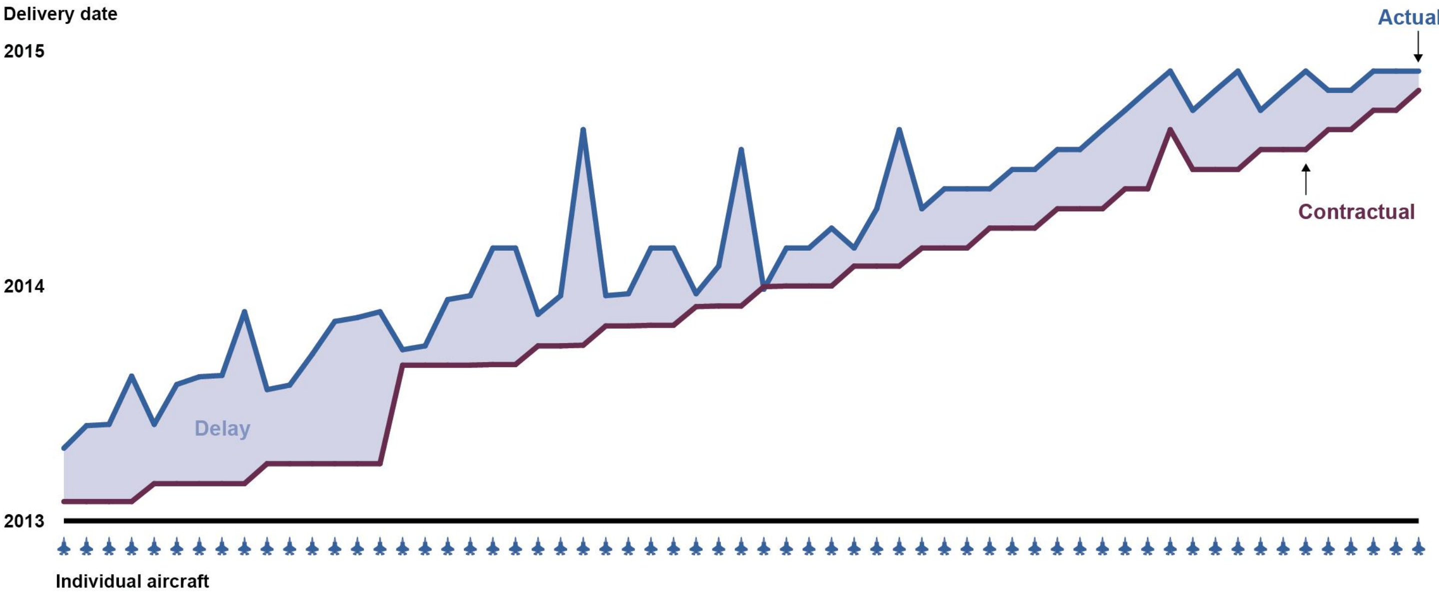
Manufacturing Efficiency Remains Steady

The number of aircraft produced in the Lockheed Martin's final assembly facility has remained relatively stable over the last 3 years. The contractor has delivered a total of 110 aircraft since 2011—9 in 2011, 30 in 2012, 35 in 2013, and 36 in 2014. None of the aircraft delivered currently possess initial warfighting capability and are being used primarily for training purposes. As a result, delivered aircraft will have to be retrofitted with 2B initial warfighting capabilities prior to becoming operational. Although aircraft continued to be delivered later than contracted delivery dates—averaging 3.6 months late in 2014—Lockheed Martin officials believe they are closing the gap and expect to begin delivering to contract dates in 2015. Figure 5 shows actual aircraft deliveries compared to contracted

[13]For a full discussion of GAO's previous analysis of the F-35 estimated sustainment costs and our recommendations, please see GAO- 14-778.

delivery dates over the last 2 years. In 2014, Lockheed Martin achieved its goal of delivering 36 aircraft despite multiple setbacks throughout the year, such as late software deliveries, a fleet grounding, and increased engine inspections.

Figure 5: Trend of F-35 Joint Strike Fighter Contractual Delivery Dates Compared to Actual Delivery Dates

