

# CRS Report for Congress

## F-35 Joint Strike Fighter (JSF) Program: Background, Status, and Issues

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Prepared for Members and  
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# F-35 Joint Strike Fighter (JSF) Program: Background, Status, and Issues

## Summary

The Defense Department's F-35 Joint Strike Fighter (JSF) is one of three aircraft programs at the center of current debate over tactical aviation, the others being the Air Force F-22A fighter and the Navy F/A-18E/F fighter/attack plane. In November 1996, the Defense Department selected two major aerospace companies, Boeing and Lockheed Martin, to demonstrate competing designs for the JSF, a joint-service and multi-role fighter/attack plane. Lockheed Martin won this competition, and was selected to develop further and to produce the JSF, a family of conventional take-off and landing (CTOL), carrier-capable (CV), and short take-off vertical landing (STOVL) aircraft for the U.S. Air Force, Navy, and Marine Corps and the UK Royal Navy as well as other allied services. Originally designated the Joint Advanced Strike Technology (JAST) program, the JSF program is a major issue in Congress because of concerns about its cost and budgetary impact, effects on the defense industrial base, and implications for U.S. national security in the early 21st century.

The JAST/JSF program evolved in response to the high cost of tactical aviation, the need to deploy fewer types of aircraft to reduce acquisition and operating costs, and projections of future threat scenarios and enemy capabilities. The program's rationale and primary emphasis is joint-service development of a next-generation multi-role aircraft that can be produced in affordable variants to meet different operational requirements. Developing an affordable tri-service family of CTOL and STOVL aircraft with different combat missions poses major technological challenges. Moreover, if the JSF is to have joint-service support, the program must yield affordable aircraft that can meet such divergent needs as those of the U.S. Air Force for a successor to its low-cost F-16 and A-10 fighter/attack planes, those of the U.S. Marine Corps and the UK Royal Navy for a successor to their Harrier STOVL aircraft, and the U.S. Navy's need for a successor and a complement to its F/A-18E/F fighter/attack planes.

This report discusses the background, status, and current issues of the JSF program. Continuing developments and related congressional actions will be reported in CRS Report RL33543, *Tactical Aircraft Modernization: Issues for Congress*, which also discusses the Air Force F-22A, the Navy F/A-18EF, and the Marine Corps V-22. These aircraft and the Air Force's B-2 strategic bomber and C-17 cargo/transport plane are the most expensive U.S. military aircraft programs. (See CRS Report RL31544, *Long-Range Bombers: Background and Issues for Congress*, and CRS Report RL30685, *Military Airlift: C-17 Aircraft Program*.) The JSF program is also addressed in CRS Report RL33390, *Proposed Termination of Joint Strike Fighter (JSF) F136 Alternate Engine*; CRS Report RS21488, *Navy-Marine Corps Tactical Air Integration Plan: Background and Issues for Congress*; and CRS Report RL31360, *Joint Strike Fighter (JSF): Potential National Security Questions Pertaining to a Single Production Line*.

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# F-35 Joint Strike Fighter (JSF) Program: Background, Status, and Issues

## Introduction

The Joint Strike Fighter (JSF) program is expected to develop and build a family of new-generation tactical aircraft for the Air Force, the Marine Corps, the Navy, and Britain's Royal Navy. As now projected, the JSF is the Defense Department's largest acquisition program in terms of cost and number of aircraft to be produced. Current DOD plans call for production of 2,458 aircraft in three versions.<sup>1</sup> Additional aircraft may be bought by Australia, Belgium, Canada, Denmark, Israel, the Netherlands, Norway, Singapore and other allied governments.

The U.S. Marine Corps and the United Kingdom's Royal Navy plan to procure a short take-off vertical landing (STOVL) version of the plane to replace their current fleets of Harrier vertical/short take-off and landing (VSTOL) attack planes.<sup>2</sup> The U.S. Navy plans to procure a carrier-capable CTOL version — termed a CV — to replace older carrier-based aircraft. The Marine Corps may also purchase some number of CV variants to replace their F/A-18 *Hornet* aircraft.<sup>3</sup> The Department of the Navy is still assessing how many of its 680 JSF's will be CTOL variants, and how many will be STOVL. The United Kingdom may purchase up to 150 JSFs for its Navy and Air Force.

The Air Force's program of record is to purchase 1,763 conventional takeoff and landing (CTOL) versions of the F-35 to replace its current force of F-16s and A-10s. In February 2003, Air Force officials announced that they would also purchase some number of the STOVL JSF to improve future close air support (CAS) capabilities.<sup>4</sup> Although the exact number to be procured have not been confirmed, Air Force

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<sup>1</sup> Fourteen of these aircraft will be purchased with RDT&E funds and will be used for developmental testing.

<sup>2</sup> The U.S. Marine Corps and the UK Royal Navy and Royal Air Force operate versions of the AV-8A/B Harrier aircraft flown by these services since the early 1970s. CRS Report 81-180, *The British Harrier V/STOL Aircraft: Analysis of Operational Experience and Relevance to U.S. Tactical Aviation* (out of print; available from the author at 7-2577).

