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F-35 Joint Strike Fighter (JSF) Program

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Summary

The largest procurement program in the Department of Defense (DOD), the F-35 Joint Strike Fighter (JSF), also called the Lightning II, is a strike fighter aircraft being procured in different versions for the United States Air Force, Marine Corps, and Navy. Current DOD plans call for acquiring a total of 2,457 JSFs. Hundreds of additional F-35s are expected to be purchased by several U.S. allies, eight of which are cost-sharing partners in the program.

The F-35 promises significant advances in military capability. Like many high-technology programs before it, reaching that capability has put the program above its original budget and behind the planned schedule.

The Administration's proposed FY2015 defense budget requested about $7.8 billion in procurement funding for the F-35 JSF program. This would fund the procurement of 26 F-35As for the Air Force, 6 F-35Bs for the Marine Corps, 2 F-35Cs for the Navy, and continuing development.

FY2014 defense authorization act: The FY2014 defense authorization bill funded F-35 procurement at $5.4 billion for 29 aircraft (19 F-35As, 6 F-35Bs, and 4 F-35Cs, as requested), plus $561.7 million in advance procurement. The conference report accompanying the bill included language repealing some previously enacted reporting requirements for the F-35 program, and mandated a review of F-35 software development.

FY2014 defense appropriations bill: The final omnibus budget bill funded F-35 procurement at $5.1 billion for 29 aircraft (19 F-35As, 6 F-35Bs, and 4 F-35Cs, as requested), plus $521.7 million in advance procurement, a reduction in 3 aircraft from the Administration's advance procurement request.

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Introduction

In General

The F-35 Joint Strike Fighter (JSF), also called the Lightning II, is a strike fighter airplane being procured in different versions for the Air Force, Marine Corps, and Navy. The F-35 program is DOD's largest weapon procurement program in terms of total estimated acquisition cost. Current Department of Defense (DOD) plans call for acquiring a total of 2,457 JSFs[1] for the Air Force, Marine Corps, and Navy at an estimated total acquisition cost (as of December 31, 2012) of about $319 billion in constant (i.e., inflation-adjusted) FY2012 dollars.[2] Hundreds of additional F-35s are expected to be purchased by several U.S. allies, eight of which are cost-sharing partners in the program.

The Administration's proposed FY2015 defense budget requested a total of about $8.3 billion for the F-35 program, including about $1.9 billion in Air Force and Navy research and development funding and about $5.7 billion in Air Force and Navy procurement funding. (Development and procurement of Marine Corps aircraft are funded through the Navy's budget.) The Administration proposed to fund the procurement of fund the procurement of 26 F-35As for the Air Force, 6 F-35Bs for the Marine Corps, and 2 F-35Cs for the Navy in FY2015.

Background

The F-35 in Brief

In General

The F-35 was conceived as a relatively affordable fifth-generation strike fighter[3] that could be procured in three highly common versions for the Air Force, the Marine Corps, and the Navy, in order to avoid the higher costs of developing, procuring, and operating and supporting three separate tactical aircraft designs to meet the services' similar but not identical operational needs.[4]

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[1] Thirteen of the aircraft will be acquired for flight testing through research and development funding.

[2] Office of the Secretary of Defense, *Selected Acquisition Report (SAR): F-35 Joint Strike Fighter Aircraft (F-35)*, December 31, 2012.

[3] "Fifth-generation" aircraft incorporate the most modern technology, and are considered to be generally more capable than earlier-generation aircraft. Fifth-generation fighters combine new developments such as thrust vectoring, composite materials, stealth technology, advanced radar and sensors, and integrated avionics to greatly improve pilot situational awareness.

Among fighters currently in service or in regular production, only the Air Force F-22 air superiority fighter and the F-35 are considered fifth-generation aircraft. Russia has flown a prototype fifth-generation fighter, and China reportedly has fifth-generation fighters under development.

Strike fighters are dual-role tactical aircraft that are capable of both air-to-ground (strike) and air-to-air (fighter) combat operations.

[4] The program's operational requirements call for 70% to 90% commonality between all three versions. Many of the three versions' high-cost components—including their engines, avionics, and major airframe structural components—are common.

(continued...)

All three versions of the F-35 will be single-seat aircraft with the ability to go supersonic for short periods and advanced stealth characteristics. The three versions will vary somewhat in their combat ranges and payloads (see **Appendix**). All three are to carry their primary weapons internally to maintain a stealthy radar signature. Additional weapons can be carried externally on missions requiring less stealth.

Three Service Versions

From a common airframe and powerplant core, the F-35 is being procured in three distinct versions tailored to the needs of each military service. Differences among the aircraft include the manner of takeoff and landing, fuel capacity, and carrier suitability, among others.

Air Force CTOL Version (F-35A)

The Air Force is procuring the F-35A, a conventional takeoff and landing (CTOL) version of the aircraft. F-35As are to replace Air Force F-16 fighters and A-10 attack aircraft, and possibly F-15 fighters.[5] The F-35A is intended to be a more affordable complement to the Air Force's new F-22 Raptor air superiority fighter.[6] The F-35A is not as stealthy[7] nor as capable in air-to-air combat as the F-22, but it is more capable in air-to-ground combat than the F-22, and more stealthy than the F-16. If the F-15/F-16 combination represented the Air Force's earlier-generation "high-low" mix of air superiority fighters and more-affordable dual-role aircraft, the F-22/F-35A combination might be viewed as the Air Force's intended future high-low mix.[8] The Air Force states that "The F-22A and F-35 each possess unique, complementary, and essential capabilities that together provide the synergistic effects required to maintain that margin of superiority across the spectrum of conflict…. Legacy 4th generation aircraft simply cannot survive to operate and achieve the effects necessary to win in an integrated, anti-access environment."[9]

(...continued)

Secretary of Defense William Cohen stated in 2000 that the JSF's joint approach "avoids the three parallel development programs for service-unique aircraft that would have otherwise been necessary, saving at least $15 billion." (Letter from Secretary of Defense William S. Cohen to Rep. Jerry Lewis, June 22, 2000. The text of letter made available by *Inside the Air Force* on June 23, 2000.)

[5] Stephen Trimble, "Lockheed says F-35s will replace USAF F-15s," *Flight International*, February 4, 2010.

[6] For more on the F-22 program, see CRS Report RL31673, *Air Force F-22 Fighter Program*.

[7] A November 13, 2009, press article states that "The F-22 had a -40dBsm all-aspect reduction requirement [i.e., a requirement to reduce the radar reflectivity of the F-22 when viewed from all angles by 40 decibels per square meter], while the F-35 came in at -30dBsm with some gaps in coverage." (David A. Fulghum and Bradley Perrett, "Experts Doubt Chinese Stealth Fighter Timeline," *Aerospace Daily & Defense Report*, November 13, 2009, pp. 1-2.)

[8] The term high-low mix refers to a force consisting of a combination of high-cost, high-capability aircraft and lower-cost, more-affordable aircraft. Procuring a high-low mix is a strategy for attempting to balance the goal for having a minimum number of very high capability tactical aircraft to take on the most challenging projected missions and the goal of being able to procure tactical aircraft sufficient in total numbers within available resources to perform all projected missions.

[9] Department of the Air Force Presentation to the House Armed Services Committee Subcommittee on Air and Land Forces, United States House of Representatives, Subject: Air Force Programs, Combined Statement of: Lieutenant General Daniel J. Darnell, Air Force Deputy Chief Of Staff For Air, Space and Information Operations, Plans And Requirements (AF/A3/5) [and] Lieutenant General Mark D. Shackelford, Military Deputy, Office of the Assistant Secretary of the Air Force for Acquisition (SAF/AQ) Lieutenant General Raymond E. Johns, Jr., Air Force Deputy Chief of Staff for Strategic Plans And Programs (AF/A8) May 20, 2009, pp. 7-8, 10.

Marine Corps STOVL Version (F-35B)

The Marine Corps is procuring the F-35B, a short takeoff and vertical landing (STOVL) version of the aircraft.[10] F-35Bs are to replace Marine Corps AV-8B Harrier vertical/short takeoff and landing attack aircraft and Marine Corps F/A-18A/B/C/D strike fighters, which are CTOL aircraft. The Marine Corps decided to not procure the newer F/A-18E/F strike fighter[11] and instead wait for the F-35B in part because the F/A-18E/F is a CTOL aircraft, and the Marine Corps prefers aircraft capable of vertical operations. The Department of the Navy states that "The Marine Corps intends to leverage the F-35B's sophisticated sensor suite and very low observable, fifth generation strike fighter capabilities, particularly in the area of data collection, to support the Marine Air Ground Task Force well beyond the abilities of today's strike and EW [electronic warfare] assets."[12]

Navy Carrier-Suitable Version (F-35C)

The Navy is procuring the F-35C, a carrier-suitable CTOL version of the aircraft.[13] The F-35C is also known as the "CV" version of the F-35, as CV is the naval designation for aircraft carrier. The Navy plans in the future to operate carrier air wings featuring a combination of F/A-18E/Fs (which the Navy has been procuring since FY1997) and F-35Cs. The F/A-18E/F is generally considered a fourth-generation strike fighter.[14] The F-35C is to be the Navy's first aircraft designed for stealth, a contrast with the Air Force, which has operated stealthy bombers and fighters for decades. The F/A-18E/F, which is less expensive to procure than the F-35C, incorporates a few stealth features, but the F-35C is stealthier. The Department of the Navy states that "the commonality designed into the joint F-35 program will minimize acquisition and operating costs of Navy and Marine Corps tactical aircraft, and allow enhanced interoperability with our sister Service, the United States Air Force, and the eight partner nations participating in the development of this aircraft."[15]

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[10] To permit STOVL operations, the F-35B has an engine exhaust nozzle at the rear than can swivel downward, and a mid-fuselage lift fan connected to the engine that blows air downward to help lift the forward part of the plane.

[11] For more on the F/A-18E/F program, see CRS Report RL30624, *Navy F/A-18E/F and EA-18G Aircraft Program*.

[12] Statement of Vice Admiral David Architzel, USN, Principal Military Deputy, Research, Development and Acquisition, LTGEN George J. Trautman III, USMC, Deputy Commandant for Aviation, [and] RADM Allen G. Myers, USN, Director of Warfare Integration, Before the Seapower and Expeditionary Warfare [sic: Forces] Subcommittee of the House Armed Services Committee [hearing] on [the] Department of the Navy's Aviation Procurement Program, May 19, 2009, pp. 1-2.

[13] Features for carrier suitability include, among other things, strengthened landing gear, a strengthened airframe, and an arresting hook so as to permit catapult launches and arrested landings, as well as folding wing tips for more compact storage aboard ship.

[14] Some F/A-18E/F supporters argue that it is a "fourth-plus" or "4.5"generation strike fighter because it incorporates some fifth-generation technology, particularly in its sensors.

[15] Statement of Vice Admiral David Architzel, USN, Principal Military Deputy, Research, Development and Acquisition, LTGEN George J. Trautman III, USMC, Deputy Commandant for Aviation, [and] RADM Allen G. Myers, USN, Director of Warfare Integration, before the Seapower and Expeditionary Warfare [sic: Forces] Subcommittee of the House Armed Services Committee [hearing] on [the] Department of the Navy's Aviation Procurement Program, May 19, 2009, p. 1.

Engine

The F-35 is powered by the Pratt and Whitney F135 engine, which was derived from the F-22's F119 engine. The F135 is produced in Pratt and Whitney's facilities in East Hartford and Middletown, CT.[16] Rolls-Royce builds the vertical lift system for the F-35B as a subcontractor to Pratt and Whitney.

Consistent with congressional direction for the FY1996 defense budget, DOD established a program to develop an alternate engine for the F-35. The alternate engine, the F136, was developed by a team consisting of GE Transportation—Aircraft Engines of Cincinnati, OH, and Rolls-Royce PLC of Bristol, England, and Indianapolis, IN. The F136 is a derivative of the F120 engine originally developed to compete with the F119 engine for the F-22 program.

DOD included the F-35 alternate engine program in its proposed budgets through FY2006, although Congress in certain years increased funding for the program above the requested amount and/or included bill and report language supporting the program.

The George W. Bush Administration proposed terminating the alternate engine program in FY2007, FY2008, and FY2009. The Obama Administration did likewise in FY2010. Congress rejected these proposals and provided funding, bill language, and report language to continue the program.[17]

The General Electric/Rolls Royce Fighter Engine Team ended their effort to provide an alternate engine on December 2, 2011.

Fuller details of the alternate engine program and issues for Congress arising from it are detailed in CRS Report R41131, *F-35 Alternate Engine Program: Background and Issues for Congress*.

Recent Developments

Significant developments since the previous edition of this report February 16, 2012, include:

Reduction of Previously Projected Quantities

The Administration's proposed FY2015 defense budget would fund the procurement of 26 F-35As for the Air Force, 6 F-35Bs for the Marine Corps, and 2 F-35Cs for the Navy. This is 4 fewer As, 2 fewer Bs, and 2 fewer Cs than projected in the FY2014 budget.

In a briefing to CRS and other analysts on February 28, 2014, the Air Force budget director stated that 2 of the 4 F-35As cut from the FY2015 budget were due to cuts in the FY2014 defense appropriations bill, and the other 2 were deferred due to overall budget issues, not program performance.

[16] Pratt and Whitney's parent firm is United Technologies.

[17] Bill language since FY2007 includes Section 211 of the FY2007 defense authorization act (H.R. 5122/P.L. 109-364 of October 17, 2006) and Section 213 of the FY2008 defense authorization act (H.R. 4986/P.L. 110-181 of January 28, 2008). (For the texts of these two provisions, see CRS Report R41131, *F-35 Alternate Engine Program: Background and Issues for Congress*.)

Approval of Three More Production Contracts

In December, 2012, DOD and Lockheed Martin agreed to a contract to acquire 32 F-35s as part of LRIP (low-rate initial production) lot 5. Subsequently, on September 27, 2013, DOD and Lockheed signed production contracts for LRIP lots 6 and 7. Quantities and agreed costs for each lot are shown below.

In LRIPs 5, 6, and 7, any cost overruns associated with concurrent development and production would be split equally between the contractor and the government. Prior to LRIP 4, the government bore those costs alone.

Table 1. F-35 LRIPs 5, 6, and 7

Costs in $M, per aircraft

LRIP Lot	5[a]	6[b]	7[c, d]
F-35A quantity/cost	22/105	23/103	19/98
F-35B quantity/cost	3/113	7/109	6/104
F-35C quantity/cost	7/125	6/120	4/116

Note: Aircraft costs shown do not include engines. Quantities exclude international orders.

a. Christopher Drew, "Lockheed Profit on F-35 Jets Will Rise With New Contract," *The New York Times*, December 17, 2012.

b. Tony Capaccio, "Lockheed Gets Approval Of Next F-35 Production Contract," *Bloomberg News*, July 6, 2012.

c. Amy Butler, "Latest F-35 Deal Targets Unit Cost Below $100 Million," *Aviation Week & Space Technology*, July 30, 2013.

d. Caitlin Lee, "Latest F-35 contracts mark new strategy to reduce costs," *Jane's Defence Weekly*, September 29, 2013. Note that these prices do not include engines.

Changes in International Orders

As noted, the F-35 is an international program, with commitments from program partners and other countries to share in the development costs and acquire aircraft. The other nations' plans have varied over time. Most recently:

- **Australia** is scheduled to take delivery of one F-35 in 2014 and 2015, and has announced a new order for 58 follow-on aircraft.[18]
- Following an unfavorable report from its auditor-general regarding its plan to acquire F-35s, **Canada** has reopened its fighter competition and recently concluded an analysis of alternatives "to decide whether to launch a competition or forge ahead with the sole-sourced purchase of F-35s." The Canadian procurement has been delayed until at least 2018.[19] [20] [21]

[18] Matt Siegel and Andrea Shalal, "Australia orders 58 F-35 Lockheed Martin stealth fighters," *Reuters.com*, April 22, 2014.

[19] David Pugliese, "Canada: No F-35 Buys Before 2018," *Defense News*, April 6, 2014.

[20] Daniel LeBlanc, "Military's fighter-jet reports to put ball in Ottawa's court on F-35s ," *The Globe and Mail*, January (continued...)

- **Italy** reduced its buy from 131 to 90 in early 2012.[22]
- **Japan** has bought long-lead items to initiate production of its 42 F-35s.[23]
- **Norway** "has ordered 16 of the 52 jets it plans to buy in coming years, with the first jets to be delivered in 2017, a year earlier than planned,"[24] and "the Norwegian parliament has already signed off on the increased budget needed for the deal."[25]
- **The Netherlands** has reduced its planned order of 85 aircraft to 37.[26]
- **Singapore**, which had been considering the F-35, deferred a decision.[27]
- **South Korea** announced a 40-plane buy for 2014 with options to purchase another 20.[28] First delivery is expected in 2018.[29]

New Program Manager

In September, 2012, Air Force Major General Christopher Bogdan succeeded Vice Admiral David Venlet as the F-35 program manager. Bogdan had been Venlet's deputy, and previously served as manager of the KC-46A tanker program.