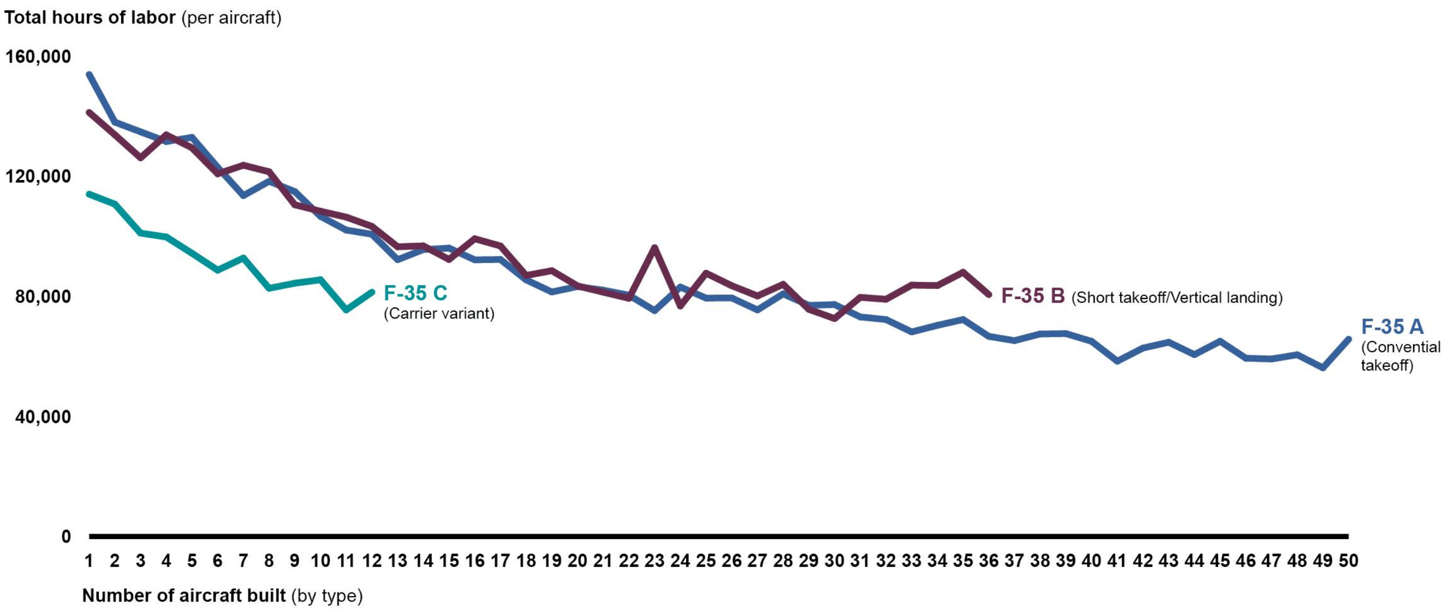


Source: GAO analysis based on Department of Defense and contractor data. | GAO-15-364

Note: This figure includes deliveries to the United States and all foreign partners.

As Lockheed Martin produces more aircraft and learns more about its manufacturing processes, it continues to reduce the number of labor hours needed to manufacture aircraft. The reduction in labor hours remained relatively steady over the last year; however, in the case of the F-35B, labor hours briefly trended upward. Officials stated that a gap in production of the F-35B variant between lots four and six and part shortages drove the increased labor hours. The number of labor hours to produce the last F-35B delivered in 2014 was lower than previous aircraft, and officials believe labor hours will continue to decrease as production quantities for the F-35B increase. Figure 6 identifies the trend in reduction of labor hours per aircraft since the beginning of low-rate initial production.

Figure 6: Trend in Labor Hours to Build the F-35 Joint Strike Fighter Aircraft by Variant



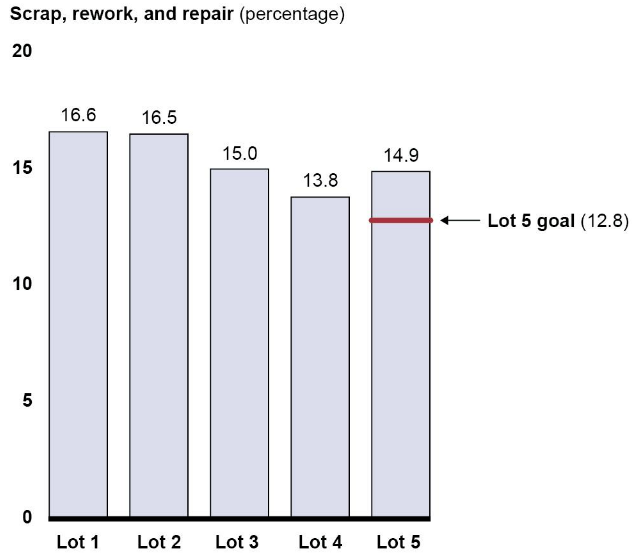
Source: GAO analysis of Department of Defense data. | GAO-15-364

Note: Labor hour data only represents aircraft built start to finish at Lockheed Martin's facility. Data includes aircraft delivered to foreign partners.

The number of major engineering design changes has also continued to decline over time, and is currently tracking to the program's plan. The reduction in labor hours and engineering design changes over time has allowed Lockheed Martin to increase manufacturing efficiency rates as measured by the hours it takes to complete certain production tasks compared to the number of hours established by engineering standards. The efficiency rate increased from about 16 to about 20 percent over the last year, nearly achieving Lockheed Martin's goal of about 22 percent.

Labor hours and efficiency rates improved despite increases in time spent on scrap, rework, and repair over the last year. The time spent on scrap, rework, and repair increased from 13.8 percent in production lot four to 14.9 percent in production lot five, falling short of Lockheed Martin's goal of 12.8 percent. At 14.9 percent, Lockheed Martin's scrap, rework, and repair rates are nearly equal to percentages experienced in the third production lot. According to Lockheed Martin officials, a majority of the scrap, rework, and repair hours are associated with fixing mislocated brackets and mismatched seams. Figure 7 shows the trend in percent of labor hours spent on scrap, rework, and repair along with the goal for the fifth production lot. If these trends continue, Lockheed Martin could have difficulty improving its manufacturing efficiency at its expected rates.