<sup>3</sup> Adam Hebert, "STOVL JSF to Replace AV-8Bs, But CV Model May Replace Marine F/A-18s," *Inside the Navy*, August 5, 2002, p.1.

<sup>4</sup> Lorenzo Cortes, "Air Force to Study Acquisition of F-35-B STOVL JSF," *Defense Daily*, February 13, 2004; Gail Kaufman, "U.S. Air Force Wants STOVL JSFs," *Defense News*, February 12, 2004; and Christopher Castelli, "Overall Impact of Air Force Interest in F-35 STOVL Variant is Unclear," *Inside the Navy*, March 1, 2004.

leaders have said Air Force STOVL variants would number “in the hundreds.”<sup>5</sup> In December 2004, Air Force leaders confirmed long-running speculation that it would reduce its total purchase of JSFs. Some observers believe it will be by as much as one-third of the 1,763 figure.<sup>6</sup>

**Figure 1. F-35 *Lightning II* Joint Strike Fighter**



## Background

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 Administration’s Bottom-Up Review (BUR) of U.S. defense policy and programs. Having affirmed plans to abandon development of both the A-12/AFX aircraft that was to replace the Navy’s A-6 attack planes and the multi-role fighter (MRF) that the Air Force had considered to replace its F-16s, the BUR envisaged the JAST program as a replacement for both these programs. In 1994, the JAST program was criticized by some observers for being a technology-development program rather than a focused effort to develop and procure new aircraft. In 1995, in response to congressional direction, a program led by the Defense Advanced Research Projects Agency (DARPA) to develop an advanced short takeoff and vertical landing

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<sup>5</sup> Elizabeth Rees, “Jumper: USAF Will Buy ‘Hundreds’ of STOVL Joint Strike Fighters,” *Inside the Air Force*. September 17, 2004.

<sup>6</sup> Marc Selinger. “Jumper Confirms Air Force Plans to Cut Joint Strike Fighter Purchase.” *Aerospace Daily & Defense Report*. December 15, 2004.

(ASTOVL) aircraft was incorporated into the JAST program, which opened the way for Marine Corps and British Navy participation.<sup>7</sup> The name of the program was then changed to JSF to focus on joint development and production of a next-generation fighter/attack plane.

During the JAST/JSF program's 1994-1996 concept development phase, three different aircraft designs were proposed by Boeing, Lockheed Martin, and McDonnell Douglas (the latter teamed with Northrop Grumman and British Aerospace) in a competitive program expected to shape the future of U.S. tactical aviation and the U.S. defense industrial base.<sup>8</sup> On November 16, 1996, the Defense Department announced that Boeing and Lockheed Martin had been chosen to compete in the 1997-2001 concept demonstration phase, in which each contractor would build and flight-test two aircraft (one CTOL and one STOVL) to demonstrate their concepts for three JSF variants to meet the different operational requirements of the various services. The CTOL aircraft demonstrated concepts for an Air Force land-based (CTOL) variant and a Navy carrier-based (CV) variant, with the STOVL aircraft demonstrated concepts for a variant to be operated by the U.S. Marine Corps and the UK Royal Navy. On October 26, 2001, DOD selected a team of contractors led by Lockheed Martin to develop and produce the JSF. The three variants — CTOL, CV and STOVL aircraft — are to have maximum commonality in airframe, engine, and avionics components to reduce production and operation and support costs.

Mainly because of their projected costs, three tactical aircraft programs are currently subjects of debate over the types and numbers of aircraft that U.S. armed forces may need in the future — the emergent JSF program, the Air Force F-22A program, and the Navy's F/A-18E/F program. Congressional decisions on these programs will have important implications for defense funding requirements, U.S. military capabilities, and the U.S. aerospace industry.

## Design and Performance

Contrary to some misconceptions that the Joint Strike Fighter would be one aircraft used by several services for different missions, the program envisions the development and production of three highly common variants: a land-based CTOL version for the Air Force, a carrier-based CTOL version (CV) for the Navy, and a STOVL version for the Marines and the Royal Navy. The JSF program is a family of aircraft, which uses a mix of components, systems, and technologies with commonality projected at 70 to 90 percent in terms of production cost. Many of the high-cost components are common, including engines, avionics, and major structural components of the airframe. Former Secretary of Defense William Cohen stated that the JSF's joint approach "avoids the three parallel development programs for service-

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<sup>7</sup> Since the early 1990s DARPA had funded various STOVL projects expected to develop aircraft to replace both U.S. Marine Corps AV-8B Harriers and the UK Royal Navy's Sea Harriers. The merger of these research-development efforts with the JAST program in early 1995 cleared the way for U.S.-UK collaboration in JSF development.