Following his nomination, Bogdan publicly scolded the F-35's prime contractor, calling "the relationship between contractor Lockheed Martin and the program office 'the worst I have ever seen,' expressing frustration with the company's continued performance and production woes.[30]

Initial F-35 Basing Announced

Air Force F-35 training has commenced at Eglin AFB, FL, and Luke AFB, AZ.

On December 3, 2013, the Air Force announced that it will base the first operational F-35As at Hill Air Force Base, UT, beginning in 2015, and the first National Guard unit at Burlington International Airport, VT, in 2020.[31]

(...continued)

2, 2014.

[21] Ian Austen and Christopher Drew, "Canada Reviews Plans To Buy F-35 Fighter Jets," *The New York Times*, December 13, 2012.

[22] Andy Nativi, "Italy To Buy 41 Fewer JSFs, Defense Chief Says," *Aerospace Daily*, February 17, 2012.

[23] Craig Hoyle, "New contract powers Japan towards F-35 assembly," *Flight International*, October 21, 2013.

[24] Andrea Shalal-Esa, "Norway says F-35 jet on track; keeping eye on costs," *Reuters.com*, January 9, 2014.

[25] Robert Wall, "JSF—Norway Signs Up," *Aviation Week/Ares blog*, June 15, 2012.

[26] Aaron Mehta, "Dutch Parliament Clears F-35 Purchase," *Defense News*, November 7, 2013.

[27] Carlo Muñoz, "Singapore in 'no particular hurry' to buy fighter jet," *The Hill*, December 12, 2013.

[28] Unattributed, "South Korea To Finalize F-35 Jet Fighter Deal This Year," *Agence France-Presse*, January 28, 2014.

[29] Joyce Lee, "South Korea boosts air defenses with about $6.8 billion budget for F-35s," *Reuters.com*, March 24, 2014.

[30] Marcus Weisgerber, "2-star F-35 chief raps Lockheed relations," *Air Force Times*, September 18, 2012.

[31] Brian Everstine, "Air Force to base F-35 squadrons in Utah, Vermont," *MilitaryTimes.com*, December 3, 2013.

Air Force F-35 instructor pilot training began at Eglin AFB, FL, in January, 2013. Initially, six classes of six students each are expected to graduate each year, "though when more aircraft are delivered for operational use an increase will be necessary."[32]

"Gen. Edward Rice, who heads the Air Education and Training Center, gave the formal nod to begin pilot training Dec. 17 during a visit to the base, which is where the first F-35 schoolhouse has been established."[33]

"The Air Force Education and Training Command (AETC) conducted an Operational Utility Evaluation (OUE) in CY2012. The OUE assessed the ability of the 33rd Fighter Wing to conduct pilot training. AETC determined the wing was ready for training and F-35 pilot training commenced in January 2013."[34]

The Marine Corps has also been training pilots using its F-35B aircraft at Eglin.[35] Operational Marine F-35Bs are stationed at MCAS Yuma, AZ. Another Marine squadron is expected at Marine Corps Air Station Miramar, CA by FY2021.[36]

Testing Progress

DOD's annual testing report stated, "Flight test teams operating the 18 test aircraft assigned to the developmental flight test centers nearly matched or exceeded flight test sortie goals through October 2013. This occurred despite loss of several government employee work days due to furloughs and sequestration, and two fleet-wide grounding instances." Since the program started, 26,689 of 27, 075 planned test points had been achieved, although achievement in FY2013 was behind schedule. [37]

An evaluation by DOD's Systems Engineering office found that the F-35 "is on track to meet seven of the eight" key performance parameters (KPPs), with the exception being sortie generation rate. It cautioned that "(a)lthough on track, the combat radius, STOVL performance, and CV recovery KPPs have limited margins." [38]

Groundings

Two issues found in test were significant enough to cause temporary grounding of the F-35 fleet in 2013. The first was a crack in an engine turbine blade, which was judged to be unique to a single aircraft.[39] Discovery of excessive wear on the rudder hinge attachments on a test airplane

[32] Amy Butler, "F-35 Pilot Training Finally Begins At Eglin AFB," *Aerospace Daily*, December 18, 2012.

[33] Ibid.

[34] Office of the Secretary of Defense, *Selected Acquisition Report (SAR): F-35 Joint Strike Fighter Aircraft (F-35)*, December 31, 2012.

[35] Amy Butler, "F-35 Pilot Training Finally Begins At Eglin AFB," *Aerospace Daily*, December 18, 2012.

[36] Gretel C. Kovach, "Military Gets First F-35 Operational Squadron," *San Diego Union-Tribune*, November 17, 2012.

[37] Director, Operational Test & Evaluation, *FY 2013 Annual Report*, January 2014, pp. 33-39.

[38] Stephen P. Welby, *FY2013 Annual Report*, Deputy Assistant Secretary of Defense Systems Engineering, March 2014, p. 132.

[39] Guy Norris, "Engine Probe Clears F-35 For Return To Flight," *Aerospace Daily*, March 4, 2013.

in early March 2013 led to the addition of wear-preventing washers to the hinges of the rest of the test fleet. [40]

Structural Cracks

> On-ground testing of the Air Force and Marine Corps versions of the fighter revealed "significant findings" of cracks on five occasions in fuselage bulkheads, flanges, stiffeners and engine mounts "that will require mitigation plans and may include redesigning parts and additional weight," according to an annual report on major weapons by Michael Gilmore, director of operational testing.[41]

In particular, in late 2013, cracks were found in a ground-test prototype of the F-35B. Program officials noted that the aircraft in question had been subjected to the equivalent of 17 years of flying, and that the discovery would not delay the F-35B's entry into Marine Corps service.[42]

Alternative Helmet Contract Awarded

BAE Systems won a contract to provide pilot helmets for the F-35 after persistent problems with the primary helmet. "The primary helmet being developed by VSI, an Elbit and Rockwell Collins joint venture, has been suffering problems with jitter in displaying data on the visor, and resolution is not high enough for its night-vision capability."[43] "The program ended development of the alternate F-35 helmet as further testing indicated it is acceptable for USMC initial operating capability."[44]

Software Delays

Development of the F-35's integrated software development continues to be a significant issue in the program. The latest information can be found in a new section on software added to this report under "Software Development."

JSF Program Origin and Milestones

The JSF program began in the early- to mid-1990s.[45] Three different airframe designs were proposed by Boeing, Lockheed, and McDonnell Douglas (teamed with Northrop Grumman and

[40] Director, Operational Test & Evaluation, *FY 2013 Annual Report*, January 2014, pp. 33-39.

[41] Tony Capaccio, "Lockheed F-35 Develops Cracks, Pentagon's Tester Finds," *Bloomberg.com*, January 28, 2014.

[42] Dave Majumdar, "Cracking Found in Marine Joint Strike Fighter Won't Delay Program," *USNI News*, February 24, 2014.

[43] Robert Wall, "BAE Systems Wins F-35 Alternative Helmet Display Work," *Aerosapce Daily*, October 11, 2011.

[44] U.S. Government Accountability Office, *DEFENSE ACQUISITIONS: Assessments of Selected Weapon Programs*, GAO-14-340SP, March 2014, p. 70.

[45] The JSF program emerged in late 1995 from the Joint Advanced Strike Technology (JAST) program, which began in late 1993 as a result of the Clinton Administration's Bottom-Up Review (BUR) of U.S. defense policy and programs. The BUR envisaged the JAST program as a replacement for two other tactical aircraft programs that were being terminated (the A-12 program, which was intended to provide a stealthy new carrier-based attack plane to replace the Navy's aging A-6 carrier-based attack planes, and the Multi-Role Fighter, which the Air Force had considered as a replacement for its F-16 fighters).

In 1995, in response to congressional direction, a program led by the Defense Advanced Research Projects Agency (continued...)

British Aerospace.) On November 16, 1996, the Defense Department announced that Boeing and Lockheed Martin had been chosen to compete in the Concept Demonstration phase of the program, with Pratt and Whitney providing propulsion hardware and engineering support. Boeing and Lockheed were each awarded contracts to build and test-fly two aircraft to demonstrate their competing concepts for all three planned JSF variants.[46]

The competition between Boeing and Lockheed Martin was closely watched. Given the size of the JSF program and the expectation that the JSF might be the last fighter aircraft program that DOD would initiate for many years, DOD's decision on the JSF program was expected to shape the future of both U.S. tactical aviation and the U.S. tactical aircraft industrial base.

In October 2001, DOD selected the Lockheed design as the winner of the competition, and the JSF program entered the System Development and Demonstration (SDD) phase, with SDD contracts awarded to Lockheed Martin for the aircraft and Pratt and Whitney for the aircraft's engine. General Electric continued technical efforts related to the development of an alternate engine for competition in the program's production phase.

Table 2. F-35 Variant Milestones

	First flown	Original IOC goal	Current IOC estimate
F-35A	December 15, 2006	March 2013	2016
F-35B	June 11, 2008	March 2012	2015
	First hover: March 17, 2010		
F-35C	June 6, 2010	March 2015	2019

Source: Prepared by CRS based on press reports and DOD testimony.

As shown in **Table 2**, the first flights of an initial version of the F-35A and the F-35B occurred in the first quarter of FY2007 and the third quarter of FY2008, respectively. The first flight of a

(...continued)

(DARPA) to develop an advanced short takeoff and vertical landing (ASTOVL) aircraft was incorporated into the JAST program. This opened the way for Marine Corps and UK participation in the JAST program, since the Marine Corps and the UK were interested procuring a new STOVL aircraft to replace their aging Harrier STOVL attack aircraft. The name of the program was then changed to Joint Strike Fighter (JSF) to focus on joint development and production of a next-generation fighter/attack plane.

A Joint Operational Requirements Document for the F-35 program was issued in March 2000 and revalidated by DOD's Joint Requirements Oversight Council (JROC) in October 2001. On October 24, 2001, the Defense Acquisition Board (DAB) held a Milestone B review for the program. (Milestone B approval would permit the program to enter the SDD phase.) On October 25, 2001, the Secretary of Defense certified to Congress (in accordance with Section 212 of the FY2001 defense authorization act [H.R. 4205/P.L. 106-398 of October 30, 2000]) that the program had successfully completed the CDP exit criteria and demonstrated sufficient technical maturity to enter SDD. On October 26, 2001, the SDD contracts were awarded to Lockheed and Pratt and Whitney. A Preliminary Design Review (PDR) for the F-35 program was conducted in April 2003, and Critical Design Reviews (CDRs) were held for the F-35A, F-35B, and F-35C in February 2006 (F-35A and F-35B) and June 2007 (F-35C).

[46] Subsequent to the selection of the Boeing and Lockheed Martin designs, Boeing acquired McDonnell Douglas and merged the two firms' JSF teams.

slightly improved version of the F-35A occurred on November 14, 2009.[47] The F-35C first flew on June 6, 2010.[48]

The F-35B's ability to hover, scheduled for demonstration in November, 2009, was shown for the first time on March 17, 2010.[49] The first vertical landing took place the next day.[50]

Initial Operational Capability

The F-35A, F-35B, and F-35C were originally scheduled to achieve Initial Operational Capability (IOC) in March 2013, March 2012, and March 2015, respectively.[51] In March, 2010, Pentagon acquisition chief Ashton Carter announced that the Air Force and Navy had reset their projected IOCs to 2016, while Marine projected IOC remained 2012.[52] Subsequently, the Marine IOC was delayed.[53]

Congress required a formal declaration of IOCs in Section 155 of the National Defense Authorization Act for Fiscal Year 2013 (P.L. 112-239.) The current dates (by fiscal year) are shown in **Table 2**.

It should be noted that IOC means different things to different services:

> F-35A initial operational capability (IOC) shall be declared when the first operational squadron is equipped with 12-24 aircraft, and Airmen are trained, manned, and equipped to conduct basic Close Air Support (CAS), Interdiction, and limited Suppression and Destruction of Enemy Air Defense (SEAD/DEAD) operations in a contested environment. Based on the current F-35 Joint Program Office (JPO) schedule, the F-35A will reach the IOC milestone between August 2016 (Objective) and December 2016 (Threshold)...
>
> F-35B IOC shall be declared when the first operational squadron is equipped with 10-16 aircraft, and US Marines are trained, manned, and equipped to conduct CAS, Offensive and Defensive Counter Air, Air Interdiction, Assault Support Escort, and Armed Reconnaissance in concert with Marine Air Ground Task Force resources and capabilities. Based on the

[47] "First Flight," *Defense Daily*, November 23, 2009, p. 3.

[48] Graham Warwick, "JSF Carrier Variant Meets Handling Goals On First Flight," *Aerospace Daily*, June 7, 2010.

[49] Graham Warwick, "F-35B Hovers for First Time," *Aviation Week/Ares* blog, March 17, 2010.

[50] Graham Warwick, "STOVL F-35B Makes First Vertical Landing," *Aviation Week/Ares* blog, March 18, 2010.

[51] The Navy had initially accelerated its estimated IOC for the F-35C to September 2014. Andrew Tilghman, "Joint Strike Fighter Timeline Moved Up," *NavyTimes.com*, September 18, 2009. In November 2009, Lockheed announced that the first flight of an F-35C test aircraft would be delayed from the final quarter of 2009 to the first quarter of 2010. (Dan Taylor, "Navy Joint Strike Fighter Carrier Variant Test Aircraft Will Not Fly Until 2010," *Inside the Navy*, November 9, 2009.)

[52] Testimony before the Senate Armed Services Committee, March 11, 2010. "Marine Corps IOC will include 15 aircraft for training at Eglin AFB, Fla., four in an operational test and evaluation detachment and the first operational squadron of 10 in Yuma, Ariz." Amy Butler, Robert Wall, Graham Warwick and Alon Ben-David, "F-35B Achieves Vertical Landing Milestone," *AviationWeek.com*, March 23, 2010.

[53] "The U.S. Marine Corps will scrap a December 2012 target to have its version of the Lockheed Martin Corp. F-35 Joint Strike Fighter ready for combat and isn't setting a new date, the service's commandant said. 'I'm really not wringing my hands over that,' General James Amos told reporters today at the Pentagon. 'It will be when it will be.'"—Tony Capaccio, "Marines to Delay Combat-Readiness Target for F-35 Jet," Bloomberg.com, December 14, 2010.

> current F-35 JPO schedule, the F-35B will reach the IOC milestone between July 2015 (Objective) and December 2015 (Threshold)...
>
> Navy F-35C IOC shall be declared when the first operational squadron is equipped with 10 aircraft, and Navy personnel are trained, manned and equipped to conduct assigned missions. Based on the current F-35 JPO schedule, the F-35C will reach the IOC milestone between August 2018 (Objective) and February 2019 (Threshold).[54]

Additionally,

> Each of the three US services will reach initial operating capability (IOC) with different software packages.
>
> The F-35B will go operational for the US Marines in December 2015 with the Block 2B software, while the Air Force plans on achieving IOC on the F-35A in December 2016 with Block 3I, which is essentially the same software on more powerful hardware. The Navy intends to go operational with the F-35C in February 2019, on the Block 3F software.[55]

Procurement Quantities

Planned Total Quantities

The F-35 program includes a planned total of 2,457 aircraft for the Air Force, Marine Corps, and Navy. This included 14 research and development aircraft and 2,443 production aircraft: 1,763 F-35As for the Air Force, 260 F-35Cs for the Navy, and 80 F-35Cs and 340 F-35Bs for the Marine Corps.[56]

Annual Quantities

DOD began procuring F-35s in FY2007. **Table 3** shows actual F-35 procurement quantities through FY2014 and requested procurement quantities for FY2015. The figures in the table do not include 13 research and development aircraft procured with research and development funding. (Quantities for foreign buyers are discussed in the next section.)

[54] United States Navy, United States Marine Corps, United States Air Force, *F-35 Initial Operational Capability*, June 2013.

[55] Aaron Mehta, "After 'Transformative' Year, F-35 Program Focuses on Software, Quantity," *Defense News*, January 14, 2014.

[56] "IHS Jane's Defence Insight Report • Air Platforms," June 2013. In 1996, preliminary planning estimated over 3,000 F-35s for DOD and the UK: 2,036 for the Air Force, 642 for the Marines, 300 for the U.S. Navy, and 60 for the Royal Navy. In May 1997, the QDR recommended reducing projected DOD procurement from 2,978 to 2,852: 1,763 for the Air Force, 609 for the Marines, and 480 for the Navy. (Quadrennial Defense Review Cuts Procurement in FY1999, 2000, *Aerospace Daily*, May 20, 1997, p. 280.) In 2003, the Navy reduced its planned procurement of 1,089 F-35s to 680 aircraft as part of the Navy/Marine Corps Tactical Aviation Integration Plan. (See CRS Report RS21488, *Navy-Marine Corps Tactical Air Integration Plan: Background and Issues for Congress*, by Christopher Bolkcom and Ronald O'Rourke.)