Figure 7: Trend in Percent of Labor Hours Spent on Scrap, Rework, and Repair for the F-35 Joint Strike Fighter



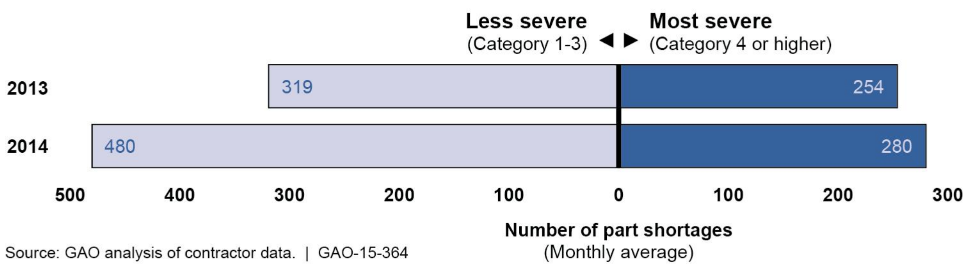
Source: GAO analysis based on contractor data. | GAO-15-364

Lockheed Martin reports that less than 40 percent of its critical manufacturing processes are considered in statistical control which means that for those processes it can consistently produce parts within quality tolerances and standards. Statistical control is a measure of manufacturing maturity. The best practice standard is to have 100 percent of the critical manufacturing processes in control by the start of low-rate initial production, which began in 2011 for the F-35 program. According to Lockheed Martin officials, only 54 percent of its F-35 critical manufacturing processes will provide enough data to measure statistical control. As a result, they do not expect to achieve 100 percent.

Late Deliveries from Suppliers Continue, and Could Challenge Planned Production Increases

Suppliers continue to deliver late parts to Lockheed Martin resulting in part shortages. Since 2013, the average number of part shortage occurrences at Lockheed Martin's facility has increased. The severity of part shortages is measured in five categories, category 1 being the least severe, and category 4 and above being the most severe with those shortages requiring a major workaround or work stoppage.[14] Figure 8 identifies changes in the average number of part shortage occurrences at Lockheed Martin's facility over the last year.

Figure 8: Average Number of F-35 Joint Strike Fighter Part Shortage Occurrences at Prime Contractor Facility



Source: GAO analysis of contractor data. | GAO-15-364

According to Lockheed Martin officials, suppliers are delivering late parts for several reasons. Those reasons include the need for suppliers to fix faulty parts and the inability of some suppliers to handle large amounts of throughput. In addition, Lockheed Martin officials stated that some delays are a result of late request for proposals, late responses to those proposals, and delayed contract negotiations with the government that result in late contract awards. Officials do not expect to begin making authorizations with appropriate lead time until the end of low-rate initial production in 2019. Part shortages will likely remain problematic and could be amplified as production rates increase over the next 5 years.

Supplier quality at Lockheed Martin has been mixed. Lockheed Martin uses a reactive approach to managing most of its supplier base because,

[14]The severity of part shortages is measured in categories by Lockheed Martin. Category 1: the part is late to on-dock requirement date. Category 2: the part is late to the material kit start date of the kit build. Category 3: the part is late to the date when production needs the kit on the manufacturing floor. Category 4: the part is late to the extent that it has become sequence critical, meaning other work may be limited while waiting for the part. A major workaround is required or production may not proceed to the next work station. Category 4 and above: the part is late to the extent that work on the production floor is stopped and there is no workaround.

according to officials, they do not have access to supplier specific manufacturing data. The company uses internal metrics to track supplier performance such as the number of quality defects—known as non-conformances—discovered at the Lockheed Martin facility and the amount of scrap, rework, and repair driven by poor supplier performance. Over the last year, the number of supplier related non-conformances has slightly increased and Lockheed Martin continues to experience supplier related non-conformances for things like hole-drilling and bracket placement, among others. Lockheed Martin officials identified 22 of their more than 1,500 suppliers that contributed to 75 percent of the non-conformances. In order to address these non-conformances, Lockheed Martin developed a management team aimed at improving quality management at those suppliers. Lockheed Martin reported a 58 percent improvement in non-conformances for those suppliers over the last year, which it attributes to the work of its team. For example, the key supplier of the aircraft weapons bay door experienced quality problems in 2013. Over the last year, Lockheed Martin sent more personnel to the supplier’s facility to work with the supplier’s management team to identify problems in their production processes and solutions to those problems. As a result, the supplier adjusted its tooling and modified its quality management techniques, and the number of defects and part shortages from that supplier decreased. In addition, the percent of time spent on scrap, rework, and repair for supplied parts has remained steady. Supplier deliveries requiring scrap, rework, and repair averaged 1.3 percent of the hours spent building an aircraft over the last 2 years.