<sup>8</sup> John Tirpak, "Strike Fighter," *Air Force Magazine*, October 1996: 22-28; Philip Hough, "An Aircraft for the 21<sup>st</sup> Century," *Sea Power*, November 1996: 33-34.

unique aircraft that would have otherwise been necessary, saving at least \$15 billion.”<sup>9</sup>

The winning Lockheed Martin design closely resembles the F-22A *Raptor*. However, the Lockheed STOVL concept which employs a shaft-driven lift fan connected to the main engine with extra thrust provided by vectoring nozzles, is a new approach. The Boeing aircraft appeared in some ways more innovative than the Lockheed design, featuring a solid wing (with considerable space for internal-fuel) and a single direct-lift engine with nozzles for vectored thrust in STOVL operations (similar to the AV-8 Harrier’s Pegasus engine). The design proposed by the McDonnell Douglas, Northrop Grumman, and British Aerospace team was an almost tailless aircraft, powered by separate lift and lift/cruise engines. The use of separate engines was reportedly a factor in the rejection of this design.<sup>10</sup>

The JSF will be powered by the Pratt & Whitney F135 engine, which was derived from the F-22A’s Pratt & Whitney F119 power plant. At congressional direction, DOD established an alternative engine, the GE F136, to compete with the F135 for JSF production and operations and support (O&S) contracts. The engines of both designs will include components made by Allison (now owned by Rolls-Royce), which developed and produced the Pegasus engines powering Harrier STOVL aircraft since the 1960s. The net cost-benefit of an alternate engine for the JSF program has periodically been debated, and DOD has attempted to eliminate funding for the F136. The most recent debate emerged with the FY2007 budget request, which proposed canceling the F136.<sup>11</sup>

All JSF planes will be single-engine, single-seat aircraft with supersonic dash capability and some degree of stealth (low observability to radar and other sensors). Combat ranges and payloads will vary in the different service variants. For example, as currently planned, range requirements would be 590-690 nautical miles (nm) for the Air Force, 600-730 nm for the Navy, and 450-550 nm for the Marine Corps. All three variants are planned to carry two 2,000-lb weapons internally. All versions will also carry AIM-120 AMRAAMs (advanced medium-range air-to-air missiles, with a range of about 26 nm/48 km depending on altitude<sup>12</sup>). Space will be reserved for an advanced gun, if one is found that meets operational requirements at an affordable

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<sup>9</sup> Letter from Secretary of Defense William S. Cohen to Rep. Jerry Lewis, June 22, 2000. Transcript made available by *Inside the Airforce*, June 23, 2000.

<sup>10</sup> Bill Sweetman, “Decision Day Looms for Joint Strike Fighter,” *Jane’s International Defence Review*, September 1996: 36-39, 42-43; Bryan Bender and Tom Breen, “Boeing, Lockheed Martin Win JSF Demonstrator Contracts,” *Defense Daily*, November 18, 1996: JSF special report.

<sup>11</sup> See CRS Report RL33390, *Proposed Termination of Joint Strike Fighter (JSF) F136 Alternate Engine*, for more information. Also see “Dual Engine Development Could Saddle JSF with up to \$800 Million Bill,” *Inside the Navy*, August 5, 1996: 2; “Despite Demand for Second JSF Engine Source, F120 Comes up Short,” *Aerospace Daily*, October 18, 1996: 102; U.S. Congressional Budget Office, *A Look at Tomorrow’s Tactical Air Forces* by Lane Pierrot and Jo Ann Vines, January 1997: 53.

<sup>12</sup> Steven Zaloga, “AIM-120 AMRAAM,” *World Missiles Briefing*, Teal Group Corp., January 1997, p.5.

cost.<sup>13</sup> JSF requirements dictate that the aircraft's gun must be able to penetrate lightly armored targets. The current plan is to equip the F-35 with the same 25-millimeter cannon fielded on the AV-8B Harrier, which is made by General Dynamics Corp.

Performance features in regard to radar signature, speed, range, and payload will be determined on the basis of trade-offs between performance and cost, with the latter being a critical factor. Program officials have emphasized that such cost and performance tradeoffs are critical elements of the program and were the basis for the joint-service operational requirements that determined the selection of the Lockheed Martin contractor team for the System Development and Demonstration (SDD) phase of full-scale development.<sup>14</sup> The 1997 QDR report observed that "Uncertainties in prospective JSF production cost warrant careful Departmental oversight of the cost-benefit tradeoffs in design to ensure that modernization and force structure remain in balance over the long term."<sup>15</sup> In other words, production costs must be low enough that these aircraft can be bought in sufficient quantities to maintain desired force levels. Thus, the parameters of the JSF's performance and operational capabilities are subject to change for reasons of cost, technological developments, and future threat assessments.

In response to the Department of the Navy's need to replace its aging EA-6B Prowler electronic attack aircraft, Lockheed Martin has proposed the development of a two-seat electronic attack variant of the JSF. Dubbed the EA-35B, the aircraft could potentially be available by 2015, according to industry representatives. The Navy currently plans to replace the Prowler with an electronic attack version of the F/A-18E/F. The Marine Corps, which currently has no plans to procure either F/A-18E/F's or the EA-18G electronic attack variant, has studied the pros and cons of a dedicated EA-35 aircraft, but reportedly will opt instead to improve the electronic attack capabilities of its baseline F-35 fighters.<sup>16</sup>

## Program Management

The JSF program is jointly staffed and managed by the Department of the Air Force and the Department of the Navy (comprising the Navy and the Marine Corps), with coordination among the services reinforced by alternating Air Force and Navy Department officials in key management positions. For example, Lt. General George Muellner, USAF, was the program's first director in 1994, with Rear Admiral Craig Steidle, USN, serving as deputy director. Subsequently Rear Admiral Steidle

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<sup>13</sup> "Advanced Gun Seen Likely for Some Joint Strike Fighters," *Aerospace Daily*, May 5, 1997. p. 195.