Table 3. Annual F-35 Procurement Quantities

(Figures shown are for production aircraft; table excludes 13 research and development aircraft)

FY	F-35A (USAF)	F-35B (USMC)	F-35C (Navy)	Total
2007	2	0	0	2
2008	6	6	0	12
2009	7	7	0	14
2010	10	16	4	30
2011	22	13	7	42
2012	18	6	7	31
2013	19	6	4	29
2014	19	6	4	29
2015 (requested)	26	6	2	34

Source: Prepared by CRS based on DOD data.

Previous DOD plans contemplated increasing the procurement rate of F-35As for the Air Force to a sustained rate of 80 aircraft per year by FY2015, and completing the planned procurement of 1,763 F-35As by about FY2034. Past DOD plans also contemplated increasing the procurement rate of F-35Bs and Cs for the Marine Corps and Navy to a combined sustained rate of 50 aircraft per year by about FY2014, and completing the planned procurement of 680 F-35Bs and Cs by about FY2025.

On February 24, 2010, Pentagon acquisition chief Ashton Carter issued an Acquisition Decision Memorandum (ADM) restructuring the program. Although the ADM did not directly address maximum production rates or when they might be achieved, it did extend the SDD phase by 13 months, and slipped full-rate production to November, 2015.[57]

Congress has also acted to reduce the rate of F-35 procurement. Division C of the Consolidated Appropriations Act, 2014 (P.L. 113-76), reduced the Administration's request for F-35 advance procurement in FY2015 by two F-35As and one F-35C. Those reductions were reflected in the Administration's FY2015 budget request.

Limits on DOD spending included in the 2011 Budget Control Act (BCA) may also affect F-35 acquisition rates. "Under the BCA profile, the Air Force would reduce procurement in FY 2016 by 14 aircraft and in FY 2017 by one aircraft... The Navy would reduce procurement of the F-35C carrier variant by two aircraft in FY 2016 under BCA funding levels." [58] [59]

There is a tension between reducing costs by increasing production rates and keeping up with developmental changes, which is easier with slower rates. Lockheed Martin "has been pushing hard to increase the production rate, arguing its production line is ready and it has reduced

[57] *F-35 Lightning II Joint Strike Fighter (JSF) Program Restructure Acquisition Decision Memorandum (ADM)*, Under Secretary of Defense (Acquisition, Technology & Logistics), February 24, 2010.

[58] Department of Defense, *Estimated Impacts of Sequestration-Level Funding* , April 2014, pp. 4-13-4-14, http://www.defense.gov/pubs/2014_Estimated_Impacts_of_Sequestration-Level_Funding_April.pdf.

[59] Tony Capaccio, "Lockheed to Lose 17 F-35s Under Automatic Pentagon Cuts," *Bloomberg.com*, April 15, 2014.

problems on the line to speed things up. Speeding up production, of course, would boost economies of scale and help lower the politically sensitive price per plane... (S)lowing production would help reduce the cost of replacing parts in jets that are being built before testing is complete."[60]

Program Management

The JSF program is jointly managed and staffed by the Department of the Air Force and the Department of the Navy. Service Acquisition Executive (SAE) responsibility alternates between the two departments. When the Air Force has SAE authority, the F-35 program director is from the Navy, and vice versa. The Navy resumed SAE authority when Air Force Lt. Gen. Christopher Bogdan was confirmed by the Senate as program manager on September 22, 2012.[61] [62]

F-35 program managers currently serve two-year terms. DOD is reportedly considering revising the program's charter, to remove the fixed term, leaving the program manager's tenure up to the Secretary of Defense.[63]

Software Development

> You can see from its angled lines, the F-35 is a stealth aircraft designed to evade enemy radars. What you can't see is the 24 million lines of software code which turn it into a flying computer. That's what makes this plane such a big deal.[64]

The F-35's integration of sensors and weapons, both internally and with other aircraft, is touted as its most unique aspect. That integration is primarily realized through complex software. It may therefore be unsurprising to observe that writing, validating, and debugging that software is among the program's greatest challenges.

> I'm concerned about the software, the operational software.... And I'm concerned about the ALIS [Autonomic Logistics Information System], that is another software system, basically

[60] Then-program manager Admiral David Venlet, cited in Richard Whittle, "JSF's Build And Test Was 'Miscalculation,' Adm. Venlet Says; Production Must Slow," *AOL Defense*, December 1, 2011.

[61] U.S. Congress, Senate, *Presidential Nomination*, 112th Cong., 2nd sess., PN1838-112, at http://thomas.loc.gov/cgi-bin/ntquery/z?nomis:112PN0183800:.

[62] In 2004, appropriations conferees followed a House recommendation to direct DOD to review this alternative management arrangement. House appropriators believed that "management of program acquisition should remain with one Service, and that the U.S. Navy, due to its significant investment in two variants of the F-35 should be assigned all acquisition executive oversight responsibilities." (H.Rept. 108-553 [H.R. 4613], p. 234) Conferees directed that DOD submit a report on the potential efficacy of this change. Prior to the release of the DOD report, former Air Force Chief of Staff General John Jumper was quoted as saying that he also supported putting one service in charge of JSF program acquisition. (Elizabeth Rees, "Jumper Supports Single Service Retaining JSF Acquisition Oversight," *Inside the Air Force*, August 6, 2004.) However, General Jumper highlighted the significant investment the Air Force was making in the JSF program in response to the congressional language favoring the Navy. In DOD's response to Congress, the report noted the current arrangement ensures one Service does not have a "disproportionate voice" when it comes to program decisions and that the current system is "responsive, efficient, and in the best interests of the success of the JSF program." (U.S. Department of Defense, *Report to Congress on Joint Strike Fighter Management Oversight* [forwarded by] Michael W. Wynne, Under Secretary of Defense for Acquisition, Technology and Logistics, December 20, 2004.)

[63] John A. Tirpak, "No F-35 Term Limits?," *Air Force Magazine Daily Report*, May 30, 2013.

[64] David Martin, "Is the F-35 worth it?," *60 Minutes*, February 16, 2014.

> that will provide the logistics support to the systems. – Frank Kendall, Under Secretary of Defense for Acquisition, Technology & Logistics.[65]

That concern is echoed by the F-35 program manager, Lt Gen Christopher Bogdan. In testimony to the House Armed Services Subcommittee on Tactical Air and Land Forces, he described the status of the Blocks 2B, 3I, and 3F software releases, required by IOC for the Marines, Air Force, and Navy respectively:[66]

> For the 2B capability that the U.S. Marine Corps is going to use to declare IOC in limited war fighting capability, we are tracking 206 individual capabilities within the software. And those are what the U.S. Marine Corps needs to declare IOC.
>
> As of today, 80 percent of those have been verified as good to go. We have 20 percent left. And I have two more increments of software to go this summer before I finish flight testing for 2B at the end of the year.
>
> My assessment and my look at the technical risk in the flight test program is that I am within 30 days of completing 2B on time. So, that's fundamentally very, very little risk in delivering software wise the capability to the U.S. Marine Corps...
>
> The 3I capability for U.S. Air Force also I'm quite confident. They have an extra year for us to get it right before they declare IOC and it has the same capability as 2B. So, fundamentally, there are some time margins built in to that.
>
> And finally, the last capability, the 3F capability, that's the one I'm most concerned about in terms of schedule delay. I would tell you today if we don't do anything else and we just continue to perform the way we are performing right now and not getting any better, we're going to be somewhere 4 and 6 months delayed on that software. It's as simple as that.

Bogdan also noted that it is the:

> 'complexity of the software that worries us the most.... Software development is always really, really tricky... We are going to try and do things in the final block of this capability that are really hard to do.' Among them is forming software that can share the same threat picture among multiple ships across the battlefield, allowing for more coordinated attacks.[67]

A report by DOD's Systems Engineering office stated that "(s)oftware delivery for the remainder of Blocks 2 /3 is a challenge because of the size and complexity (~ 28.9 million software lines of code (SLOC), with ~ 2 million SLOC remaining). DASD(SE) forecasts a schedule delay for Block 2 and a delay for Block 3. As a result, the program improved software processes but also shifted resources to Block 2 at the expense of Block 3." The Systems Engineering office plans to conduct an F-35 software development review in FY2014.[68] It is not clear whether this is the

[65] Aaron Mehta, "After 'Transformative' Year, F-35 Program Focuses on Software, Quantity," *Defense News*, January 14, 2014.

[66] U.S. Congress, House Committee on Armed Services, Subcommittee on Tactical Air and Land Forces, *Hearing on the Proposed Fiscal 2015 Defense Authorization for the U.S. Navy, Marine Corps and Air Force Combat Aviation Programs*, 113th Cong., 2nd sess., March 26, 2014.

[67] Amy Butler, "Bogdan Warns Of Possible Six-Month F-35 Slip After Development Ends," *AviationWeek.com*, February 26, 2014.

[68] Stephen P. Welby, *FY2013 Annual Report*, Deputy Assistant Secretary of Defense Systems Engineering, March 2014, p. 132.

same review being undertaken by DOD in response to a requirement in the FY2014 defense authorization bill, which was due in March, 2014 but will reportedly be issued in June, 2014.[69]

The Government Accountability office also reported on F-35 software delays. "(P)ersistent software problems have slowed progress in mission systems flight testing, which is critical to delivering the warfighting capabilities expected by the military services. These persistent delays put the program's development cost and schedule at risk. As a result, DOT&E now projects that the warfighting capabilities expected by the Marine Corps in July 2015, will not likely be delivered on time, and could be delayed as much as 13 months."[70]

Autonomic Logistics Information System

The reports cited above focused on software development for the F-35's onboard mission systems. A supporting system, the Autonomic Logistics Information System (ALIS), also requires extensive software development and testing. "ALIS is at the core of operations, maintenance and supply-chain management for the F-35, providing a constant stream of data from the plane to supporting staff." [71]

DOD's Director of Operational Test & Evaluation identified current shortcomings in ALIS: "To date, diagnostic system performance has failed to meet basic functional requirements, including fault detection, fault isolation, and false alarm rates. Due to the failure to meet these requirements, the program has discontinued the development of enhanced diagnostics (model-based reasoning) for the remainder of SDD."[72]

Building on the DOT&E work, GAO reported that "the F-35 program ... continued to encounter slower than expected progress in developing (ALIS)... Testing of this ALIS increment is about two months behind largely due to a lack of test facilities. Program officials note that they are in the process of adding facilities. The third, and final, increment of ALIS that provides full capability is not expected to be released until 2016." [73] Bogdan "could spend hours talking about what's right and what's wrong with ALIS,"[74] noting that at this point, "'(i)t is not the font of all knowledge about the airplane' as expected," [75] and that development is "in catch-up mode." [76]

[69] "Kendall: F-35 Software Review Expected by June," *Politico Pro Defense*, March 13, 2014.

[70] U.S. Government Accountability Office, *F-35 JOINT STRIKE FIGHTER: Problems Completing Software Testing May Hinder Delivery of Expected Warfighting Capabilities*, GAO-14-322, March 2014.

[71] Aaron Mehta, "After 'Transformative' Year, F-35 Program Focuses on Software, Quantity," *Defense News*, January 14, 2014.

[72] Director, Operational Test and Evaluation, *FY2013 Annual Report*, January 2014.

[73] U.S. Government Accountability Office, *F-35 JOINT STRIKE FIGHTER: Problems Completing Software Testing May Hinder Delivery of Expected Warfighting Capabilities*, GAO-14-322, March 2014, pp. 10-12.

[74] Colin Clark, "F-35′s ALIS 'Way Behind,' Bogdan Says; One Step Forward Last Week," *BreakingDefense.com*, February 25, 2014.

[75] Amy Butler, "Bogdan Warns Of Possible Six-Month F-35 Slip After Development Ends," *AviationWeek.com*, February 26, 2014.

[76] Colin Clark, "F-35′s ALIS 'Way Behind,' Bogdan Says; One Step Forward Last Week," *BreakingDefense.com*, February 25, 2014.

Cost and Funding[77]

Total Program Acquisition Cost[78]

As of December 31, 2013, the total estimated acquisition cost (the sum of development, procurement, and military construction [MilCon] costs) of the F-35 program in constant (i.e., inflation-adjusted) FY2012 dollars was about $323.5 billion, including about $59.2 billion in research and development, about $260.6 billion in procurement, and about $3.7 billion in MilCon.[79]

In then-year dollars (meaning dollars from various years that are not adjusted for inflation), the figures are about $398.6 billion, including about $54.9 billion in research and development, about $339.3 billion in procurement, and about $4.4 billion in military construction.

Prior-Year Funding

Through FY2013, the F-35 program has received a total of roughly $83.3 billion of funding in then-year dollars, including roughly $49.0 billion in research and development, about 33.1 billion in procurement, and roughly $1.2 billion in military construction.

Unit Costs

As of December 31, 2013, the F-35 program had a program acquisition unit cost (or PAUC, meaning total acquisition cost divided by the 2,457 research and development and procurement aircraft) of about $108.7 million and an average procurement unit cost (or APUC, meaning total procurement cost divided by the 2,443 production aircraft) of $89.0 million, in constant FY2012 dollars.

However, this reflects the cost of the aircraft without its engine, as the engine program was broken out as a separate reporting line in 2011.

As of December 31, 2013, the F-35 engine program had a program acquisition unit cost of about $23.0 million and an average procurement unit cost of $17.7 million in constant FY2012 dollars. Just as the reported airframe costs represent a program average and do not discriminate among the variants, the engine costs do not discriminate between the single engines used in the F-35A and C and the more expensive engine/lift fan combination for the F-35B.

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[77] The F-35 program receives (or in the past received) funding from the Air Force, Navy, and Defense-Wide research, development, test, and evaluation (RDT&E) accounts (the Defense-Wide RDT&E funding occurred in FY1996-FY1998); Non-Treasury Funds (i.e., financial contributions from the eight other countries participating in the F-35 program)—a source of additional research and development funding; the Air Force and Navy aircraft procurement accounts (the Navy and Marine Corps are organized under the Department of the Navy, and Marine Corps aircraft development and procurement costs are funded through the Navy's RDT&E and aircraft procurement accounts); and the Air Force MilCon account and the Navy and Marine Corps MilCon account.

[78] Figures in this section come from Office of the Secretary of Defense, *Selected Acquisition Report (SAR): F-35 Joint Strike Fighter Aircraft (F-35)*, December 31, 2013.

[79] The procurement cost figure of about $256.1 billion does not include the cost of several hundred additional F-35s that are to be procured other countries that are participating in the F-35 program. The $256.1 billion figure does, however, assume certain production-cost benefits for DOD aircraft that result from producing F-35s for other countries.

However, the December 31, 2013 Selected Acquisition Report broke out unit recurring flyaway costs of the three engines as well as the separate airframes, as follows:

Table 4. F-35 Projected Unit Recurring Flyaway Cost

Includes hardware costs over the life of the program and assumes 673 international sales

$M (2012)	F-35A	F-35B	F-35C
Airframe	66.0	76.8	78.2
Engine	11.7	28.7	11.5
Total	77.7	105.5	89.7

Source: Office of the Secretary of Defense, *Selected Acquisition Report (SAR): F-35 Joint Strike Fighter Aircraft (F-35)*, December 31, 2013

Critics note that the costs reported in the Selected Acquisition Reports contain a number of assumptions about future inflation rates, production learning curves, and other factors, and argue that these figures do not accurately represent the true cost of developing and acquiring the F-35.[80]

Other Cost Issues

Acquisition Cost

In its latest report on the F-35 program, the Government Accountability Office questioned the ability of the F-35 program to meet its cost targets.

> Currently the acquisition program requires $12.6 billion per year through 2037, which does not appear to be achievable given the current fiscal environment. The program is reducing unit costs to meet targets, but a significant amount of additional cost reduction is needed if it expects to meet those targets before the beginning of full rate production—currently scheduled for 2019.[81]

Although the December, 2013 Selected Acquisition Report was issued after the GAO report, the revised figures are similar to those GAO used. "The (2013 selected acquisition) report said the program's anticipated cost, which encompasses the production of 2,443 jets, rose 1.9% from last year's estimate to $398.6 billion, despite years of efforts to trim the price tag."[82]

[80] A detailed critique of the SAR figures with suggestions for alternatives appeared in *Time* magazine's "Battleland" blog. Authored by Winslow Wheeler of the Center for Defense Information, the most relevant entries are http://nation.time.com/2013/06/04/alphabet-soup-paucs-apucs-urfs-cost-variances-and-other-pricing-dodges/ and http://nation.time.com/2013/06/05/the-deadly-empirical-data/.