Pratt & Whitney is also experiencing challenges with part shortages and supplier quality. Nearly 45 percent of Pratt & Whitney’s key suppliers have delivered late parts over the past year. In order to mitigate some of the risk, Pratt & Whitney has pulled or borrowed some parts meant for spare engines to use in place of the late parts. According to Pratt & Whitney officials, they have taken steps to reduce the number of parts that are borrowed; however, the number of borrowed parts remains high, which could lead to further part shortages and late engine deliveries if production rates increase over the next several years as planned. In addition, in 2014, poor supplier quality negatively impacted engine performance. For example, improper lubrication of an oil valve adapter by the valve supplier resulted in an in-flight emergency in June 2014. As a result, the oil valves on 136 F-35 aircraft—28 of which were in production and 108 of which were delivered—had to be removed and replaced. According to Pratt & Whitney officials, the associated retrofit costs were borne by the valve supplier. The supplier also made changes to its procedures to prevent future incidents.

Conclusions

The F-35 remains DOD's most costly and ambitious programs and one of its highest priority acquisition programs. The program began with an acquisition strategy that called for high levels of concurrency between developmental testing and aircraft procurement. Since then, however, the program has experienced significant technical problems that have resulted in schedule delays and additional unplanned, or latent, concurrency. With more than 100 production aircraft delivered as of December 2014, the program continues to encounter significant technical problems like the engine and bulkhead failures that require design changes. Programs in developmental testing are expected to encounter technical problems that require design changes. However, in a concurrent acquisition environment, the destabilizing effects of design changes are amplified as more systems are produced and delivered, thus requiring costly retrofits, and rework. With around 40 percent of developmental testing remaining, additional unanticipated changes are likely as much of that testing will be very challenging. At the same time, DOD plans to steeply increase its procurement funding requests over the next 5 years and projects that it will need between $14 and $15 billion annually for nearly a decade. It is unlikely that the program will be able to receive and sustain such a high and unprecedented level of funding over this extended period, especially with other significant fiscal demands weighing on the nation. This poses significant affordability challenges to DOD as other costly, high priority acquisition efforts, including the KC-46A Tanker and the DDG 51 Class Destroyer, compete for limited resources at the same time. DOD continues to adjust its F-35 procurement plans on an annual basis. This reactionary approach indicates that DOD may not be accurately accounting for the future technical and funding uncertainty it faces, and thus may not fully understand the affordability implications of increasing F-35 procurement funding at the planned rates.

Recommendations

As DOD plans to significantly increase F-35 procurement funding over the next 5 years, we recommend that the Secretary of Defense conduct an affordability analysis of the program's current procurement plan that reflects various assumptions about future technical progress and funding availability.

Agency Comments and Our Evaluation

We provided a draft of this report to DOD for comment. In its written comments, which are reprinted in appendix III, DOD concurred with our recommendation. DOD also provided technical comments which we incorporated as appropriate.

We are sending copies of this report to appropriate congressional committees; the Secretary of Defense; the Secretaries of the Air Force, Army, and Navy; the Commandant of the Marine Corps; and the Director of the Office of Management and Budget. The report is available at no charge on the GAO website at http://www.gao.gov.

If you or your staff have any questions about 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 Committees

The Honorable John McCain
Chairman
The Honorable Jack Reed
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Thad Cochran
Chairman
The Honorable Richard J. Durbin
Ranking Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable Mac Thornberry
Chairman
The Honorable Adam Smith
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Rodney Frelinghuysen
Chairman
The Honorable Pete Visclosky
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Appendix I: Prior GAO Reports on F-35 Joint Strike Fighter (JSF) and Department of Defense (DOD) Responses and Subsequent Actions

GAO report	Estimated Development Costs Development Length Aircraft unit cost	Key program event	Primary GAO Conclusion/Recommendation	DOD response and actions
2001 GAO-02-39	$34.4 Billion 10 years $69 Million	Start of system development and demonstration approved.	Critical technologies needed for key aircraft performance elements are not mature. Program should delay start of system development until critical technologies are mature to acceptable levels.	DOD did not delay start of system development and demonstration, stating technologies were at acceptable maturity levels and stated it would manage risks in development.
2005 GAO-05-271	$44.8 Billion 12 years $82 Million	The program underwent a re-plan to address higher than expected design weight, which added $7 billion and 18 months to development schedule.	We recommended that the DOD reduce risks and establish an executable business case that is knowledge-based with an evolutionary acquisition strategy.	DOD partially concurred but did not adjust strategy, believing that its approach was balanced between cost, schedule, and technical risk.
2006 GAO-06-356	$45.7 Billion 12 years $86 Million	Program set in motion a plan to enter production in 2007 shortly after first flight of the non-production representative aircraft.	The program was entering production with less than 1 percent of testing complete. We recommended that DOD delay investing in production until flight testing shows that JSF performs as expected.	DOD partially concurred but did not delay start of production because it believed the risk level was appropriate.
2007 GAO-07-360	$44.5 Billion 12 years $104 Million	Congress reduced funding for first two low-rate production buys thereby slowing the ramp up of production.	Progress was being made but concerns remained about undue overlap in testing and production. We recommended limits to annual production quantities to 24 a year until flying quantities were demonstrated.	DOD non-concurred and felt that the program had an acceptable level of concurrency and an appropriate acquisition strategy.
2008 GAO-08-388	$44.2 Billion 12 years $104 Million	DOD implemented a Mid-Course Risk Reduction Plan to replenish management reserves from about $400 million to about $1 billion by reducing test resources.	We found the new plan increased risks and recommended that DOD should revise the plan to address concerns about testing, management reserves, and manufacturing. We determined that the cost estimate was not reliable and that a new cost estimate and schedule risk assessment was needed.	DOD did not revise risk plan or restore testing resources, stating that it will monitor the new plan and adjust it if necessary. Consistent with one of our recommendations, a new cost estimate was prepared, but DOD did not conduct a risk and uncertainty analysis.
GAO report	Estimated Development Costs Development Length Aircraft unit cost	Key program event	Primary GAO Conclusion/Recommendation	DOD response and actions