<sup>14</sup> "Tradeoffs Will Be Made to Contain JSF Costs," *Aerospace Daily*, September 26, 1997. P. 469.

<sup>15</sup> U.S. Department of Defense, *Report of the Quadrennial Defense Review* [by] William S. Cohen, Secretary of Defense, May 1997: 46.

<sup>16</sup> Craig Hoyle, "US Outlines New Electronic Attack Aircraft," *Jane's Defence Weekly*, June 4, 2003. Graham Warwick. "JSF Team Rejects Dedicated EA-35." *Flight International*. February 12, 2006.



directed the program, with Brigadier General Leslie Keane, USAF, as his deputy in late 1996 and his successor as program director in August 1997. The current director is Brig. Gen. Charles Davis, USAF. Service Acquisition Executive (SAE) responsibility also alternates, with the Air Force having that responsibility when the program director is from the Navy Department and the Navy or Marine Corps in that role with an Air Force director of the program.

In FY2005, 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.”<sup>17</sup> Conferees directed that DOD submit a report on the potential efficacy of this change. Press reports state that DOD’s study recommended against making changes to the program’s management oversight structure.<sup>18</sup> This may not be a consensus decision within DOD however. Former Air Force Chief of Staff General Jumper, for example, was quoted as saying that he supported putting one service in charge of JSF program acquisition.<sup>19</sup>

## Funding and Projected Costs

The Defense Department’s quarterly Selected Acquisition Report of December 31, 2006, estimated the JSF program at \$299,824.1 million in current-year dollars for 2,458 aircraft, which equates to a program unit acquisition cost (PUAC) of \$121.9 million per aircraft in then-year dollars (accounting for inflation). The average procurement cost (APUC) (which does not include R&D or other “sunk” costs) is estimated at \$104.4 million per aircraft in then-year dollars. The December 2005 SAR noted that the JSF program has breached a “Nunn-McCurdy” cost growth limit: unit cost growth over 30% of the original Acquisition Program Baseline. The latest PUAC and APUC cost estimates are, respectively, 66.6% and 65.9% higher than cost estimates made in October 2001.

The JSF program estimate has increased over \$68 billion from the September 2003 estimate due primarily to a one year extension in the program’s System Development and Demonstration phase, a corresponding one year delay in procurement (from FY2006 to FY207), revised annual quantity profiles, and revised labor and overhead rates.<sup>20</sup> Much of this increased cost and schedule slippage was incurred to address growing weight issues in the development of the F-35B, the STOVL variant.

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<sup>17</sup> H.Rept. 108-553 (H.R. 4613), p. 234

<sup>18</sup> Marc Selinger, “JSF management approach to be kept, DOD says,” *Aerospace Daily & Defense Report*, January 11, 2005.

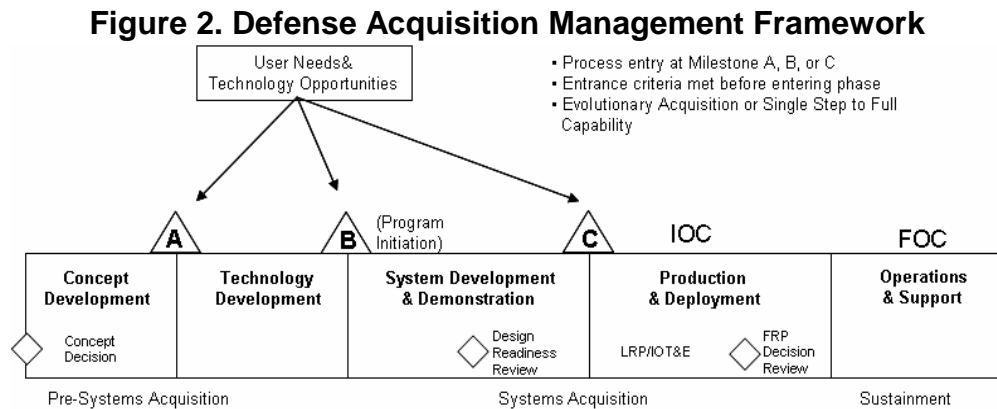
<sup>19</sup> Elizabeth Rees, “Jumper Supports Single Service Retaining JSF Acquisition Oversight,” *Inside the Air Force*, August 6, 2004.

<sup>20</sup> Summaries of DOD’s Select Acquisition Reports can be found at [<http://www.acq.osd.mil/ara/am/sar/index.html>].

DOD’s FY2008 budget requests \$6.1 billion in total JSF funding. As it did in FY2007, DOD proposes to eliminate funding for the F136 Alternate Engine. The proposed termination of the F136 drew considerable scrutiny in the 109<sup>th</sup> Congress (2<sup>nd</sup> Session). The Senate Armed Services Committee held two hearings specifically on this issue (March 14 and March 15), and the Air Land Subcommittee held a hearing on March 28. The House Armed Services Committee also addressed this issue in a March 1 hearing, as did the Tactical Air Land Subcommittee on March 16. FY2007 Conferees agreed to prohibit F136 termination pending an independent analysis of the alternate engine’s potential cost savings.