[81] U.S. Government Accountability Office, *F-35 JOINT STRIKE FIGHTER: Problems Completing Software Testing May Hinder Delivery of Expected Warfighting Capabilities*, GAO-14-322, March 2014, p. 12.

[82] Doug Cameron, "Pentagon official criticizes Pratt & Whitney," *Marketwatch.com*, April 17, 2014.

Unit Cost Projections

The F-35 program continues efforts to make the F-35 cost-competitive with previous-generation aircraft. (It should be noted that the articles cited below reference the cost of the F-35A, the simplest model.)

> F-35 fighter jets will sell for as little as $80 million in five years, according to the Pentagon official running the program.
>
> 'The cost of an F-35A in 2019 will be somewhere between $80 and $85 million, with an engine, with profit, with inflation,' U.S. Air Force Lieutenant General Christopher Bogdan, the Pentagon's manager of the program, told reporters in Canberra today.[83]
>
> Assistant Air Force Secretary William LaPlante said the price of the new A-model F-35 is on track to drop from $112 million now to the mid-$80 million range by 2018 or 2019, but the program is developing plans to drive the price even lower.
>
> The Government Accountability Office, a congressional watchdog agency, remains skeptical about those efforts, noting that the A-model jets procured in 2013 cost $124.8 million each, about $41 million above the Pentagon's target for 2019."[84]

As noted in **Table 4**, the average unit flyaway cost of an F-35A is officially projected at $77.7 million.

Engine Costs

Prior to the release of the December, 2013 Selected Acquisition Report on the F-35, engine maker Pratt & Whitney had embarked on a program to reduce the engine's cost.[85] [86] Following the report's release, which showed the "cost of acquiring the planned 2,443 airframes and associated systems rose 1%, while engine costs climbed 6.7%,"[87] the program manager singled out Pratt for criticism "after having improved relations with the F-35's prime contractor, Lockheed Martin Corp., securing lower prices for each batch of new airframes and closing deals far quicker than in the past."[88]

"'We had a price curve for these engines. We thought we knew how much it was going to cost … Pratt is not meeting their commitment. It is as simple as that … It is not good. Not good at all,' (Lt. Gen. Christopher) Bogdan told reporters."... "'When you are in a sole source environment it is difficult to find the right leverage and motivation and drive the cost out of a program.'"[89]

In response,

[83] Jason Scott, "F-35s to Sell for as Low as $80 Million in 2019, Pentagon Says," *Bloomberg.com*, March 11, 2014.

[84] Andrea Shalal, "U.S. focuses on cheaper, more reliable F-35 jet: Air Force official," *Reuters.com*, April 1, 2014.

[85] Andrea Shalal-Esa, "Pentagon, suppliers draft plan to lower F-35 cost: Pratt," *Reuters.com*, December 20, 2013.

[86] Andrea Shalal, "Pratt must push harder to cut F-35 engine cost -Pentagon," *Reuters.com*, April 7, 2014.

[87] Doug Cameron, "Pentagon official criticizes Pratt & Whitney," *Marketwatch.com*, April 17, 2014.

[88] Ibid.

[89] Amy Butler, "F-35 Cost Up $7.8B, Bogdan Fires on Pratt," *AviationWeek.com*, April 17, 2014.

> Pratt & Whitney spokesman Matthew Bates says the company has decreased its pricing 40% since the first production lot, but the company is claiming competitive privilege in its sole-source deal for F-35 engines in not releasing its actual numbers. Negotiations for low-rate, initial production lots 7-8 are under way and slated for completion in the summer, he says.[90]

Anticipated Upgrade Costs

The degree of concurrency in the F-35 program, in which aircraft are being produced while the design is still being revised through testing, appears to make upgrades to early-production aircraft inevitable. The cost of those upgrades may vary, depending on what revisions are made during the testing process. However, the cost of such upgrades is not included in the negotiated price of each production lot.

The first F-35As, for example, were loaded with a basic software release (Block 1B) that provides basic aircraft control, but does not have the degree of sensor fusion or weapons integration expected in later blocks. "The initial estimate for modifying early-production F-35As from a basic configuration to a capable warfighting level is $6 million per jet, plus other associated expenses not included in that figure."[91] That would make the current cost of upgrading the earliest F-35As to Block 3F about $100 million. In order to increase capability, the Air Force intends to upgrade the aircraft step-by-step as new software releases become available rather than waiting and jumping to the final release of Block 3F.

DOD is also withholding parts of payments for completed F-35s until other problems identified in earlier testing are fixed. Those issues include protection against lightning strikes, inlet doors on F-35Bs, and an onboard inert gas generator system that helps prevent fuel tank explosions. The withholds are reported to be approximately $7.1 million per affected plane, for a total of $231 million.[92]

Operating and Support Costs

Since 2011, Selected Acquisition Report projected lifetime operating and sustainment costs for the F-35 fleet have been estimated at slightly over $1 trillion,[93] "which DOD officials have deemed unaffordable. The program's long term sustainment estimates reflect assumptions about key cost drivers that the program does not control, including fuel costs, labor costs, and inflation rates."[94] "The eye-popping estimate has raised hackles at the Defense Department and on Capitol Hill since it was disclosed in 2011. It covers the cost of fuel, spare parts, logistics support and repairs."[95] It may be worth noting that "the F-35 was ... the first big Pentagon weapons program

[90] Ibid.

[91] Gabe Starosta, "Block Upgrades For Earliest F-35s To Cost $6M Per Aircraft," *InsideDefense.com*, March 26, 2014.

[92] Tony Capaccio, "Pentagon Holds Back $231 Million for Lockheed F-35 Fixes," *Bloomberg.com*, March 19, 2014.

[93] Office of the Secretary of Defense, *Selected Acquisition Report (SAR): F-35*, December 31, 2011, 2012, and 2013.

[94] U.S. Government Accountability Office, *F-35 JOINT STRIKE FIGHTER: Problems Completing Software Testing May Hinder Delivery of Expected Warfighting Capabilities*, GAO-14-322, March 2014, p. 12.

[95] Sandra I. Erwin, "Next Battle for F-35: Bring Down Operations Costs," *National Defense (nationaldefensemagazine.org)*, April 6, 2014.

to be evaluated using a 50-year lifetime cost estimate—about 20 years longer than most programs—which made the program seem artificially more expensive."[96]

"(F-35 program manager Lt. Gen. Christopher) Bogdan said his office has more recent testing data and projects the sustainment costs much lower, at $917 billion.[97]

"The operation and sustainment cost is a bigger issue," (Air Force acquisition chief William) LaPlante said. "It's the one that will say whether or not we can afford (the F-35) in the longer run."[98]

Operations costs are being addressed on several fronts, including changes in training, basing, support, and other approaches.

> To attack this problem, the F-35 program office in October 2013 set up a "cost war room" in Arlington, Va ... A team of government and contractor representatives assigned to the cost war room are investigating 48 different ways to reduce expenses. They are also studying options for future repair and maintenance of F-35 aircraft in the United States and abroad. [99]
>
> The U.S. Air Force is looking to slash the number of locations where it will base F-35 Joint Strike Fighter squadrons to bring down the jet's estimated trillion-dollar sustainment costs.... 'When you reduce the number of bases from 40 to the low 30s, you end up reducing your footprint, making more efficient the long-term sustainment,' David Van Buren, the service's acquisition executive, said in a March 2 exit interview at the Pentagon.[100]
>
> The Pentagon on Friday moved toward bringing in other companies to operate and maintain its most expensive weapons program, the F-35 Joint Strike Fighter.... The move is the latest action by the Pentagon to drive down the cost of the new single-engine, single-seat warplane, whose operations and maintenance costs are currently projected to reach a staggering $1.11 trillion over the coming decades ... the Defense Department invited companies to participate in a two-day public forum on November 14-15 on possible opportunities to compete for work managing the supply chain of the new fighter jet and providing support equipment, simulators for training and a computer-based logistics system.[101]
>
> "There are many ways to reduce sustainment costs, according to Richard Aboulafia, an analyst with the Teal Group. This could include diagnostic systems that help with spare-parts management and taking a lean approach to field repairs. 'The problem is that very often cutting your sustainment costs is at odds with actual warfighting needs, a classic battle of accountants versus logisticians,' he said. [102]

[96] Marine Corps Assistant Commandant for Aviation LtGen. Terry Robling, cited in Andrea Shalal-Esa, "Lifetime cost to run F-35 fighter: about $1 trillion," *Reuters.com*, February 26, 2012.

[97] Marcus Weisgerber, "F-35 Engine Cost Up, Sustainment Down," *Defense News*, April 17, 2014.

[98] Andrea Shalal, "U.S. focuses on cheaper, more reliable F-35 jet: Air Force official," *Reuters.com*, April 1, 2014.

[99] Sandra I. Erwin, "Next Battle for F-35: Bring Down Operations Costs," *National Defense (nationaldefensemagazine.org)*, April 6, 2014.

[100] Marcus Weisgerber, "USAF Eyes Deep Cuts To F-35 Bases," *Defense News*, March 3, 2012.

[101] Andrea Shalal-Esa, "Pentagon Seeks Competition For Sustainment Of Lockheed F-35," *Reuters.com*, September 28, 2012.

[102] Marcus Weisgerber, "USAF Eyes Deep Cuts To F-35 Bases," *Defense News*, March 3, 2012.

Deficit Reduction Commission Recommendation

On December 3, 2010, the National Commission on Fiscal Responsibility and Reform released its report on ways to decrease the United States' national debt. The commission's suggestions included canceling the F-35B outright, for a savings of $17.6 billion, and substituting F-16s and F/A-18Es for half of the planned F-35A and C purchases. The commission estimated the new fighter mix would save $9.5 billion through FY2015.[103]

Lockheed Martin chief financial officer Bruce Tanner "said the commission's proposal is currently not viable… because Lockheed Martin's Fort Worth fighter factory is now optimized for F-35 production and would only be able to build a maximum of four F-16s per month."[104]

Cost Sharing Structure

On November 19, 2010, DOD announced the award of a contract for the fourth lot of low rate initial production (LRIP) F-35s. Although other contracts have since followed (see "Approval of Three More Production Contracts" above), they follow the formula established in LRIP IV for how costs in excess of the contract target are shared between the government and contractor. Lockheed Martin and the government "would equally share the burden of a cost overrun up to 40% over the fixed price. Any overage above 40% would be Lockheed's responsibility. (For example), based on the per-unit price of roughly $126 million, the cost could go as high as about $176 million, but the price paid by the government would be capped at around $151 million."[105]

Cost Tracking

On October 5, 2010, DOD decertified the "Earned Value Management" system used by contractor Lockheed Martin to track the cost performance of the F-35 program, and began withholding some payments in March, 2012.[106] The government is allowed to withhold up to 5% of payments in case such systems are not functioning correctly. Over time, the withheld amount reached $46.5 million.[107]

> De-certification of the Fort Worth-based unit's "earned value management system" was intended to "help ensure Lockheed Martin devotes the needed attention to complete" corrective actions "in a timely manner," Pentagon spokeswoman Cheryl Irwin said in a statement via e-mail.[108]

[103] Jim Wolf, "Lockheed F-35 fighter in US deficit panel's sights," *Reuters.com*, November 10, 2010; John T. Bennett, "U.S. Debt Panel: Cut Weapon Programs," *Defense News*, December 6, 2010.

[104] Marina Malenic, "Lockheed Martin Officials Defend F-35 As 'Affordable,'" *Defense Daily*, December 3, 2010.

[105] Amy Butler, "Lockheed Says Latest F-35 Buy Following Predicted Cost Curve," *Aerospace Daily*, December 3, 2010.

[106] Tony Capaccio, "Pentagon To Withold Lockheed F-35 Payments Over Tracking," *Bloomberg.com*, February 28, 2012.

[107] Tony Capaccio, "Pentagon Withholds $47 Million From Lockheed on F-35," *Bloomberg.com*, October 26, 2012.

[108] "Lockheed Warned On Cost-Tracking," *The Washington Post*, October 6, 2010, p. 16.

Lockheed's system was recertified on December 2, 2013.[109]

Manufacturing Locations

Current plans call for the F-35 to be manufactured in several locations. Lockheed will build the aircraft's forward section in Fort Worth, TX. Northrop will build the mid-section in Palmdale, CA, and the tail will be built by BAE Systems in the United Kingdom. Final assembly of these components will take place in Fort Worth. Program officials are considering the potential of establishing a second final assembly and checkout facility in Italy.[110]

The Pratt and Whitney F135 engine for the F-35 is produced in East Hartford and Middletown, CT.

International Participation

In General

The F-35 program is DOD's largest international cooperative program. DOD has actively pursued allied participation as a way to defray some of the cost of developing and producing the aircraft, and to "prime the pump" for export sales of the aircraft.[111] Allies in turn view participation the F-35 program as an affordable way to acquire a fifth-generation strike fighter, technical knowledge in areas such as stealth, and industrial opportunities for domestic firms.

Eight allied countries—the United Kingdom, Canada, Denmark, The Netherlands, Norway, Italy, Turkey, and Australia—are participating in the F-35 program under a Memorandum of Understanding (MOU) for the SDD and Production, Sustainment, and Follow-On Development (PSFD) phases of the program, although March, 2010 reports indicated Denmark may withdraw.[112] These eight countries have contributed varying amounts of research and development funding to the program, receiving in return various levels of participation in the program. International partners are also assisting with Initial Operational Test and Evaluation (IOT&E), a subset of SDD.[113] The eight partner countries are expected to purchase hundreds of F-35s, with the United Kingdom's 138 being the largest anticipated foreign fleet.[114]

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[109] Marina Malenic, "Lockheed Martin regains aeronautics EVMS certification," *IHS Jane's Defence Weekly*, December 3, 2013.

[110] "Eventually [Lockheed Martin] may want to open a second production line in Italy to better match demand, said Tom Burbage, executive vice president and general manager of the F-35 program." Christopher Hinton, "Lockheed Martin sees international demand growing for F-35," *MarketWatch.com*, June 17, 2009.

[111] Congress insisted from the outset that the JAST program include ongoing efforts by DARPA to develop more advanced STOVL aircraft, opening the way for UK participation in the program.

[112] See, inter alia, Bill Sweetman, "Denmark bails from JSF," *Aviation Week/Ares blog*, March 15, 2010.

[113] Currently, the UK, Italy, and the Netherlands have agreed to participate in the IOT&E program. UK, the senior F-35 partner, will have the strongest participation in the IOT&E phase. Italy and the Netherlands are contributing a far smaller amount and will take part only in the coalition concept of operations (CONOPS) validation testing. (Telephone conversation with OSD/AT&L, October 3, 2007.) Other partner nations are still weighing their option to participate in the IOT&E program. The benefits to participation are expedited acquisition of aircraft, pilot training for the test cycle, and access to testing results.

[114] Gareth Jennings, "UK to approve bulk F-35B buy in 2017," *IHS Jane's 360*, February 6, 2014.

Two additional countries—Israel and Singapore—are security cooperation participants outside the F-35 cooperative development partnership.[115] Israel has agreed to purchase 20 F-35s.[116] Japan chose the F-35 as its next fighter in October 2011, and sales to additional countries are possible.[117] [118] Some officials have speculated that foreign sales of F-35s might eventually surpass 2,000 or even 3,000 aircraft.[119]

The UK is the most significant international partner in terms of financial commitment, and the only Level 1 partner.[120] On December 20, 1995, the U.S. and UK governments signed an MOU on British participation in the JSF program as a collaborative partner in the definition of requirements and aircraft design. This MOU committed the British government to contribute $200 million toward the cost of the 1997-2001 Concept Demonstration Phase.[121] On January 17, 2001, the U.S. and UK governments signed an MOU finalizing the UK's participation in the SDD phase, with the UK committing to spending $2 billion, equating to about 8% of the estimated cost

[115] DOD offers Foreign Military Sales (FMS)-level of participation in the F-35 program for countries unable to commit to partnership in the program's SDD phase. Israel and Singapore are believed to have contributed $50 million each, and are "Security Cooperative Participants." (Selected Acquisition Report, Office of the Secretary of Defense for Acquisition. December 31, 2005.)

[116] Bob Cox, "Israeli government ok's F-35 buy," *Fort Worth Star-Telegram*, September 16, 2010. Yaakov Lappin, "Israel, US Sign F-35 Agreement," *Jerusalem Post*, October 8, 2010.

[117] Paul Kallender-Umezu, "Japan F-X Competition Win Victory for JSF Program," *Defense News*, December 20, 2011.

[118] Viola Gienger, "Pentagon Awaits India's Interest in Lockheed Martin F-35 Fighter," *Bloomberg News*, November 2, 2011.