GAO report	Estimated Development Costs Development Length Aircraft unit cost	Key program event	Primary GAO Conclusion/Recommendation	DOD response and actions
2009 GAO-09-303	$44.4 Billion 13 years $104 Million	The program increased the cost estimate and added a year to development but accelerated the production ramp up. Independent DOD cost estimate (JET I) projects even higher costs and further delays.	Moving forward with an accelerated procurement plan and use of cost reimbursement contracts is very risky. We recommended the program report on the risks and mitigation strategy for this approach.	DOD agreed to report its contracting strategy and plans to Congress and conduct a schedule risk analysis. The program reported completing the first schedule risk assessment with plans to update semi-annually. The Department announced a major program restructure, reducing procurement and moving to fixed-price contracts.
2010 GAO-10-382	$49.3 Billion 15 years $112 Million	The program was restructured to reflect findings of recent independent cost team (JET II) and independent manufacturing review team. As a result, development funds increased, test aircraft were added, the schedule was extended, and the early production rate decreased.	Costs and schedule delays inhibited the program's ability to meet needs on time. We recommended the program complete a full comprehensive cost estimate and assess warfighter and initial operating capability requirements. We suggested that Congress require DOD to tie annual procurement requests to demonstrated progress.	DOD continued restructuring, increasing test resources and lowering the production rate. Independent review teams evaluated aircraft and engine manufacturing processes. Cost increases later resulted in a Nunn-McCurdy breach. Military services are currently reviewing capability requirements as we recommended.
2011 GAO-11-325	$51.8 Billion 16 years $133 Million	Restructuring continued with additional development cost increases; schedule growth; further reduction in near-term procurement quantities; and decreased the rate for future production. The Secretary of Defense placed the Short-takeoff Vertical Landing (STOVL) variant on a two-year probation; decoupled STOVL from the other variants; and reduced STOVL production plans for fiscal years 2011 to 2013.	The restructuring actions were positive and if implemented properly should lead to more achievable and predictable outcomes. Concurrency of development, test, and production was substantial and provided risk to the program. We recommended the DOD maintain funding levels as budgeted; establish criteria for STOVL probation; and conduct an independent review of software development, integration, and test processes.	DOD concurred with all three of the recommendations. DOD lifted STOVL probation citing improved performance. Subsequently, DOD further reduced procurement quantities, decreasing funding requirements through 2016. The initial independent software assessment began and ongoing reviews were planned to continue through 2012.

GAO report	Estimated Development Costs Development Length Aircraft unit cost	Key program event	Primary GAO Conclusion/Recommendation	DOD response and actions
2012 GAO-12-437	$55.2 Billion 18 years $137 Million	The program established a new acquisition program baseline and approved the continuation of system development, increasing costs for development and procurements and extending the period of planned procurements by 2 years.	Extensive restructuring placed the program on a more achievable course. Most of the program's instability continued to be concurrency of development, test, and production. We recommended the Cost Assessment Program Evaluation office conduct an analysis on the impact of lower annual funding levels; and the program office conduct an assessment of the supply chain and transportation network.	DOD partially concurred with conducting an analysis on the impact of lower annual funding levels and concurred with assessing the supply chain and transportation network.
2013 GAO-13-309	$55.2 Billion 18 years $137 Million	The program continued to move forward following a new acquisition program baseline in 2012. In doing so, the program incorporated positive and more realistic restructuring actions taken since 2010 including more time and funding for development and deferred procurement of more than 400 aircraft to future years.	The program was moving in the right direction but must fully validate design and operational performance and at the same time make the system affordable. We did not make recommendations to DOD in this report.	DOD agreed with GAO's observations.
2014 GAO-14-322	$55.2 Billion 18 years $135 Million	The services established initial operational capabilities dates in 2013. The Marine Corps and Air Force are planning to field initial operational capabilities in 2015 and 2016, respectively, and the Navy plans to field its initial capability in 2018.	Delays in developmental flight testing of the F-35's critical software may hinder delivery of the warfighting capabilities the military services. We recommended DOD conduct an assessment of the specific capabilities that can be delivered and those that will not likely be delivered to each of the services by their established initial operational capability dates	DOD concurred with our recommendation and is in the process of conducting the assessment.