## Development and Schedule

The JSF is currently in the System Development and Demonstration Phase (SDD). **Figure 2**, below from DOD Instruction 5000.2, *Operation of the Defense Acquisition System*, depicts graphically the acquisition system, and where SDD fits into the process.



Until late in 2003, the JSF program’s SDD phase was scheduled to run until around 2008, at which time full rate production was scheduled to begin, with a projected initial operational capability around 2010. Subsequent schedule changes have added time and cost to the program.

To address growing weight problems encountered in the development phase, DOD extended the SDD phase one year, and correspondingly delayed the F-35’s scheduled first flight from late 2005 to the summer of 2006 (first flight occurred on December 15, 2006, and the beginning of low-rate initial production shifted from 2006 to 2007. Procurement profiles in the Future Years Defense Plan (FYDP) are as follows:

	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013
USAF	6 aircraft	8	12	24	42	48
USN	6	8	18	19	40	42

Initial Operational Capability (IOC) for the CTOL variant has slipped from FY2011 to FY2013. First flight of the Air Force variant — the F-35A — is tentatively scheduled for 2009. In June 2005, DOD officials reported that weight reduction efforts were successful, and approved the revised schedule and path forward.<sup>21</sup> In December 2004 it was reported that DOD was delaying almost \$300 million in potential payments to Lockheed Martin Corp. as an incentive to fix schedule delays and cost overruns in the JSF program. According to Pentagon officials, this tactic would help put the program back on track.<sup>22</sup>

In March 2006, the GAO issued a report highly critical of the JSF testing and production schedule.<sup>23</sup> GAO asserted that the amount of overlap between testing and production in the JSF program is risky and could lead to considerable cost growth in the future. GAO found that the JSF program will begin low-rate initial production (LRIP) in 2007, when the program will have completed less than 1% of flight tests. Up to 424 F-35 aircraft may be built, at a cost of \$49 billion, before development testing is complete. The JSF program intends to make initial production orders on a cost reimbursement contract, “placing an unusually high risk burden on the government during the early production phase.”<sup>24</sup> GAO recommended adopting a more evolutionary approach to developing and producing the F-35, similar to the block upgrade approach pursued successfully in the F-16 program.

The JSF is expected to remain in production at least through the 2020s. Current plans call for the JSF to be manufactured in several locations. Lockheed Martin will build the aircraft’s forward section in Fort Worth, TX. Northrop Grumman 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.

## Production Quantities

In 1996, the program included over 3,000 aircraft: 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, however, the QDR recommended reducing projected procurement for the U.S. armed forces from 2,978 JSF aircraft to 2,852: 1,763 for the Air Force, 609 for the Marines, and up to 480 for the Navy.<sup>25</sup> Thus, the program would comprise 2,912 aircraft (2,852 U.S. and 60 UK JSFs), based on these recommendations. The 1997 QDR also concluded that some 230 of the Navy’s projected buy of 480 JSFs could instead be F/A-18E/Fs, depending on the progress of the JSF program and the price of its Navy variant compared to the F/A-18E/F. Former Defense Secretary William Cohen and other DOD officials stated in May 1997 that they anticipated a “creative tension”

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<sup>21</sup> Marc Selinger, “DoD Approves detailed ‘re-plan’ for Joint Strike Fighter,” *Aerospace Daily & Defense Report*, June 2, 2005.

<sup>22</sup> “Pentagon Delays JSF Payments to Lockheed,” *Baltimore Sun*. December 28, 2004.

<sup>23</sup> *Joint Strike Fighter: DoD Plans to Enter Production before Testing Demonstrates Acceptable Performance*. (GAO-060356) Government Accountability Office. March 2006.

<sup>24</sup> *Ibid.*, p. 6.

<sup>25</sup> Quadrennial Defense Review Cuts Procurement in FY1999, 2000, *Aerospace Daily*, May 20, 1997: 280.

between contractors producing the F/A-18E/F and those developing the JSF, which would result in a competitive situation similar to what occurred in the C-17 program in response to Boeing's proposed alternatives for Air Force transport planes.<sup>26</sup>

As part of an FY2004 budget briefing, on February 3, 2003, OSD Comptroller Dov Zackheim confirmed that as part of the Navy and Marine Corps Tactical Air Integration Plan (TAI) the Navy is planning to reduce JSF purchases from 1,089 to 680 aircraft.<sup>27</sup> According to news accounts, the proposed reduction would cut 259 jets from the Marine Corps buy, and 50 from the Navy purchase.<sup>28</sup> Navy officials say that this reduction in aircraft is consistent with attempts to transform the services, and that the final decision on the number of JSF's to procure rests with top officials in DOD.<sup>29</sup>

The Air Force Air Combat Command (ACC) is re-examining the total number of F-35s the Air Force will ultimately purchase.<sup>30</sup> The GAO has reported that preliminary ACC studies recommend a purchase of 1,300 CTOL and 250 STOVL variants, which would be a reduction of 210 aircraft from the previously planned quantity of 1,763 F-35s.<sup>31</sup>