[119] Andrea Shalal-Esa, "Pentagon sees 6,000 possible F-35 sales," *Reuters.com*, June 17, 2009. See also Marina Malenic, "F-35 Sales Could Double As Countries Look To Replace Aging Fleets, General Says," *Defense Daily*, June 18, 2009: 6, and Marcus Weisgerber, "JSF Program Anticipates Nearly 700 F-35 Buys [For International Customers] Between FY-09 and FY-23, *Inside the Air Force*, July 31, 2009.

[120] International participation in the F-35 program is divided into three levels, according to the amount of money a country contributes to the program—the higher the amount, the greater the nation's voice with respect to aircraft requirements, design, and access to technologies gained during development. Level 1 Partner status requires approximately 10% contribution to aircraft development and allows for fully integrated office staff and a national deputy at director level.

Level II partners consist of Italy and the Netherlands, contributing $1 billion and $800 million, respectively. On June 24, 2002, Italy became the senior Level II partner ("F-35 Joint Strike Fighter (JSF) Lightning II: International Partners," http://www.globalsecurity.org/military/systems/aircraft/f-35-int.htm). Italy wants to have its own F-35 final assembly line, which would be in addition to a potential F-35 maintenance and upgrade facility. The Netherlands signed on to the F-35 program on June 17, 2002, after it had conducted a 30-month analysis of potential alternatives.

Australia, Denmark, Norway, Canada, and Turkey joined the F-35 program as Level III partners, with contributions ranging from $125 million to $175 million. ("Australia, Belgium Enter Joint Strike Fighter Program as EMD Partners," *Inside the Air Force*, April 21, 2000.)

Unlike the SDD phase, PSFD phase does not make any distinction as to levels of participation. Also unlike the bilateral SDD MOUs, there is a single PSFD MOU for all partner nations. In signing the PSFD MOU, partner nations state their intentions to purchase the F-35, including quantity and variant, and a determination is made as to their delivery schedule. PSFD costs will be divided on a "fair-share" based on the programmed purchase amount of the respective nation. So-called "offset" arrangements, considered the norm in defense contracts with foreign nations, usually require additional incentives to compensate the purchasing nation for the agreement's impact to its local workforce. F-35 officials decided to take a different approach, in line with the program's goal to control costs, to avoid offset arrangements and promote competition as much as possible. Consequently, all partner nations have agreed to compete for work on a "best-value" basis and have signed the PSFD MOU.

[121] "U.S., U.K. Sign JAST Agreement," *Aerospace Daily,* December 21, 1995, p. 451.

of SDD. A number of UK firms, such as BAE and Rolls-Royce, participate in the F-35 program.[122]

International Sales Quantities and Schedule

The cost of F-35s for U.S. customers depends in part on the total quantity of F-35s produced. As the program has proceeded, some new potential customers have emerged, such as South Korea and Japan, mentioned above. Other countries have considered increasing their buys, while some have deferred previous plans to buy F-35s. Recent updates to other countries' purchase plans are detailed in "Changes in International Orders," above.

Previously, the Italian government announced on February 15, 2012, that its planned buy of 131 F-35s would be reduced to 90.[123] Norway has deferred its buy by two years, to 2016.[124] The Netherlands reportedly delayed delivery of its first F-35s by four years, to 2019.[125] Canada has reduced its projected buy from 80 aircraft to 65. "'One of the reasons there will be fewer of the new fighters is we anticipate the new fighters will have significantly greater capacity than existing fighters,' Prime Minister Stephen Harper told a news conference."[126] "Defence Minister Peter MacKay, a strong advocate of the F-35, dismissed growing criticism of Canada's pledge to buy 65 of the planes as 'clatter and noise.'... Mr. MacKay said the plane is 'absolutely crucial' for the protection of North America. Later, asked if he has a plan B, he replied that no other jet is comparable."[127] On the other hand, Turkey may reportedly increase its buy from 100 to 120, and Israel from 20 to 40.[128] Australia "held off until 2012 on a further commitment,"[129] but since announced the intention to purchase 58 more F-35s (for a total of 72.)[130] [131]

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[122] BAE is a major partner to Lockheed Martin and is providing the aft fuselage, empennage, and electronic warfare suite for the aircraft. Rolls-Royce is partnered with GE on the F136 engine and is a subcontractor to Pratt and Whitney for producing components for the F-35B's STOVL lift system. In October 2009, Rolls Royce broke ground on a new plant in Virginia to make parts for the F136 engine. (Rolls Royce press release, "Rolls-Royce expands US capability; begins construction on new manufacturing facility in Virginia," October 19, 2009, available at http://www.rolls-royce.com/investors/news/2009/091019_manufacturing_virginia.jsp.) Rolls Royce's 2001 contract with Pratt and Whitney for design and development of the STOVL lift components is valued at $1 billion over 10 years. ("Rolls-Royce Finishes First JSF Propulsion System Flight Hardware," Rolls-Royce Media Room, available at http://www.rolls-royce.com/media/showPR.jsp?PR_ID=40243.) All F-35Bs, regardless of what engine they use, are to employ Rolls Royce components in their STOVL lift systems.

[123] Chiara Vasarri and Sabine Pirone, "Italy to Cut F-35 Fighter Jet Orders in Revamp," *Bloomberg News*, February 15, 2012.

[124] Robert Wall, "Norway Delays Most F-35 Deliveries," *Aerospace Daily*, September 28, 2010; John Reed, "Norway Buys 4 JSFs, Pitches New Missile," *DefenseTech.org*, June 21, 2011.

[125] Robert Wall, "Dutch Say JSF Delays Will Not Impact Air Force, For Now," *Aerospace Daily*, November 30, 2011.

[126] Randall Palmer and David Ljunggren, "Canada to buy fewer F-35 fighters than thought," *Reuters.com*, May 12, 2008. Daniel Leblanc, " Ottawa to spend $9-billion in sole-source deal for U.S. fighter jets," *The Globe and Mail*, June 8, 2010. See also "Canada Commits $8.5 Billion For 65 Lockheed Martin F-35s," *Defense Daily*, July 19, 2010; "Purchase Decision Allows Canada To Begin F-35 Planning," *Aerospace Daily*, July 19, 2010, and Dana Hedgpeth, "Lockheed In $9 Billion Jet Deal With Canada," *Washington Post*, July 17, 2010.

[127] Oliver Moore, "Panetta Reassures Canada: U.S. 'Committed' To F-35 Jet Program," *The Globe and Mail*, November 19, 2011.

[128] Umit Enginsoy and Burak Ege Bekdil, "Fighter Buys Top Turkish Shopping List," *Defense News*, April 28, 2008. Gopal Ratnam and Viola Gienger, "Israel Seeks 20 Additional F-35s After Failure Of U.S. Swap For Peace Plan," *Bloomberg.com*, December 14, 2010.

[129] Robert Wall, "Will Australian JSF Buy Avoid Delays?" *AviationWeek.com*, December 2, 2009.

[130] Matt Siegel and Andrea Shalal, "Australia orders 58 F-35 Lockheed Martin stealth fighters," *Reuters.com*, April 22, (continued...)

Friction over Work Shares and Technology Transfer

DOD and foreign partners in the JSF program have occasionally disagreed over the issues of work shares and proprietary technology. Denmark, Italy, the Netherlands, Norway, and Turkey expressed dissatisfaction in 2003-2004 with the type and quantity of the work their companies had been awarded on the F-35.[132] These countries threatened to reduce their participation in the program, or to purchase European fighters instead of the F-35.

Israel announced that it had an agreement for $5.3 billion in proposed offsets as part of its deal to acquire 20 F-35s, leading to Canadian objections that their much larger investment would yield a proportionally smaller share of offset work.[133]

The governments of Italy and the United Kingdom have lobbied for F-35 assembly facilities to be established in their countries. In July 2010, Lockheed and the Italian firm Alenia Aeronautica reached an agreement to establish an F-35 final assembly and checkout facility at Cameri Air base, Italy, to deliver aircraft for Italy and the Netherlands beginning in 2014.[134] The facility opened in July, 2013.[135] It was also reported that South Korean companies could bid for work on the F-35 if South Korea purchases the aircraft.[136]

In November 2009, it was reported that the Confederation of Danish Industries had demanded that the Danish government secure subcontract guarantees with Lockheed regarding Danish work on the F-35 program before the Danish government makes a selection to purchase the F-35 for Denmark's Combat Aircraft Replacement Program.[137]

Some foreign partners in the F-35 program have argued that the United States has been too cautious regarding the transfer of JSF technologies. Following UK expressions in early 2006 of frustration regarding technology sharing,[138] Congress included a provision (Section 233) in the FY2007 defense authorization act (H.R. 5122/P.L. 109-364 of October 17, 2006) expressing the sense of the Congress that the Secretary of Defense should share JSF technology between the

(...continued)

2014.

[131] Robert Wall, "Will Australian JSF Buy Avoid Delays?" *AviationWeek.com*, December 2, 2009.

[132] "Norway Signs Industrial Partnership with Eurofighter Consortium," *Defense Daily,* January 29, 2003. Joris Janssen Lok, "Frustration Mounts Among JSF Partners," *Jane's Defence Weekly*, March 24, 2004; Thomas Dodd, "Danish Companies Consider Quitting JSF Programme," *Jane's Defence Weekly*, January 9, 2004. Tom Kingston, "Unsatisfied Italy May Cut JSF Participation," *Defense News*, May 10, 2004. Lale Sariibrahimoglu, "Turkey may withdraw from JSF program," *Jane's Defence Weekly*, November 10, 2004.

[133] Barbara Opall-Rome and David Pugliese, "Israeli Clarification Calms Canada's Ire on Offsets," *Defense News*, December 20, 2010.

[134] Amy Butler, "Deal For Italian JSF Assembly Facility Finally Set," *Aerospace Daily*, July 20, 2010.

[135] Craig Hoyle, "An Italian view on the F-35," *Flightglobal.com/DEW Line blog*, August 7, 2013.

[136] "Lockheed Martin Dangles F-35 Work Opportunities For S. Korea," *Aerospace Daily & Defense Report*, October 21, 2009: 5.

[137] Gerard O'Dwyer, "Danish Industry Pushes for F-35 Work Guarantees," *Defense News*, November 23, 2009: 23.

[138] The UK's top defense procurement official reportedly stated in 2006 that his country would cease participation in the F-35 program if the F136 engine were cancelled and technology transfer issues were not resolved to the UK's satisfaction. (Megan Scully, "British Demand Better Access To Fighter." *National Journal's Congress Daily AM,* March 15, 2006. George Cahlink. "U.K. Procurement Chief Warns Backup Engine Dispute Threatens JSF Deal." *Defense Daily*, March 15, 2006.)

U.S. and UK governments consistent with the national security interests of both nations.[139] However, a November 24, 2009, report indicated that the Pentagon had decided not to share critical technologies with the UK.[140]

As of 2008, international content in the initial F-35 aircraft was approximately 20%, and Lockheed expected international content to potentially expand to about 30% as the program transitions to full-rate production and the supply base potentially diversifies.[141]

Proposed FY2015 Budget

FY2015 Funding Request

Table 5 shows the Administration's FY2015 request for Air Force and Navy research and development and procurement funding for the F-35 program, along with FY2013 and FY2014 funding levels.

Table 5. FY2015 Funding Request for F-35 Program

(Figures in millions of then-year dollars; FY2013 and FY2014 figures shown for reference)

	FY2013		FY2014		FY2015 (request)	
	Funding	**Quantity**	**Funding**	**Quantity**	**Funding**	**Quantity**
RDT&E funding						
Air Force	1,129.9	—	856.4	—	611.7	
Dept. of Navy	1,281.4	—	631.5	—	1,029.5	
Subtotal	2,411.3	—	1,487.9	—	1,641.2	
Procurement funding						
Air Force	2,906.3	19	3,355.9	19	4,032.6	26
Dept. of Navy	2,031.2	10	2,528.2	10	2,290.8	8
Subtotal	4,937.5	29	5,884.1	29	6,323.4	34
Spares	281.0		172.8		349.8	
TOTAL	7,629.8	29	7,544.9	29	8,314.4	34

Source: *Program Acquisition Costs by Weapons System*, Office of the Under Secretary of Defense (Comptroller)/Chief Financial Officer, March, 2014.

Notes: Figures shown do not include funding for MilCon funding or research and development funding provided by other countries. Advance procurement requested in FY2014 for future years is included in the procurement amounts shown.

[139] The text of the provision is as follows:

> SEC. 233. SENSE OF CONGRESS ON TECHNOLOGY SHARING OF JOINT STRIKE FIGHTER TECHNOLOGY.
>
> It is the sense of Congress that the Secretary of Defense should share technology with regard to the Joint Strike Fighter between the United States Government and the Government of the United Kingdom consistent with the national security interests of both nations.

[140] Jim Wolf, "U.S. to Withhold F-35 Fighter Software Code," *Reuters.com*, November 24, 2009. Rhys Jones, "UK confident U.S. will hand over F-35 fighter codes," *Reuters.com*, December 7, 2009.

[141] "F-35 International Program Content," JSF Joint Program Office paper, March 4, 2008.

According to the March, 2014 DOD justification books, procurement cost of the 26 F-35As requested for FY2015 in the Air Force budget is estimated at $3,892.6 million, or an average of $149.7 million each. These aircraft have received $339.5 million in prior-year advance procurement (AP) funding, leaving another $3,844.9 million to be funded in FY2015 to complete their estimated procurement cost. The FY2015 Air Force funding request for the F-35 program also includes $291.9 million in advance procurement funding for F-35As to be procured in future years, and $236.4 million for F-35A initial spares, bringing the total FY2015 Air Force procurement funding request for the program to $4,313.2 million.

The 6 F-35Bs and 2 F-35Cs requested for FY2015 in the Department of the Navy budget have a combined estimated procurement cost of $1,993.3 million, or an average of $249.2 million each. These aircraft have received $182.2 million in prior-year AP funding, leaving another $1,811.1 million to be funded in FY2015 to complete their estimated procurement cost. The FY2015 Department of the Navy procurement funding request for the F-35 program also includes $173.3 million in advance procurement funding for F-35Bs and Cs to be procured in future years, and $114.4 million funding for initial spares, bringing the total FY2015 Navy procurement funding request for the program to $2,098.8 million.

Issues for Congress

Overall Need for F-35

The F-35's cutting-edge capabilities are accompanied by significant costs. Some analysts have suggested that upgrading existing aircraft might offer sufficient capability at a lower cost, and that such an approach makes more sense in a budget-constrained environment. Others have produced or endorsed studies proposing a mix of F-35s and upgraded older platforms; yet others have called for terminating the F-35 program entirely. Congress has considered the requirement for F-35s on many occasions and has held hearings, revised funding, and added oversight language to defense bills. As the arguments for and against the F-35 change, the program matures, and/or the budgetary situation changes, Congress may wish to consider the value of possible alternatives, keeping in mind the program progress thus far, funds expended, evolving world air environment, and the value of potential capabilities unique to the F-35.

Planned Total Procurement Quantities

A potential issue for Congress concerns the total number of F-35s to be procured. As mentioned above, planned production totals for the various versions of the F-35 we left unchanged by the 2010 Quadrennial Defense Review (QDR). Since then, considerable new information has appeared regarding cost growth that may challenge the ability to maintain the expected procurement quantities. "'I think we are to the point in our budgetary situation where, if there is unanticipated cost growth, we will have to accommodate it by reducing the buy,' said Undersecretary of Defense Robert Hale, the Pentagon comptroller."[142]

[142] Marina Malenic, "DoD Comptroller: Further F-35 Cost Growth Jeopardizes Buy Quantity," *Defense Daily*, March 4, 2010.

Some observers, noting potential limits on future U.S. defense budgets, potential changes in adversary capabilities, and competing defense-spending priorities, have suggested reducing planned total procurement quantities for the F-35. A September 2009 report on future Air Force strategy, force structure, and procurement by the Center for Strategic and Budgetary Assessments (CSBA), for example, states that

> [A]t some point over the next two decades, short-range, non-stealthy strike aircraft will likely have lost any meaningful deterrent and operational value as anti-access/area denial systems proliferate. They will also face major limitations in both irregular warfare and operations against nuclear-armed regional adversaries due to the increasing threat to forward air bases and the proliferation of modern air defenses. At the same time, such systems will remain over-designed – and far too expensive to operate – for low-end threats….
>
> Reducing the Air Force plan to buy 1,763 F-35As through 2034 by just over half, to 858 F-35As, and increasing the [annual F-35A] procurement rate to end [F-35A procurement] in 2020 would be a prudent alternative. This would provide 540 combat-coded F-35As on the ramp, or thirty squadrons of F-35s[,] by 2021[, which would be] in time to allow the Air Force budget to absorb other program ramp ups[,] like NGB [the next-generation bomber].[143]

Program Performance

The F-35 program is behind the original schedule and budget. Congress may wish to review the causes of these issues, whether the plan put forward in February 2010 and subsequent procurement delay in February 2012 are sufficient to recover schedule and stabilize costs, and/or the credibility of projections by DOD, GAO, and others regarding the program's likely future performance.