GAO report	Estimated Development Costs Development Length Aircraft unit cost	Key program event	Primary GAO Conclusion/Recommendation	DOD response and actions
2014 GAO-14-778	Not reported	The Department of Defense (DOD) currently has or is developing several plans and analyses that will make up its overall F-35 sustainment strategy, which is expected to be complete in fiscal year 2019.	The annual F-35 operating and support costs are estimated to be considerably higher than the combined annual costs of several legacy aircraft. DOD had not fully addressed several issues that have an effect on affordability and operational readiness. Operating and support cost estimates may not be reliable. We recommended that DOD develop better informed affordability constraints; address three risks that could affect sustainment, affordability, and operational readiness; and take steps to improve the reliability of its cost estimates.	DOD concurred with all but one recommendation and partially concurred with the recommendation to conduct uncertainty analysis on one of its cost estimates, stating it already conducts a form of uncertainty analysis. GAO continues to believe that the recommended analysis would provide a more comprehensive sense of the uncertainty in the estimates.

Source: GAO

Appendix II: Scope and Methodology

To assess the program's ongoing development and testing we reviewed the status of software development and integration and contractor management improvement initiatives. We also interviewed officials from the program office, Lockheed Martin, Pratt & Whitney, and the Defense Contract Management Agency (DCMA) to discuss current development status and software releases. In addition, we compared management objectives to progress made on these objectives during the year. We obtained and analyzed data on flights and test points, both planned and accomplished during 2014. We compared test progress against the total program plans to complete. In addition, we interviewed officials from the F-35 program office, Lockheed Martin, Pratt & Whitney, and Director, Operational Test and Evaluation office to discuss development test plans and achievements. We also collected information from the program office, prime contractor, engine contractor, and Department of Defense test pilots regarding the program's technical risks including the helmet mounted display, autonomic logistics information system, carrier arresting hook, structural durability, and engine. We analyzed reliability data and discussed these issues with program and contractor officials.

To assess the program's cost and affordability, we reviewed financial management reports and monthly status reports available as of December 2014. In addition, we reviewed total program funding requirements from the December 2014 Selected Acquisition Report. We used these data to project annual funding requirements through the expected end of the F-35 acquisition in 2038. We also compared the December 2014 Selected Acquisition Report data to prior Selected Acquisition Reports to identify changes in cost and quantity. We obtained life-cycle operating and support cost through the program's Selected Acquisition Report and projections made by the Cost Analysis and Program Evaluation (CAPE) office. We discussed future plans of the Department of Defense (DOD) and contractors to try and reduce life-cycle sustainment costs with officials from the program office, Lockheed Martin, and Pratt & Whitney.

To assess manufacturing and supply chain performance we obtained and analyzed data related to aircraft delivery rates and work performance data through the end of calendar year 2014. This data was compared to program objectives identified in these areas and used to identify trends. We reviewed data and briefings provided by the program office, Lockheed Martin, Pratt & Whitney, and DCMA in order to identify issues in manufacturing processes. We discussed reasons for delivery delays and plans for improvement with Lockheed Martin and Pratt & Whitney. We also toured Pratt and Whitney's manufacturing facility in Middletown, Connecticut and collected and analyzed data related to aircraft quality through December 2014. We collected and analyzed supply chain performance data and discussed plans taken to improve quality and deliveries with Lockheed Martin and Pratt & Whitney.

We assessed the reliability of DOD and contractor data by reviewing existing information about the data, and 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 July 2014 to April 2015 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 III: DOD Comments

ASSISTANT SECRETARY OF DEFENSE
3015 DEFENSE PENTAGON
WASHINGTON, DC 20301-3015

ACQUISITION

APR 2 2015

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

Dear Mr. Sullivan:

This is the Department of Defense (DoD) response to the Government Accountability Office (GAO) Draft Report, GAO-15-364, "F-35 JOINT STRIKE FIGHTER: Assessment Needed to Address Affordability Challenges," dated February 26, 2015 (GAO Code 121234). Detailed comments on the report are enclosed.

The DoD concurs with your recommendation and we appreciate the opportunity to comment on the draft report. My point of contact for this effort is Colonel Todd Levine, 703-697-2573, todd.j.levine.mil@mail.mil.

Sincerely,

Katharina McFarland

Enclosure:
As stated

GAO DRAFT REPORT DATED FEBRUARY 26, 2015
GAO-15-364 (GAO CODE 121234)

"F-35 JOINT STRIKE FIGHTER: ASSESSMENT NEEDED TO ADDRESS AFFORDABILITY CHALLENGES"

DEPARTMENT OF DEFENSE COMMENTS TO THE GAO RECOMMENDATION

RECOMMENDATION: As DoD plans to significantly increase F-35 procurement funding over the next five years, the GAO recommends that the Secretary of Defense conduct an affordability analysis of the program's current procurement plan that reflects various assumptions about future technical progress and funding availability.