The Air Force plans to integrate some number of Active and Reserve squadrons through its Future Total Force (FTF) concept, which would save money in part by cutting the number of aircraft needed to equip these squadrons. Also, the commitment to purchase 1,763 JSF's is based on a strategy to replace legacy aircraft (F-16s and A-10s) on a one-for-one basis. Considering the JSF's improved capabilities over today's aircraft, some say that a one-for-one strategy is not required and that fewer JSF's can do the job of a greater number of today's aircraft.<sup>32</sup> On the

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<sup>26</sup> Vago Muradian, "'QDR Tac Air Cuts Will Save \$30 Billion,' Ralston Says," *Defense Daily*, May 20, 1997, pp. 301-302; "'F/A-18E/F Buy Depends on JSF Progress,' Cohen Tells SASC," *Aerospace Daily*, May 21, 1997: 285, 288. See also CRS Issue Brief IB93041, *C-17 Cargo Aircraft Program* (out of print; for copies contact Christopher Bolkcom at 7-2577.)

<sup>27</sup> DOD News Transcript, *Undersecretary Zackheim Briefs on 2004 Defense Budget*, February 3, 2003. See also: Anne Marie Squeo, "Pentagon Might Slash Its Plans to Buy Fighter Jets By About 30%," *Wall Street Journal*, March 22, 2002.

<sup>28</sup> Vago Muradian, "DoD Assesses Navy Proposal to Scale Back JSF Purchase by 409 Jets," *Defense News*, March 22, 2002.

<sup>29</sup> Marc Selinger, "Navy Chief Defends Willingness to Look At JSF, Super Hornet Cuts," *Aerospace Daily*, March 29, 2002.

<sup>30</sup> John Bennett and Elizabeth Reese. "ACC Officials to Brief Keys This Summer On JSF Requirement Study." *Inside the Air Force*. June 24, 2005.

<sup>31</sup> GAO-05-271, p. 13.

<sup>32</sup> Sharon Weinberger, "Air Force Considers Cuts to F-35, F/A-22," *Defense Daily*, October 17, 2003, p. 1.

other hand, DOD's recommendation to cut 96 aircraft from the planned purchase of F-22As may discourage the Air Force from reducing the JSF purchase significantly.<sup>33</sup>

Since the JSF is a long-term program, projected quantities are more subject to change than in the case of aircraft already in full-rate production. Near-term reductions in quantity could be made up in future years either through increased U.S. purchases or through foreign sales. However, concerns have been raised that near-term quantity reductions could scare off foreign participation, and raise the aircraft's unit price. The GAO views the budget and schedule changes to the JSF program in a more negative light. In March 2005 GAO wrote that the original business case for the aircraft "unexecutable," in large part due to decreased numbers of aircraft to be procured.<sup>34</sup>

## Congressional Action

The Bush Administration's FY2008 budget requested \$6,141.7 million (\$6.1 billion) in funding for the Joint Strike Fighter. This request is summarized in **Table 1**, below.

**Table 1. JSF F-35 FY2008 Funding**  
(\$ Millions)

	USN R&D	USAF R&D	USN Proc.	USAF Proc.
Request	1,707.3	1,780.8	(6 aircraft) 1,112.5 (APCY) 119.5	(6 aircraft) 1,298.1 (APCY) 123.5
House Authorization (H.R. 1585, H.Rept. 110-146)	<b>1,822,372</b>	<b>1,895,874</b>	Both Chambers matched procurement requests	
Senate Authorization (S. 1547, S.Rept. 110-77)	<b>1,927,672</b>	<b>2,001,174</b>		

House Authorizers matched procurement requests, but took issue with DOD's R&D plans for the JSF. As it did in FY2007, DOD proposed to cancel the F136 alternate engine. As it did in FY2007, House Authorizers increased the R&D accounts by \$230 million and directed that \$480 million be used on the F136 program. Sec. 213 of the report requires DOD to annually fund a competitive engine program for the JSF.

Senate Authorizers also directed that \$480 million in R&D be applied to fund the F136 engine. The Senate cut \$39 million from JSF R&D due to excessive award fees paid to the contractor.

<sup>33</sup> See CRS Report RL31673, *F/A-22 Raptor*, by Christopher Bolkcom, for more information.

<sup>34</sup> GAO-05-271, March 15, 2005.

The Bush Administration's FY2007 budget requested \$5,290.1 million (\$5.3 billion) in funding for the Joint Strike Fighter. The Air Force requested \$1,015 million in procurement funds to build five aircraft and purchase long-lead items for eight aircraft in FY2008, and \$ 1,999.1 in RDT&E funds. The Navy requested \$245 in advance procurement funds (to build eight F-35B aircraft in FY2008) and \$2,031 in RDT&E funds. Congressional action on this request is summarized in **Table 2**, below. Changes to the request are highlighted in **bold** text.