Cost Increases and Nunn-McCurdy Breach

On March 20, 2010, DOD formally announced that the JSF program had exceeded the cost increase limits specified in the Nunn-McCurdy cost containment law, as average procurement unit cost, in FY2002 dollars, had grown 57% to 89% over the original program baseline. Simply put, this requires the Secretary of Defense to notify Congress of the breach, present a plan to correct the program, and to certify that the program is essential to national security before it can continue.[144]

> On June 2, 2010, the Under Secretary of Defense for Acquisition, Technology and Logistics issued an Acquisition Decision Memorandum (ADM) certifying the F-35 Program in accordance with section 2433a of title 10, United States Code. As required by section 2433a, of title 10, Milestone B was rescinded. A Defense Acquisition Board (DAB) was held in November 2010… No decision was rendered at the November 2010 DAB… Currently, cumulative cost and schedule pressures result in a critical Nunn-McCurdy breach to both the

[143] Thomas P. Ehrhard, *An Air Force Strategy for the Long Haul*, Washington, Center for Strategic and Budgetary Assessments, 2009, pp. xii and xiv. The report was released on September 17, 2009, according to CSBA's website, and is available at http://www.csbaonline.org/4Publications/PubLibrary/R.20090917.An_Air_Force_Strat/R.20090917.An_Air_Force_Strat.pdf. Subsequent to writing this report, the author became a special assistant to the Air Force Chief of Staff.

[144] For a history of the Nunn-McCurdy law and options for its future, see CRS Report R41293, *The Nunn-McCurdy Act: Background, Analysis, and Issues for Congress*, by Moshe Schwartz.

> original (2001) and current (2007) baseline for both the Program Acquisition Unit Cost (PAUC) and Average Procurement Unit Cost (APUC). The breach is currently reported at 78.23% for the PAUC and 80.66% for the APUC against the original baseline and 27.34% for the PAUC and 31.23% for the APUC against the current baseline.[145]

This breach led to the January 2011 program restructuring described in "Recent Developments."

February 2010 Program Restructuring

In November 2009, DOD's Joint Estimating Team issued a report (JET II) stating that the F-35 program would need an extra 30 months to complete the SDD phase. In response to JET II, the then-impending Nunn-McCurdy breach and other developments, on February 24, 2010, Pentagon acquisition chief Ashton Carter issued an Acquisition Decision Memorandum (ADM) restructuring the F-35 program. Key elements of the restructuring included the following:

- Extending the SDD phase by 13 months, thus delaying Milestone C (full-rate production) to November 2015 and adding an extra low-rate initial production (LRIP) lot of aircraft to be purchased during the delay. Carter proposed to make up the difference between JET II's projected 30-month delay and his 13-month schedule by adding three extra early-production aircraft to the test program. It is not clear how extra aircraft could be added promptly if production is already behind schedule.
- Funding the program to the "Revised JET II" (13-month delay) level, implicitly accepting the JET II findings as valid.
- Withholding $614 million in award fees from the contractor for poor performance, while adding incentives to produce more aircraft than planned within the new budget.
- Moving procurement funds to R&D. "More than $2.8 billion that was budgeted earlier to buy the military's next-generation fighter would instead be used to continue its development."[146]

"Taken together, these forecasts result in the delivery of 122 fewer aircraft over the Future Years Defense Program (FYDP), relative to the President's FY 2010 budget baseline," Carter said.[147] This reduction led the Navy and Air Force to revise their dates for IOC as noted above.

February 2012 Procurement Stretch

With the FY2013 budget, F-35 acquisition was slowed, with the acquisition of 179 previously-planned aircraft being moved to years beyond the FY2013-2017 FYDP "2017 for a total of $15.1 billion in savings."[148]

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[145] Office of the Secretary of Defense, *Selected Acquisition Report (SAR): F-35*, December 31, 2010, p. 4.

[146] Tony Capaccio, "Lockheed F-35 Purchases Delayed in Pentagon's Fiscal 2011 Plan," *Bloomberg News*, January 6, 2010.

[147] *F-35 Lightning II Joint Strike Fighter (JSF) Program Restructure Acquisition Decision Memorandum (ADM)*, Under Secretary of Defense (Acquisition, Technology & Logistics), February 24, 2010.

[148] Tony Capaccio, "Pentagon Takes $1.6 Billion From Lockheed F-35 in Biggest Cut," *Bloomberg News*, February 13, (continued...)

Concurrency

Both the F-35 program manager, Admiral David Venlet, and acting Under Secretary for Acquisition, Technology and Logistics Frank Kendall took issue in 2011 with "a fundamental assumption of the JSF business model: concurrency."[149]

> The JSF program was originally structured with a high rate of concurrency—building production model aircraft while finishing ground and flight testing—that assumed less change than is proving necessary.
>
> "Fundamentally, that was a miscalculation," Venlet said. "You'd like to take the keys to your shiny new jet and give it to the fleet with all the capability and all the service life they want. What we're doing is, we're taking the keys to the shiny new jet, giving it to the fleet and saying, 'Give me that jet back in the first year. I've got to go take it up to this depot for a couple of months and tear into it and put in some structural mods, because if I don't, we're not going to be able to fly it more than a couple, three, four, five years.' That's what concurrency is doing to us."┐

Kendall went farther:

> Putting the Lockheed Martin F-35 Joint Strike Fighter into production before flight testing had started was "acquisition malpractice," acting Pentagon acquisition chief Frank Kendall told an industry group this morning at the Center for Strategic and International Studies.
>
> The program, Kendall said, had started with "the optimistic prediction that we were good enough at modeling and simulation that we would not find problems in flight test."
>
> "That was wrong, and now we are paying for that," Kendall added.[150]

Secretary Gates's January 2011 Program Restructure

The director of the F-35 program completed a baseline technical review of the program in late 2010, "which was a technical, 'bottoms-up,' independent review of the air vehicle platform, sustainment, mission systems software, and test."[151] Responding to issues detailed in the technical review, on January 6, 2011, Secretary of Defense Gates announced a change in the F-35 testing and production plan focused on the F-35B:

> In short, two of the JSF variants, the Air Force version and the Navy's carrier-based version, are proceeding satisfactorily.
>
> By comparison, the Marine Corps' short take-off and vertical-landing (STOVL) variant is experiencing significant testing problems. These issues may lead to a redesign of the

(...continued)

2012.

[149] Richard Whittle, "JSF's Build And Test Was 'Miscalculation,' Adm. Venlet Says; Production Must Slow," *AOL Defense*, December 1, 2011.

[150] Bill Sweetman, "JSF "Acquisition Malpractice"—Pentagon Procurement Boss," *AviationWeek/Ares blog*, February 6, 2012.

[151] Director, Operational Test & Evaluation, *FY 2010 Annual Report*, December 2010, p. 13.

> aircraft's structure and propulsion, changes that could add yet more weight and more cost to an aircraft that has little capacity to absorb more of either.
>
> As a result, I am placing the STOVL variant on the equivalent of a two-year probation. If we cannot fix this variant during this time frame and get it back on track in terms of performance, cost and schedule, then I believe it should be canceled.
>
> We will also move the development of the Marine variant to the back of the overall JSF production sequence.[152]

Three major technical issues emerged for the F-35B.

The first was premature wear on hinges for the auxiliary inlet door feeding the F-35B's lift fan, which caused the F-35B fleet to be grounded in September 2010. A technical fix was in place by January 2011.

Second, cracks were discovered in a bulkhead of an F-35B used for fatigue testing "after the airplane had been subjected to the equivalent of about 1,500 hours of flight time out of a total 16,000 hours planned." Prime contractor Lockheed Martin has redesigned the bulkhead, and "'(o)ther locations of similar design are also being assessed,' company spokesman John Kent said in an e-mailed statement Jan. 11."[153] The aluminum bulkhead is unique to the F-35B; "F-35A and F-35C bulkheads are still made of titanium, as are similar bulkheads on the F-22."[154]

Third, the driveshaft, lift-fan clutch, and actuator for the F-35B's roll-post nozzles will be redesigned following discovery that the driveshaft contracts and expands more than expected, and that the other components experience more heat than anticipated during flight operations.[155]

Moving F-35B development, which had been scheduled to lead the program, to the back of the queue should reduce the impact of F-35B issues on the schedule for the A and C models, which are encountering fewer development challenges.

The schedule changes Gates announced mean that "the Pentagon now plans to order 325 jets between 2012 and 2016, 124 fewer than anticipated a few months ago.... Of the money saved by buying fewer jets, $4.6 billion would pay for continued development and testing. Another $4 billion would be used by the Pentagon for other purposes, including acquiring more F/A-18 Super Hornets, one of the planes the F-35 is supposed to replace, for the Navy."[156] The F/A-18 buy is reportedly 41 aircraft.[157]

While there are no specific criteria for the F-35B to meet in order to exit probation, "program officials have begun restructuring the program to hit four key goals … maintaining propulsion

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[152] Office of the Assistant Secretary of Defense (Public Affairs), "DOD News Briefing with Secretary Gates and Adm. Mullen from the Pentagon," press release, January 6, 2011, http://www.defense.gov/transcripts/transcript.aspx?transcriptid=4747.

[153] Dave Majumdar, "Lockheed: One F-35B Problem Fixed," *DefenseNews.com*, January 10, 2011.

[154] Bill Sweetman, "Major F-35B Component Cracks In Fatigue Test," *AviationWeek/Ares blog*, November 17, 2010.

[155] Stephen Trimble, "New design changes raises pressure on future of F-35B variant," *Flight International*, January 12, 2011.

[156] Bob Cox, "Defense Secretary Proposes Cutting 124 F-35 Purchases," *Fort Wiorth Star-Telegram*, January 7, 2011.

[157] Andrea Shalal-Esa, "Pentagon delays F-35, buys more Boeing fighters," *Reuters*, January 6, 2011.

levels while reducing aircraft weight, ensuring the aircraft's ability to gain full flight clearance, proving the fighter's suitability for ship operations and hitting the program's key performance parameters."[158]

Subsequently, the incoming F-35 program manager, Maj Gen Christopher Bogdan, caled that restructuring "a great gift," adding, "We will not go back and ask for any more, simple as that," he said. "This is fundamentally a fixed-price development program." [159]

Competition

Lt. Gen. Bogdan's comments regarding the difficulty of cost control in a sole-source environment (see "Engine Costs," above) reflect a broader issue affecting defense programs as industry consolidates and fewer sources of supply are available for advanced systems.[160] Congress may wish to consider the merits of maintaining competition when overseeing system procurements (for example, the use of competition to maintain cost pressure was a principal argument in favor of the F-35 alternate engine program.)[161]

Affordability and Projected Fighter Shortfalls

An additional potential issue for Congress for the F-35 program concerns the affordability of the F-35, particularly in the context of projected shortfalls in both Air Force fighters and Navy and Marine Corps strike fighters.

Although the F-35 was conceived as a relatively affordable strike fighter, some observers are concerned that in a situation of constrained DOD resources, F-35s might not be affordable in the annual quantities planned by DOD, at least not without reducing funding for other DOD programs. As the annual production rate of the F-35 increases, the program will require more than $10 billion per year in acquisition funding at the same time that DOD will face other budgetary challenges. The issue of F-35 affordability is part of a larger and long-standing issue concerning the overall affordability of DOD's tactical aircraft modernization effort, which also includes procurement of F/A-18E/Fs (through FY2012, at least).[162] Some observers who are concerned about the affordability of DOD's desired numbers of F-35s have suggested procuring upgraded F-16s as complements or substitutes for F-35As for the Air Force, and F/A-18E/Fs as complements or substitutes for F-35Cs for the Navy.[163] F-35 supporters argue that F-16s and F/A-18E/Fs are less capable than the F-35, and that the F-35 is designed to have reduced life-cycle costs.

[158] Carlo Muñoz, "Venlet: No 'Black And White' Metrics To Evaluate Future of Suspended STOVL Program," *Defense Daily*, February 16, 2011.

[159] Marcus Weisgerber, "2-star F-35 chief raps Lockheed relations," *Air Force Times*, September 18, 2012.

[160] See testimony of Moshe Schwartz, CRS Specialist in Defense Acquisition, U.S. Congress, House Committee on Armed Services, *Twenty-five years of Acquisition Reform: Where do we go from here?*, 113th Cong., 2nd sess., October 29, 2013.

[161] For more on this issue, see CRS Report R41131, *F-35 Alternate Engine Program: Background and Issues for Congress*.

[162] For more on this issue, see CRS Report RL33543, *Tactical Aircraft Modernization: Issues for Congress*.

[163] See, inter alia, George Wilson, "Kill the F-35?" *CongressDaily AM*, March 22, 2010.

The issue of F-35 affordability occurs in the context of a projected shortfall of up to 800 Air Force fighters that was mentioned by Air Force officials in 2008,[164] and a projected shortfall of more than 100 (and perhaps more than 200) Navy and Marine Corps strike fighters.[165] In the interim, "in light of delays with the F-35 Lightning II Joint Strike Fighter, the U.S. Air Force is set to begin looking at which of its newer F-16s will receive structural refurbishments, avionics updates, sensor upgrades or all three."[166]

Future of Marine Corps Aviation

The possibility of increasing unit cost due to lower quantities, coupled with the testing and development challenges unique to the STOVL B model, have led some commentators[167] to question whether the Marine Corps will or should continue to acquire the F-35B. Marine Corps doctrine states that the Marine Air Ground Task Force (MAGTF) must include organic tactical aviation assets. Some note that advances in threat make forward operation of STOVL aircraft increasingly impractical, and that Navy or Marine F-35Cs flown from carriers could provide air capability for forces ashore. Although conscious of the threat to forward operating bases, Under Secretary of the Navy Robert Work

> said that the Marine Corps' short take-off vertical-landing version of the Joint Strike Fighter, which has faced the most troubles in the turbulent JSF program, will still provide a vital capability.... "Having the flexibility of a short take-off vertical-landing aircraft that's supersonic, that's stealthy, that works in tandem with longer-range Navy systems off a wide variety of ships really provides us with a lot of capability."[168]

The Marine Corps intends to build in a hedge against possible further delays in the F-35B by extending the life of its F/A-18 fleet to 2030, in part by using surplus Navy F-18s. The Corps plans to retire is AV-8 Harrier fleet around 2024.[169]

Implications for Industrial Base

Another potential issue for Congress regarding the F-35 program concerns its potential impact on the U.S. tactical aircraft industrial base. The award of the F-35 SDD contract to a single company (Lockheed Martin) raised concerns in Congress and elsewhere that excluding Boeing from this program would reduce that company's ability to continue designing and manufacturing fighter aircraft.[170]

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[164] Testimony of Lieutenant General Daniel Darnell, Deputy Chief of Staff, Air, Space and Information Operations, Plans and Requirements, before an April 9, 2008, hearing on Air Force and Navy aviation programs before the Airland subcommittee of the Senate Armed Services Committee. (Source: Transcript of hearing.)

[165] For more on the projected Navy-Marine Corps strike fighter shortfall, see CRS Report RL30624, *Navy F/A-18E/F and EA-18G Aircraft Program*.

[166] John Reed, "JSF Woes Push AF to F-16s," *DoD Buzz*, November 4, 2010.

[167] See, *inter alia,* Bill Sweetman, "The Next JSF Debate," *Aviation Week/Ares blog*, October 25, 2010.

[168] Cid Standifer, "Joint Amphibious Assaults Will Be Phased, Count On Air Force And Army," *Inside the Navy*, August 9, 2010.

[169] Remarks of Brigadier General Matthew G. Glavy, Assistant Deputy Commandant for Aviation, United States Marine Corps, at the Center for Strategic and International Studies, 28 April 2014.

[170] For more information, see CRS Report RL31360, *Joint Strike Fighter (JSF): Potential National Security Questions Pertaining to a Single Production Line*, by Christopher Bolkcom and Daniel H. Else.

Similar concerns regarding engine-making firms have been raised since 2006, when DOD first proposed (as part of the FY2007 budget submission) terminating the F136 alternate engine program. Some observers are concerned that that if the F136 were cancelled, General Electric would not have enough business designing and manufacturing fighter jet engines to continue competing in the future with Pratt and Whitney (the manufacturer of the F135 engine). Others argued that General Electric's considerable business in both commercial and military engines was sufficient to sustain General Electric's ability to produce this class of engine in the future.

Exports of the F-35 could also have a strong impact on the U.S. tactical aircraft industrial base through export. Most observers believe that the F-35 could potentially dominate the combat aircraft export market, much as the F-16 has. Like the F-16, the F-35 appears to be attractive because of its relatively low cost, flexible design, and promise of high performance. Competing fighters and strike fighters, including France's Rafale, Sweden's JAS Gripen, and the Eurofighter Typhoon, are positioned to challenge the F-35 in the fighter export market.