DoD RESPONSE: Concur. The Department agrees that there is value in conducting an affordability analysis of the program's current procurement plan that reflects assumptions about future technical progress and funding availability. The Department accomplishes this annually as part of the internal, deliberative and cross-service process that culminates in the Department's submittal of its annual budget request.

Appendix IV: GAO Contact and Staff Acknowledgments

GAO Contact

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

Acknowledgments

In addition the contact name above, the following staff members made key contributions to this report: Travis Masters, Assistant Director; Peter Anderson; James Bennett; Marvin Bonner; Kristine Hassinger; Megan Porter; Marie Suding; and Abby Volk.

Appendix V: Accessible Data

Data Table for Highlights bar chart, F-35 Joint Strike Fighter Budgeted Costs by Service, 2015-2019

Year	Air Force development	Air Force procurement	Navy development	Navy procurement	Total	Aircraft purchased
2015	0.54	4.41	0.97	2.54	8.4	38
2016	0.52	6.03	0.97	3.13	10.6	57
2017	0.32	6.44	0.84	3.57	11.2	66
2018	0.11	7.25	0.13	4.48	12.0	88
2019	0.01	7.15	0.01	4.73	11.9	90

Total spending for 2015-2019: 54.1 billion

Total aircraft purchased for 2015-2019: 339

Data Table for Figure 1: Changes in F-35 Joint Strike Fighter Near-Term Procurements

Year	System Design and Development and 2003 annual plan (1,966 aircraft by 2019)	2007 annual plan (1,035 aircraft by 2019)	2012 annual plan (585 aircraft by 2019)
2006	10	0	0
2007	22	2	2
2008	49	12	12
2009	82	16	14
2010	108	30	30
2011	156	43	32
2012	194	82	31
2013	194	90	29
2014	194	110	29
2015	194	130	44
2016	194	130	66
2017	194	130	76
2018	194	130	110
2019	181	130	110

Accessible Data for Figure 2: Subsequent Development of F-35 Joint Strike Fighter Software Blocks

Illustration of a triangle showing Block 1 and 2a on bottom, working up to Block 3f at apex of triangle. (text below)

- Block 1 and 2a; Training capability - Includes basic navigation, mission planning, flight displays, voice communication, and threat jamming (Required for Navy 2018 Initial Operational Capability (IOC))
- Block 2b: Initial warfighting capability - Includes basic close air support/interdiction, and initial air-to-air capability (Required for 2015 Marine Corps IOC)
- Block 3i: Extension of Block 2B capabilities- Includes adding Block 2B capabilities to new technology hardware, export compliance, and new helmet with improved display system (Required for 2016 Air Force IOC)
- Block 3f: Full warfighting capability - Includes full avionics and weapons envelope

Figure 3: Measured Mean Flight Hours between Failure-(design controlled) for the F-35 Joint Strike Fighter Engine Only

Year	F-35 B Operational data	F-35 A and C Operational data	F-35 A and C Reliability growth plan	F-35 B Reliability growth plan
2012	NA	NA	90	68
	NA	NA	NA	NA
	NA	NA	NA	NA
	NA	39.5	NA	NA
	NA	71.2	NA	NA
	NA	84.3	92	69
	67.6	101	NA	NA
	119.3	27.5	NA	NA
	104.9	42	NA	NA
	54.7	41.5	NA	NA
	35.8	47.7	NA	NA
	36.8	49	NA	NA
2013	25.6	50	96	72
	25.6	51.9	NA	NA
	28	56.3	NA	NA
	28.6	41.6	NA	NA
	33	31.8	NA	NA
	34	29.7	100	75
	35.4	25.6	NA	NA
	34.4	27.1	NA	NA

Year	F-35 B Operational data	F-35 A and C Operational data	F-35 A and C Reliability growth plan	F-35 B Reliability growth plan
	32.7	23.6	NA	NA
	34	21.1	NA	NA
	35	20.3	NA	NA
	35.7	19.6	NA	NA
2014	45	19.8	107	80
	44.6	18.9	NA	NA
	44.4	18.4	NA	NA
	49.3	19.4	NA	NA
	47.6	19.3	NA	NA
	43.7	19.7	115	87
	43.2	20.5	NA	NA
	45.6	22.1	NA	NA
	47	25	NA	NA
2015	NA	NA	128	96
	NA	NA	144	108
2016	NA	NA	159	119
	NA	NA	174	130
2017	NA	NA	188	141
	NA	NA	202	152
2018	NA	NA	215	162
	NA	NA	228	172
2019	NA	NA	242	183
	NA	NA	255	193
2020	NA	NA	269	204
	NA	NA	283	215