**Table 2. JSF F-35 FY2007 Funding**  
(\$ Millions)

	USN R&D	USAF R&D	USN Proc.	USAF Proc.
Request	2,031	1,999.1	245	1,015
Authorization Conference (H.R. 5122, H.Rept. 109-702)	<b>2,200</b>	<b>2,170</b>	<b>123</b>	<b>921</b>
Appropriations Conference (H.R. 5631, H.Rept. 109-676)	<b>2,172</b>	<b>2,138</b>	<b>123</b>	<b>489</b>

Both authorizers and appropriators objected to DOD's plan to eliminate the F136 Alternate Engine and added JSF R&D funds to continue the program. Similarly, both authorizers and appropriators expressed concern about program risk, either explicitly or implicitly reacting to what some to believe to be an excessive overlap between JSF testing and JSF development.

The Bush Administration's FY2006 budget requested \$5,020.0 million (\$5 billion) in funding for the Joint Strike Fighter. The Air Force requested \$152.4 million in advance procurement and \$2,474.8 million in RDT&E funds. The Navy requested \$2,393 million in RDT&E funds. Congressional action on this request is summarized in **Table 3**, below. Changes to the request are highlighted in bold text.

**Table 3. JSF F-35 FY2006 Funding**  
(\$ Millions)

	USN R&D	USAF R&D	USAF Proc.
Request	2,393.0	2,474.0	152.4
Authorization Conference (H.R. 1815, H.Rept. 109-360)	2,393.0	2,474.0	152.4
Appropriations Conference (H.R. 2863, H.Rept. 109-359)	<b>2,305.1</b>	<b>2,366.7</b>	<b>120</b>

In cutting JSF funding, Appropriators noted that “excessive program risk remains,”<sup>35</sup> and that “under the revised aircraft build sequence all of these aircraft do not require full funding prior to the beginning of fiscal year 2008.”<sup>36</sup>

## Major Issues

The Joint Strike Fighter program poses a number of policy issues concerning (1) the need for such new aircraft to cope with future military threats, (2) the affordability of this program in its full-scale development and production phases, (3) the feasibility of such a joint-service approach to diverse service requirements, (4) potential alternatives to the JSF, (5) the implications for the U.S. defense industrial base, and (6) Allied participation in the program.

### Need for New-Generation Aircraft

Some argue that future threat scenarios will not require the combat capabilities promised by JSF aircraft. According to this view, continued production of modified versions of the Air Force F-16, the Marine Corps AV-8B, and the Navy F/A-18E/F along with the Air Force’s stealthy B-2 bombers and F-22A fighters in conjunction with sea-launched missiles and air-launched precision-guided munitions would suffice for the most probable combat scenarios.<sup>37</sup> As noted above, CBO analysts considered the relative costs of several options involving greater reliance on upgrades of existing aircraft vs. development and procurement of the JSF. Following the 1991 Gulf War, GAO analysts questioned the need for new-generation aircraft such as the F-22A and the F/A-18E/F as well as the JSF, arguing that current aircraft would provide more capability than was needed, concluding that it would be unlikely that potential adversaries could prevent U.S. forces from achieving their military objectives in future conflicts.<sup>38</sup> Subsequent U.S. airpower dominance in Bosnia, Kosovo, Afghanistan and Iraq may strengthen this argument.

JSF proponents argue that it would be more cost-effective to acquire new-generation aircraft than to upgrade current aircraft to such an extent that they could perform effectively after 2010, maintaining that existing planes would require major modifications at considerable cost and would provide less combat effectiveness than a new JSF family of fighter/attack aircraft. In this view, the proliferation of Russian and other advanced surface-to-air and air-to-air missiles to hostile countries is likely

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<sup>35</sup> H.R. 2863 (H.Rept. 109-359), p. 418.

<sup>36</sup> H.R. 2863 (H.Rept. 109-119), p. 172.

<sup>37</sup> Center for Strategic and Budgetary Assessments. *U.S. Tactical Aircraft Plans: Preparing for the Wrong Future?* by Steven Kosiak, CSBA Backgrounder, October 3, 1996: 5-10.

<sup>38</sup> U.S. General Accounting Office, *Combat Air Power: Joint Mission Assessments Needed Before Making Program and Budget Decisions*, GAO/NSIAD-96-177, September 20, 1996: 9-10. See also GAO testimony before the House National Security Committee’s Subcommittees on Military Research and Development and Military Procurement, June 27, 1996. GAO/T-NSIAD-96-196: 4-5 (“Forces of Potential Adversaries Are Limited and Likely Slow to Improve”).

to continue, which would pose much more serious threats to U.S. and allied aircraft than they faced in the 1991 Gulf War. Moreover, some argue, many currently operational aircraft will need to be replaced by the time JSF types could be in full production in the 2010s, when most of these planes will be about twenty years old. JSF proponents would recommend reducing procurement of F-22As and F/A-18E/Fs in order to fund the JSF program.<sup>39</sup> Given the difficulties of accurately predicting what might be needed in future conflict scenarios, how combat-effective JSF aircraft would be, and what it would cost to develop, procure, and operate these aircraft, any analyses of military requirements and the combat effectiveness and budgetary costs of such new-generation aircraft allow for a range of conjecture and debate.