Some observers are concerned that by allowing foreign companies to participate in the F-35 program, DOD may be inadvertently opening up U.S. markets to foreign competitors who enjoy direct government subsidies. A May 2004 GAO report found that the F-35 program could "significantly impact" the U.S. and global industrial base.[171] GAO found that two laws designed to protect segments of the U.S. defense industry—the Buy American Act and the Preference for Domestic Specialty Metals clause—would have no impact on decisions regarding which foreign companies would participate in the F-35 program, because DOD has decided that foreign companies that participate in the F-35 program, and which have signed reciprocal procurement agreements with DOD to promote defense cooperation, are eligible for a waiver.

Future Joint Fighter Programs

DOD states that the F-35 program "was structured from the beginning to be a model of acquisition reform, with an emphasis on jointness, technology maturation and concept demonstrations, and early cost and performance trades integral to the weapon system requirements definition process."[172] A subsequent RAND Corporation study found that the fundamental concept behind the F-35 program—that of making one basic airframe serve multiple services' requirements—may have been flawed.[173]

[171] General Accountability Office, *Joint Strike Fighter Acquisition: Observations on the Supplier Base*, GAO-04-554, May 2004.

[172] Department of Defense. *Selected Acquisition Report (SAR)[for] F-35 (JSF)*, December 31, 2007, p. 4.

[173] Mark A. Lorell, Michael Kennedy, Robert S. Leonard, Ken Munson, Shmuel Abramzon, David L. An, Robert A. Guffey, *Do Joint Fighter Programs Save Money?*, RAND Project Air Force, Santa Monica, CA, 2013, http://www.rand.org/pubs/monographs/MG1225.html.

Legislative Activity for 2014

Table 6. Summary of Action on FY2014 F-35 Quantities and Funding

Funding figures in millions of dollars, rounded to nearest tenth

Cuts are detailed in "Legislative Activity for 2014" below.

		Authorization (H.R. 3304 /S. 1253)			Appropriations (S. 3800/H.R. 2219)		
	Request	HASC report	SASC report	Conference report	HAC report	SAC report	Conference report
Procurement quantities							
F-35As (Air Force)	19	19	19	19	19	19	19
F-35Bs (Marine Corps)	6	6	6	6	6	6	6
F-35Cs (Navy)	7	7	7	7	7	6[a]	7
Total	32	32	32	32	32	31	32
Procurement funding							
Air Force procurement funding	3,060.8	3,060.8	3,060.8	2,989.3	2,863.5	2,911.3	2,889.6
Air Force advance procurement funding	363.8	363.8	363.8	363.8	323.5	315.3	339.5
Navy procurement funding	2,402.7[b]	2,402.7	2.402.7	2,402.7	2,276.6[c]	2,275.0[d]	2,204.9[e]
Navy advance procurement funding	198.0[f]	198.0	198.0	198.0	198.0	169.5[g]	182.2
Research and development funding							
Air Force	849.3	849.3	849.3	849.3[h]	798.5	802.2	631.5[i]
Navy	1,046.8[j]	1,046.8	1,046.8	1,026.8	1,020.5	1,006.8	856.5

Source: Prepared by CRS based on committee reports, bill text, and floor amendments.

a. $151 million cut for 1 aircraft; $100 million added (from initial spares execution) to cover concurrency costs.

b. $1,135.4 million for 4 F-35Cs; 1,267.3 million for 6 F-35Bs.

c. $1,076.1 million for 4 F-35Cs, $1,200.5 million for 6 F-35Bs.

d. $1,058.7 million for 4 F-35Cs; $1,216.3 million for 6 F-35Bs.

e. $1,028.4 million for 4 F-35Cs; $1,176.5 million for 6 F-35Bs.

f. $94.8 million for F-35C; $103.2 million for F-35B.

g. $63.3 million for F-35C; $103.2 million for F-35B.

h. $816.3M for JSF EMD and $33.0M for F-35 Squadrons.

i. $628.5 million for EMD and $3.0 million for F-35 Squadrons.

j. $512.6 million Navy; $534.2 million Marine Corps

FY2014 Defense Authorization Act (H.R. 1960/S. 1197)

House

As passed by the House, H.R. 1960 funded all F-35 accounts at the Administration's requested amounts. Section 145 of the bill repealed the requirement for the F-35 program to report a system maturity matrix:

> SEC. 145. REPEAL OF CERTAIN F-35 REPORTING REQUIREMENTS.
>
> Section 122 of the Ike Skelton National Defense Authorization Act for Fiscal Year 2011 (P.L. 111-383; 124 Stat. 4157) is amended—
>
> (1) by striking subsection (b); and
>
> (2) by redesignating subsection (c) as subsection (b).

H.R. 1960 also established a new requirement to report on the F-35's software development.

> SEC. 219. REVIEW OF SOFTWARE DEVELOPMENT FOR F-35 AIRCRAFT.
>
> (a) Review- The Under Secretary of Defense for Acquisition, Technology, and Logistics shall establish an independent team consisting of subject matter experts to review the development of software for the F-35 aircraft program (in this section referred to as the `software development program'), including by reviewing the progress made in—
>
> (1) managing the software development program; and
>
> (2) delivering critical software capability in accordance with current program milestones.
>
> (b) Report- Not later than March 3, 2014, the Under Secretary shall submit to the congressional defense committees a report on the review under subsection (a). Such report shall include the following:
>
> (1) An assessment by the independent team with respect to whether the software development program—
>
> (A) has been successful in meeting the key milestone dates occurring before the date of the report; and
>
> (B) will be successful in meeting the established program schedule.
>
> (2) Any recommendations of the independent team with respect to improving the software development program to ensure that, in support of the start of initial operational testing, the established program schedule is met on time.

> (3) If the independent team determines that the software development program will be unable to deliver the full complement of software within the established program schedule, any potential alternatives that the independent team considers appropriate to deliver such software within such schedule.

The report accompanying H.R. 1960, H.Rept. 113-102, explained the provision thusly:

> F–35 aircraft program
>
> The budget request contained $1.9 billion in PEs 64800F, 64800N, and 64800M for development of the F–35 aircraft. The budget request also contained $5.5 billion in Aircraft Procurement, Air Force and Aircraft Procurement, Navy for procurement of 19 F–35As, 6 F–35Bs, and 4 F–35Cs.
>
> The F–35 aircraft program is the largest acquisition program within the Department of Defense, with a current planned procurement of 2,443 aircraft for the Navy, the Marine Corps, and the Air Force to meet fifth generation U.S. fighter requirements. The committee continues to support the requirement for fifth generation fighter aircraft due to projected increases in the effectiveness and quantities of threat anti-aircraft ground systems and adversary air- craft and their associated air-to-air weapons. The committee notes that without advanced fifth generation aircraft that the United States may be significantly limited in its ability to project power in the future.
>
> The F–35 program is approximately 34 percent through its flight test program which is planned to be completed in the first quarter of fiscal year 2018. The committee notes that the F–35 program executive officer believes the F–35 program is now on a realistic baseline with slow, but steady progress being made. The committee also notes that the F–35 program executive officer has identified the software development for the final development software block, known as block 3F, as an area with some risk remaining. At a hearing held by the Subcommittee on Tactical Air and Land Forces on April 17, 2013, the witness from Government Accountability Office also identified block 3F software as an area of risk because of its complexity. The committee shares this concern. Accordingly, elsewhere in this Act, the committee recommends a provision that would require the Under Secretary of Defense for Acquisition, Technology, and Logistics to establish an independent team consisting of subject matter experts to review the development of F–35 software and to submit a report to the congressional defense committees by March 3, 2014.

Under Title XVI, Industrial Base Matters, H.Rept. 113-102 included other language relevant to the F-35 program:

> Specialty Metals Clause Waiver Processes and Notification
>
> The committee is concerned that the Department of Defense (DOD) issued national security waivers to the specialty metals clause under section 804 of the National Defense Authorization Act for Fiscal Year 2008 (Public Law 110–181) for certain samarium-cobalt magnets and magnet assemblies in the F–35 Lightning II aircraft. The committee is aware that at least two qualified sup- pliers in the domestic defense industrial base currently hold con- tracts directly with the Department for similar magnets and mag- net assemblies. Moreover, a third qualifying supplier indirectly pro- vides these materials to the Department through other prime con- tractors. These qualifying suppliers continue to manufacture samarium-cobalt magnets and magnet assemblies for fixed wing, missile, and radar programs. The committee is increasingly concerned that this use of national security waivers contravenes the congressional intent of Public Law 110–181, which, among other purposes, is to facilitate competition and guarantee a secure supply chain of certain materials.

Therefore, the committee directs the Comptroller General of the United States to investigate the issuance of these national security waivers for samarium-cobalt magnets and magnet assemblies, and to submit a report to the congressional defense committees by March 1, 2014, that includes, at minimum, a description of the following:

(1) The extent to which distributor-fabricators who supplied non-compliant samarium-cobalt magnets and magnet assemblies to DOD prime or subcontractors knowingly and/or will-fully supplied samarium-cobalt magnets and magnet assemblies manufactured by foreign suppliers to subcontractors for inclusion in the F–35 program;

(2) The extent to which distributor-fabricators who supplied non-compliant samarium-cobalt magnets and magnet assemblies to DOD prime or subcontractors were aware of, or en- gaged with, qualified sources for samarium-cobalt magnets and magnet assemblies on other commercial or defense contracts;

(3) The extent to which acquisition officials within the Office of the Secretary of Defense (OSD) and the F–35 Joint Program Office were aware of, or engaged with, qualified sources for samarium-cobalt magnets and magnet assemblies on other sub- contracts;

(4) The criteria, method, or process utilized by OSD acquisition officials to define and determine ''knowing and willful'' as it pertains to noncompliance with the specialty metals clause;

(5) Recommendations to improve the criteria, method, or process utilized by OSD acquisition officials to define and determine ''knowing and willful'' as it pertains to noncompliance with the specialty metals clause;

(6) Recommendations for DOD acquisition policy changes, such as consideration of previous noncompliance on future con- tracts, fines by non-compliant lower-tier suppliers, or suspension and debarment, that may adequately deter or dissuade lower-tier suppliers from knowingly and/or willingly violating acquisition regulations and other rules promulgated in accordance with section 2533b of title 10, United States Code; and

(7) Recommendations to improve the Department's supply chain management procedures and actions necessary to prevent such lapses in the future.

Senate

As passed by the House, S. 1197 funded all F-35 accounts at the Administration's requested amounts. The report accompanying S. 1197, S.Rept. 113-44, included language on two F-35 issues:

F–35 production rate

The committee believes that the continued development and funding of all three variants of the F–35 Joint Strike Fighter is critical to maintaining U.S. air dominance. The committee supported restructuring the program to keep production remaining flat for the past 4 years to reduce concurrency risk and allow the program to make additional progress in the testing program before ramping up production. The committee notes that the program has been executing close to the planned testing and development schedule. The Marine Corps will declare initial operational capability (IOC) in 2015 with the Block 2B software capability. The Air Force will declare IOC in 2016 with the Block 2B/3I software capability, rather than waiting for the Block 3F capability as previously planned. The Navy will declare IOC in late 2018 with the Block 3F software capability. Achieving these IOC dates depend in part on

> increasing production according to the current plan. With the program now achieving most testing milestones, the committee believes that the Department of Defense should seriously consider continuing with the current plan to increase production in fiscal year 2015 and beyond.
>
> F–35 technical issues
>
> In his testimony before the Subcommittee on Airland of the Senate Committee on Armed Services, the F–35 Program Executive Officer (PEO) discussed the development issues which present the greatest technical risks to the program. Regarding the software, the committee notes that a critical design review (CDR) is planned which will shed more light on progress of the Block 3F software against the requirements and delivery timeline. Block 3F software provides the capability that will allow all three services to declare full operational capability. The committee directs the PEO to provide a briefing to the congressional defense committees on the results of the CDR within 30 days of its conclusion. In addition to software, the PEO also highlighted other known technical risks to the F–35 program, to include the helmet mounted display system, the tailhook, the fuel dumping system, and the autonomic logistics information system. The committee directs the F– 35 PEO to provide a briefing to the congressional defense committees on the status of the risk and cost reduction efforts to these four systems within 30 days from the completion of any major test objective or risk reduction effort involving these four programs.

The Senate report also discussed F-35s in the context of naval aviation:

> Department of the Navy strike fighter inventories
>
> Throughout the past several years, the committee has expressed concern that the Navy is facing a sizeable gap in aircraft inventory as older F/A–18A–D retire before the aircraft carrier variant (F– 35C) of the Joint Strike Fighter is available to replace them. In any case, the F/A–18E/F will be a critical part of the Navy's fleet for the next 25 years, complementing the Navy's F–35C. The F–35C is expected to reach initial operational capability in late 2018. Additionally, the Navy now intends to inspect legacy F/A–18A– D aircraft periodically above 8,000 flight hours, in combination with executing a service life extension program (SLEP) on 150 of those aircraft, in an effort to extend a portion of the inventory to 10,000 hours. As yet, the Navy does not have sufficient data to predict the failure rate for aircraft being inducted into the SLEP. The current SLEP engineering analysis has not been completed. In addition, the costs and schedules associated with the Navy's plans remain unknown. As a result, executing the Navy's plan could negatively impact the tactical aviation shortfall, as there are already reports of aircraft backed up at Navy depots awaiting parts and maintenance. The committee understands that more than 42 percent of the legacy F/A–18A–D aircraft, approximately 260 aircraft, are currently out of service awaiting some form of maintenance, inspection, or repair.
>
> The committee believes a strong carrier-based fleet is vital as part of the increased emphasis on the Pacific region. This emphasis requires the Navy to have a viable fleet of both F/A–18E/F and F– 35C aircraft to avoid creating a risk for the Navy's future strike fighter force structure.

Final Action

Following conference, H.R. 1960 and S. 1197 were passed as P.L. 113-66, the National Defense Authorization Act for Fiscal Year 2014. P.L. 113-66 funded the F-35 accounts at the amounts requested by the Administration, with two exceptions:

Table 7. FY2014 Authorization Final Actions on F-35A Procurement

in Aircraft Procurement, Air Force ($M)

Item	Amount
Requested for F-35As	3,060,770
Non-recurring engineering - cost growth initiatives	-71,500
Authorized	2,989,270

Table 8. FY2014 Authorization Final Actions on Navy F-35 Research & Development

in Research, Development, Test, & Engineering, Navy ($M)

Item	Amount
Requested for F-35 EMD	512,631
F-35B follow-on development ahead of need	-10,000
Authorized for F-35 EMD	502,631
Requested for F-35	534,187
F-35B follow-on development ahead of need	-10,000
Authorized for F-35	524,187

The joint explanatory statement accompanying P.L. 113-66 included the following text:

> Repeal of certain F–35 reporting requirements (sec. 142)
>
> The House bill contained a provision (sec. 145) that would amend section 122 of the Ike Skelton National Defense Authorization Act for Fiscal Year 2011 (P.L. 111-383) to eliminate the requirement to provide an annual update to the F-35 system maturity matrix.
>
> The Senate committee-reported bill contained no similar provision.
>
> The agreement includes this provision.
>
> Review of software development for F–35 aircraft (sec. 218)
>
> The House bill contained a provision (sec. 219) that would require the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) to establish an independent team consisting of subject matter experts to review the development of software for the F–35 aircraft program and to report on the results of that review.
>
> The Senate committee-reported bill contained no similar provision.
>
> The agreement includes the House provision with an amendment that would require the USD(AT&L) to provide a plan for the sustainment of the Autonomic Logistics Information System for the F-35 aircraft.
>
> F–35 Sustainment Plan
>
> The committee recognizes the importance of the F–35 Joint Strike Fighter Program to our national defense. This advanced fighter aircraft will replace a variety of existing aircraft in the Air Force, the Navy, and the Marine Corps. In 2012, the Department of Defense reported

that sustainment of the F–35 aircraft fleet could cost more than $1.0 trillion (in then-year dollars) over the planned 30-year service life. However, the Department has said that it is actively engaged in evaluating opportunities to reduce life-cycle sustainment costs based on concerns about the affordability of the program. Past experience has shown that decisions made during the development of a weapon system can influence, positively or negatively, the cost of sustaining that system over its life cycle. Considering the magnitude of the estimated sustainment costs for the F–35, the committee is concerned about whether the Department has established comprehensive sustainment plans, developed appropriate cost analyses, and identified potential options to control and/or minimize future sustainment costs for the aircraft program. Given the fiscal uncertainties facing the Department and growing concerns related to the affordability of the F–35's long- term sustainment costs, the committee directs the Government Accountability Office (GAO) to review the Department's ongoing F–35 sustainment planning efforts. This review should include:

(1) The extent to which the Department has developed comprehensive sustainment plans, including a Life-Cycle Sustainment Plan, and regularly updated these plans to reflect program changes;

(2) The extent to which the Department has utilized appropriate analyses of operating and support costs, including a business case analysis, to evaluate the full range of sustainment options available for the F–35 program; (3) The extent to which the Department is pursuing additional opportunities, such as competition for sustainment contracts, to reduce long-term sustainment costs; and

(4) Any other issues that the Comptroller General determines appropriate with respect to the sustainment of the F–35.