Figure 4: Budgeted Development and Procurement Costs by Service, 2015-2038

Year	Air Force development	Air Force procurement	Navy development	Navy procurement	Total	Aircraft purchased
2015	0.54	4.41	0.97	2.54	8.4	38
2016	0.52	6.03	0.97	3.13	10.6	57
2017	0.32	6.44	0.84	3.57	11.2	66
2018	0.11	7.25	0.13	4.48	12.0	88
2019	0.01	7.15	0.01	4.73	11.9	90

Year	Air Force development	Air Force procurement	Navy development	Navy procurement	Total	Aircraft purchased
2020	0.01	6.67	0.01	4.97	11.7	92
2021	0.00	6.69	0.00	5.48	12.2	100
2022	0.00	8.71	0.00	5.63	14.3	120
2023	0.00	8.61	0.00	5.42	14.0	120
2024	0.00	8.73	0.00	5.55	14.3	120
2025	0.00	9.09	0.00	5.59	14.7	120
2026	0.00	9.24	0.00	5.61	14.9	120
2027	0.00	9.42	0.00	5.57	15.0	120
2028	0.00	9.30	0.00	5.54	14.8	120
2029	0.00	9.49	0.00	5.56	15.1	120
2030	0.00	9.83	0.00	5.30	15.1	120
2031	0.00	10.21	0.00	2.98	13.2	101
2032	0.00	10.13	0.00	2.80	12.9	100
2033	0.00	10.30	0.00	2.76	13.1	100
2034	0.00	10.39	0.00	1.60	12.0	92
2035	0.00	10.78	0.00	0.00	10.8	80
2036	0.00	10.96	0.00	0.00	11.0	80
2037	0.00	10.39	0.00	0.00	10.4	80
2038	0.00	3.39	0.00	0.00	3.4	20

Figure 5: Trend of F-35 Joint Strike Fighter Contractual Delivery Dates Compared to Actual Delivery Dates

Type of aircraft schedule to be delivered	Delay in contractual delivery (in months)
A	3
A	4
B	4
B	7
A	3
A	6
A	6
B	6
B	9
B	4
B	4
A	6

Type of aircraft schedule to be delivered	Delay in contractual delivery (in months)
C	8
B	8
B	8
A	1
A	1
C	4
B	4
B	6
C	6
A	2
A	3
B	11
A	2
A	2
C	4
A	4
A	1
A	2
C	8
A	0
A	2
A	2
A	3
A	1
A	3
C	7
A	2
C	3
A	3
A	2
A	3
A	3
A	3
A	3
C	4
A	4
B	5

Type of aircraft schedule to be delivered	Delay in contractual delivery (in months)
C	3
A	4
A	4
C	5
A	3
A	3
B	4
A	2
A	2
A	2
A	2
A	1

Figure 6: Trend in Labor Hours to Build the F-35 Joint Strike Fighter Aircraft by Variant

Number of aircraft built (by type)	F-35 A (Conventional takeoff)	F-35 B (Short takeoff/ Vertical landing)	F-35 C (Carrier variant)
1	153875	141219	113997
2	138007	133781	110681
3	134776	126119	101032
4	131550	133758	99750
5	132922	129453	94322
6	122957	120784	88690
7	113535	123641	92732
8	118299	121476	82652
9	114877	110488	84344
10	106620	108321	85492
11	102047	106370	75449
12	100662	103280	81356
13	92181	96485	NA
14	95551	96783	NA
15	96043	92265	NA
16	92145	99151	NA
17	92250	96761	NA
18	85465	86929	NA

Number of aircraft built (by type)	F-35 A (Conventional takeoff)	F-35 B (Short takeoff/ Vertical landing)	F-35 C (Carrier variant)
19	81430	88521	NA
20	83242	83442	NA
21	82027	81366	NA
22	80369	79316	NA
23	75221	96175	NA
24	83065	76762	NA
25	79400	87687	NA
26	79433	83520	NA
27	75454	80105	NA
28	80788	83967	NA
29	76982	75651	NA
30	77229	72576	NA
31	73115	79642	NA
32	72250	78999	NA
33	68126	83709	NA
34	70311	83564	NA
35	72250	87986	NA
36	66640	80560	NA
37	65221	NA	NA
38	67445	NA	NA
39	67566	NA	NA
40	64989	NA	NA
41	58373	NA	NA
42	62752	NA	NA
43	64681	NA	NA
44	60565	NA	NA
45	65012	NA	NA
46	59366	NA	NA
47	59100	NA	NA
48	60522	NA	NA
49	56161	NA	NA
50	65687	NA	NA

Figure 7: Trend in Percent of Labor Hours Spent on Scrap, Rework, and Repair for the F-35 Joint Strike Fighter

Lot	Percentage scrap, rework, and repair
Lot 1	16.6
Lot 2	16.5
Lot 3	15
Lot 4	13.8
Lot 5 Actual	14.9
Lot 5 Goal	12.8

Figure 8: Average Number of F-35 Joint Strike Fighter Part Shortage Occurrences at Prime Contractor Facility

	Less severe (Category 1-3)	Most severe (Category 4 or higher)
2013	319	254
2014	480	280

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