The committee directs the Comptroller General of the United States to provide a preliminary briefing by March 14, 2014, on the above factors, with a report or reports to follow.

In Title XVI, Industrial Base Matters, the conference report included the following:

Report on the Implementation of Rare Earth Elements Strategy in the Joint Strike Fighter Program

The committee is aware that the Department of Defense intends to pursue a three-pronged strategy to secure supplies of rare earth elements, which consists of diversification of supply, pursuit of substitutes, and a focus on reclamation of waste as part of a larger U.S. Government recycling effort. However, it remains unclear how this strategy will be implemented in the Department's major defense acquisition programs (MDAPs). Several high-profile MDAPs, including the F-35 Lightening II program, may use significant amounts of rare earth elements in full-rate production. The committee is concerned that the introduction of substitute materials and components may increase acquisition and sustainment costs through the qualification of manufacturers for substitutes, implementation of engineering changes to accommodate substitutes, and the long-term costs associated with supplier networks.

Therefore, the committee directs the Assistant Secretary of the Navy for Research, Development and Acquisition, in coordination with the Program Executive Officer for the F-35, to submit a report to the congressional defense committees by February 15, 2014, on the potential for substitution of components and materials into F-35 aircraft to reduce consumption of rare earth materials. The report, which may include a classified annex, should include the following:

(1) A list and description of subsystems that contain rare earth elements and the approximate quantities of each rare earth element by subsystem;

(2) An assessment of the potential to incorporate substitute components or materials in each subsystem based on technical acceptability, to include consideration of performance requirements, and engineering changes that may be necessary for integration of the substitute; and

(3) An assessment of the potential to incorporate substitute components or materials in each subsystem based on cost acceptability to include consideration of material costs, qualification and testing costs, and engineering change costs.

FY2014 Defense Appropriations Act (H.R. 2397/S. 1429)

House

In H.R. 2397 and its accompanying report (H.Rept. 113-113, accompanying H.R. 2397), the House made the following funding changes from the requested amounts in the F-35 accounts. The bill and report did not include additional language on the F-35.

Table 9. FY2014 House Appropriations Actions on F-35A Procurement

in Aircraft Procurement, Air Force ($M)

Item	Amount
Requested for F-35	3,060,770
Life-of-type buys previously funded	-22,932
Non-recurring engineering - restrain cost growth	-128,000
Engine cost growth	-2,736
Simulators cost growth	-8,600
Production engineering support growth	-35,000
Appropriated for F-35	2,863,502
Requested for F-35 Modifications	157,777
Block 3i upgrades ahead of need	-63,420
Concurrency modifications	-31,000
Appropriated for F-35	63,357

Table 10. FY2014 House Appropriations Actions on Air Force F-35 R&D

in Research, Development, Test, & Engineering, Air Force ($M)

Item	Amount
Requested for F-35	816,335
Deployability and Suitability Enhancements delay	-17,800
Appropriated for F-35	798,535
Requested for F-35 Squadrons	33,000
Block 4 ahead of need	-23,000
Appropriated for F-35 Squadrons	10,000

Table 11. FY2014 House Appropriations Actions on Navy F-35 Procurement

in Aircraft Procurement, Navy ($M)

Item	Amount
Requested for Joint Strike Fighter	1,135,444
Airframe/CFE cost growth	-7,024
Engine cost growth	-2,552
Airframe PGSE growth	-35,000
Engine PGSE growth	-9,000
Unit cost savings due to life of type buys previously funded	-5,753
Appropriated for Joint Strike Fighter	1,076,115
JSF STOVL	1,267,260
Engine cost growth	-47,586
NRE growth	-10,000
Unit cost savings due to life of type buys previously funded	-9,176
Appropriated for JSF STOVL	1,200,498

Table 12. FY2014 House Appropriations Actions on Navy F-35 R&D

in Research, Development, Test, & Engineering, Navy ($M)

Item	Amount
Requested for Joint Strike Fighter (JSF) - EMD	512,631
F-35B follow-on development ahead of need	-14,904
Appropriated for Joint Strike Fighter (JSF) - EMD	497,727
Requested for Joint Strike Fighter (JSF)	534,187
F-35B follow-on development ahead of need	-11,442
Appropriated for Joint Strike Fighter (JSF)	522,745

Senate

Table 13. FY2014 Senate Appropriations Actions on F-35A Procurement

in Aircraft Procurement, Air Force ($M)

Item	Amount
Requested for F-35	3,060,770
Restoring acquisition accountability: decrease tooling	-78,000
Restoring acquisition accountability: decrease non-recurring engineering initiatives	-71,500
Appropriated for F-35	2,911,270
Requested for F-35 Advance Procurement	363,783
Restoring acquisition accountability: reduce by 4 aircraft	-48,500
Appropriated for F-35 Advance Procurement	315,283

Table 14. FY2014 Senate Appropriations Actions on Air Force F-35 R&D

in Research, Development, Test, & Engineering, Air Force ($M)

Item	Amount
Requested for F-35 EMD	816,335
Maintaining program affordability: F-135 Propulsion System cost growth	-20,000
Appropriated for F-35 EMD	796,335
Requested for F-35 Squadrons	33,000
Restoring acquisition accountability: Follow-on Development-no approved Capabilities Development Document	-10,000
Restoring acquisition accountability: Developmental Test and Evaluation-no approved Capabilities Development Document	-7,100
Restoring acquisition accountability: B61-no approved Capabilities Document	-10,000
Appropriated for F-35 Squadrons	5,900

Table 15. FY2014 Senate Appropriations Actions on Navy F-35 Procurement

in Aircraft Procurement, Navy ($M)

Item	Amount
Requested for Joint Strike Fighter CV	1,135,444
Restoring acquisition accountability: decrease tooling	-40,000
Restoring acquisition accountability: decrease non-recurring engineering initiatives	-36,700
Appropriated for Joint Strike Fighter CV	1,058,744
Requested for Joint Strike Fighter CV advance procurement	94,766

Item	Amount
Restoring acquisition accountability: reduce by 2 aircraft	-31,500
Appropriated for Joint Strike Fighter CV advance procurement	63,266
Requested for JSF STOVL	1,267,260
Restoring acquisition accountability: decrease tooling	-34,000
Restoring acquisition accountability: decrease non-recurring engineering initiatives	-17,000
Appropriated for JSF STOVL	1,216,260

Table 16. FY2014 House Appropriations Actions on Navy F-35 R&D

in Research, Development, Test, & Engineering, Navy ($M)

Item	Amount
Requested for Joint Strike Fighter (JSF)-EMD Navy	512,631
Maintain program affordability: F-135 Propulsion system cost growth	-10,000
Restoring acquisition accountability: Follow-on development-no approved capabilities development document	-5,000
Restoring acquisition accountability: Development test and evaluation-no approved capabilities development document	-5,000
Appropriated for Joint Strike Fighter (JSF)-EMD Navy	492,631
Requested for Joint Strike Fighter (JSF)-EMD USMC	534,187
Maintain program affordability: F-135 Propulsion system cost growth	-10,000
Restoring acquisition accountability: Follow-on development-no approved capabilities development document	-5,000
Restoring acquisition accountability: Development test and evaluation-no approved capabilities development document	-5,000
Appropriated for Joint Strike Fighter (JSF)-EMD USMC	514,187

Additionally, the Senate report (S.Rept. 113-85, accompanying S. 1429) stated:

> F-35 JOINT STRIKE FIGHTER
>
> On June 19, 2013, the Committee held its first dedicated hearing on the F-35 Joint Strike Fighter [JSF]. While the program is making progress in the development and test of the aircraft, significant challenges remain. Therefore, the Committee recommends the following adjustments to the fiscal year 2014 budget request to ensure that the program stays focused on reducing risk in the development and test phase, remains on a positive trend of reducing concurrency costs, and is affordable for both U.S. and allied purchase now and into the future.
>
> The Department's fiscal year 2014 request maintains production of F-35 aircraft at 29 aircraft, consistent with 2013 levels, but increases advance procurement of 2015 aircraft by 13, to a total of 42 aircraft. This would be a 45-percent increase in production when the F-35 program continues to experience considerable challenges with software development, system reliability, and maintenance system development. Given the scope of issues that must be

addressed in this phase of the program, a large increase in the production of aircraft is not yet warranted. However, the Committee acknowledges the positive trends in the program and understands the need to increase production rates to bring down unit cost. Therefore, the Committee recommends an increase in fiscal year 2014 advance procurement of seven aircraft for the Air Force variant for a total of 26 aircraft, a reduction in advance procurement of four aircraft and $48,000,000. In addition, the Committee does not recommend increased advance procurement for the Navy F-35 variant since it remains behind the other two variants in testing, a reduction of two aircraft and $31,500,000. This recommendation provides a 24-percent increase in F-35 production from fiscal year 2014 to fiscal year 2015, or an increase of seven aircraft.

The budget request includes $32,000,000 to start the follow-on development program. The Committee believes it is too early to start new efforts when the current development program still has challenges and, therefore, recommends a $20,000,000 reduction. The remaining funds should be used to complete the analysis and staffing necessary to finalize the F-35 follow-on development capabilities development document that should be approved by the Joint Requirements Oversight Council [JROC] during fiscal year 2014. Furthermore, the Committee notes that the F-35 draft schedule for follow-on Block 4 capabilities would span over 6 years, would be concurrent with the ongoing F-35 development efforts, and is projected to cost $3,800,000,000. Given the current fiscal environment and the anticipated ramp-up of F-35 production during this same time period, the Committee believes Block 4, as currently planned, is unaffordable. Understanding that the F-35 international partners are interested in getting their specific weapons integrated onto the aircraft and will fund the requisite work, the Committee encourages the Secretary of Defense and the JROC to place priority on integrating these weapons onto the F-35 during Block 4 follow-on development.

In addition, the Department requests $10,000,000 to assess B61 nuclear bomb integration onto the F-35. The Committee understands the Department is currently planning that the B61 capability will deliver as part of Block 4, but the JROC has not approved the capability content of Block 4. Therefore, the Committee recommends no funding for F-35 dual capable aircraft.

F-35 MANAGEMENT

The Committee supports the Department's decision to modify the F-35 management charter and specify that the Program Executive Officer [PEO] serves at the pleasure of the Secretary of Defense rather than for a 2-year term. The Committee believes the F-35 program will benefit from consistent leadership that will ensure positive programmatic changes become embedded in the F-35 culture.

The Senate report also stated:

F-35 Conventional Take-off and Landing Total Quantities- During the Committee's hearing to review the Joint Strike Fighter budget for fiscal year 2014, the Committee was informed that the Air Force's planned F-35 procurement quantity of 1,763 aircraft is based on a one-for-one replacement of legacy aircraft. While the F-35 will provide the Air Force with much greater fifth generation fighter capability for certain future threats, less capable aircraft may be effective and more cost-effective to operate and maintain in other less contentious scenarios. The Committee believes that given these times of fiscal austerity, the Department of Defense should review the Air Force tactical fighter force mix. The Committee directs the Vice Chairman of the Joint Chiefs of Staff, in conjunction with the Air Force Chief of Staff, to deliver not later than 180 days after enactment of this act, to the congressional defense committees an analysis that outlines the appropriate total quantity of Air Force fifth generation and less capable aircraft based on the anticipated threat during the next 30 years.

Final Action

As detailed in the Joint Explanatory Statement of the Committee of Conference, P.L. 113-76 changed the requested funding for the F-35 as follows:

Table 17. FY2014 Appropriations Final Actions on F-35A Procurement

in Aircraft Procurement, Air Force ($M)

Item	Amount
Requested for F-35As	3,060,770
Life-of-type buys previously funded	-22,932
Non-recurring engineering - cost growth initiatives	-71,500
Engine cost growth	-2,736
Production engineering support growth	-35,000
Decrease tooling	-39,000
Appropriated for F-35As	2,889,602
Requested for advance procurement for FY2015	363,783
Reduce by two aircraft	-24,250
Appropriated	339,533

Table 18. FY2014 Appropriations Final Actions on Air Force F-35 R&D

in Research, Development, Test, & Engineering, Air Force ($M)

Item	Amount
Requested for F-35 R&D	816,335
Deployability and Suitability Enhancements delay	-17,800
F-135 propulsion system cost growth	-20,000
Program decrease for forward financing	-150,000
Appropriated for F-35 R&D	628,535
Requested for F-35 Squadrons	33,000
Block 4 ahead of need	-23,000
B61-no approved Capabilities Development Document	-10,000
Block 4 CDD planning only (see text following tables)	3,000
Appropriated for F-35 Squadrons	3,000

Table 19. FY2014 Appropriations Final Actions on F-35C Procurement

in Aircraft Procurement, Navy ($M)

Item	Amount
Requested for F-35Cs	1,135,444
Airframe/CFE cost growth	-7,024
Engine cost growth	-2,552
Airframe PGSE growth	-35,000
Unit cost savings due to life of type buys previously funded	-5,753
Decrease tooling	-20,000
Decrease non-recurring engineering initiatives	-36,700
Appropriated for F-35Cs	1,028,415
Requested for F-35 CV series	31,100
Concurrency pricing adjustment (OSIP 023-14)	-1,150
Appropriated for F-35 CV series	29,950
Requested for advance procurement for FY2015	94,766
Reduce one aircraft	-15,750
Appropriated	79,016

Table 20. FY2014 Appropriations Final Actions on F-35B Procurement

in Aircraft Procurement, Navy ($M)

Item	Amount
Requested for F-35Bs	1,267,260
Engine cost growth	-47,586
Unit cost savings due to life of type buys previously funded	-9,176
Decrease tooling	-17,000
Decrease non-recurring engineering initiatives	-17,000
Appropriated for F-35Bs	1,176,498
Requested for F-35 STOVL series	147,130
Concurrency pricing adjustment (OSIP 023-14)	-35,972
Appropriated for F-35 STOVL series	111,158

Table 21. FY2014 Appropriations Final Actions on Navy F-35 R&D

in Research, Development, Test, & Engineering, Navy ($M)

Item	Amount
Requested for F-35 EMD	512,631
F-35B follow-on development ahead of need	-14,904
F-135 propulsion system cost growth	-10,000
Block 4 capabilities development document planning only	1,500
Program decrease	-73,500
Appropriated for F-35 EMD	415,727
Requested for F-35	534,187
F-35B follow-on development ahead of need	-11,442
F-135 propulsion system cost growth	-10,000
Block 4 capabilities development document planning only	1,500
Program decrease	-73,500
Appropriated for F-35	440,745

Text included in the Joint Explanatory Statement stated:

> JOINT STRIKE FIGHTER FOLLOW-ON DEVELOPMENT
>
> The agreement finds that a formal capability development document for Block 4, defining the next increment of warfighting capability to be integrated into the F-35 platform, must be approved before any funding may be used to begin Block 4 development. The agreement provides $6,000,000 only to perform the work necessary to produce, staff, and gain approval of a Block 4 capability development document.

Appendix. F-35 Key Performance Parameters

Table A-1 summarizes key performance parameters for the three versions of the F-35.

Table A-1. F-35 Key Performance Parameters (KPPs)

Source of KPP	KPP	F-35A Air Force CTOL version	F-35B Marine Corps STOVL version	F-35C Navy carrier-suitable version
Joint	Radio frequency signature	Very low observable	Very low observable	Very low observable
	Combat radius	590 nm Air Force mission profile	450 nm Marine Corps mission profile	600 nm Navy mission profile
	Sortie generation	3 surge / 2 sustained	4 surge / 3 sustained	3 surge / 2 sustained
	Logistics footprint	< 8 C-17 equivalent loads (24 PAA)	< 8 C-17 equivalent loads (20 PAA)	< 46,000 cubic feet, 243 short tons
	Mission reliability	93%	95%	95%
	Interoperability	Meet 100% of critical, top-level information exchange requirements; secure voice and data		
Marine Corps	STOVL mission performance – short-takeoff distance	n/a	550 feet	n/a
	STOVL mission performance – vertical lift bring-back	n/a	2 x 1K JDAM, 2 x AIM-120, with reserve fuel	n/a
Navy	Maximum approach speed	n/a	n/a	145 knots

Source: F-35 program office, October 11, 2007.

Notes: PAA is primary authorized aircraft (per squadron); vertical lift bring back is the amount of weapons with which plane can safely land.

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