## Affordability of Program

JSF program officials anticipate major savings due to a high degree of commonality in components and systems among the three versions, which are to be built on a common production line. They also expect significant savings to be achieved by basing performance requirements on tradeoffs between cost and performance features, with industry and the services working together as a team. The contractors are expected to use new technologies and manufacturing techniques that reportedly could greatly reduce the JSF's development and production costs; e.g., wider use of composite materials in place of metal, CAD/CAM (computer-aided design/computer-aided manufacture) systems, and a recently developed plastic laminate that can be used instead of paint on the airframe.<sup>40</sup> Composite materials have frequently proven more expensive than metal, raising questions about the savings to be achieved via composites.

Program officials are also counting on the availability of adequate funding to procure the aircraft at efficient rates of production. Moreover, they expect Lockheed Martin to be able to produce the JSF at less cost than was the case with previous military aircraft, when cost controls were less compelling. For example, the F-16's production costs declined by 38% between mid-1992 and early 1997, largely due to more efficient production methods and reduced labor costs, even though production rates fell from 20 to 25 aircraft per month in 1991 to about six aircraft per month in 1994-95, soon after Lockheed Martin acquired the F-16 plant in Fort Worth, Texas, from General Dynamics.<sup>41</sup> Similarly, Boeing's experience in high-volume production

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<sup>39</sup> Lawrence J. Korb, "Should We Pay \$21 Billion for This Plane? — Yes, It's a Bargain for the Future," *Christian Science Monitor*, November 25, 1996: 19.

<sup>40</sup> Craig E. Steidle, "The Joint Strike Fighter Program," *Johns Hopkins APL Technical Digest*, January-March 1997, p. 6-8, 10-13, 17-18; "Kaminski Praises Industry Response to DOD Initiatives," *Aerospace Daily*, February 16, 1996, p.249; Bender, Bryan. "'Paintless' Design to Save JSF an Estimated \$3 Billion," *Defense Daily*, July 18, 1997, p. 108.

<sup>41</sup> William C. Scott, "Lockheed Martin Reconstructs TAS [Tactical Aircraft Systems] Unit as 'Fighter Enterprise,'" *Aviation Week & Space Technology*, July 28, 1997: 64-66.



of commercial transport planes is expected to facilitate cost-efficient production of military aircraft such as the JSF.<sup>42</sup>

Others doubt these optimistic forecasts, citing past experience with new aircraft programs, concern about budget deficits, and support for non-defense programs in this post-Cold War period, which might preclude procurement of the JSF at projected rates.<sup>43</sup> According to this view, we cannot afford to launch a new JSF program while having to continue buying improved and ever more expensive versions of current planes to maintain force structures during what may be a long interim if the JSF runs into technical or budgetary problems.<sup>44</sup> It can also be argued that critical performance features may have to be traded off to make the JSF affordable enough to be procured in the quantities deemed necessary to maintain force structures.<sup>45</sup>

Disagreements over performance and capability versus cost and affordability may threaten multi-service support of the JSF program. CBO analysts have noted that the performance/capability compromises required to achieve commonality "... could mean that the service with the most modest requirements in terms of capability (the Air Force) would have to accept a higher price and capability [compared to the F-16] than it needs so that the needs of the services with the greater capability requirements (the Navy and Marine Corps) could be met." They argue that if history is a guide, JSF planes "... are apt to be more costly than Air Force requirements might dictate, but provide less capability than the Navy might desire." They note further that "... price increases and decreases in capability are consistent with the history of many single service programs as well," since development programs usually provide less capability at higher prices than early estimates suggest, and they conclude that the JSF program's success "... will depend on persuading the services to lower their expectations from the stand-alone programs they might have without the Joint Strike Fighter.<sup>46</sup>

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<sup>42</sup> Schneider, Greg. "Boeing Aftershocks," *Baltimore Sun*, December 22, 1996. p 1D, 3D. Peter Pae. "Assembly Line Tactic For New Jet." *Los Angeles Times*. January 14, 2007.

<sup>43</sup> For discussion of budgetary constraints and competing defense programs, see Center for Strategic and Budgetary Assessments, *U.S. Tactical Aircraft Plans: Preparing for the Wrong Future?* by Steven Kosiak, CSBA Backgrounder, October 3, 1996: 4-5.

<sup>44</sup> Vago Muradian and John Robinson, "Public Confidence at Odds with Private Concerns about Tacair," *Defense Daily*, November 19, 1996: 277; John J. Shanahan, "Should We Pay \$219 Billion for This Plane? — No, It's Squandering on Imaginary Enemies," *Christian Science Monitor*, November 25, 1996: 19.

<sup>45</sup> The difficulties of balancing performance and cost in the JSF program are discussed in detail in CBO's *A Look at Tomorrow's Tactical Air Forces*, January 1997: 48-50; see also Cole, Jeff, Andy Pasztor, and Thomas E. Ricks, "The Sky, the Limit: Do Lean Times Mean Fighting Machines Will Be Built for Less?" *Wall Street Journal*, November 18, 1996: A1.

<sup>46</sup> U.S. Congressional Budget Office, *A Look at Tomorrow's Tactical Air Forces*, by Lane Pierrot and Jo Ann Vines, January 1997: 48-50.

## Feasibility of Joint-Service Aircraft

Those skeptical of developing aircraft to meet the needs of several services often point to the TFX program in the 1960s as a classic example of DOD's failure to produce an aircraft that was both carrier-capable as well as suitable for land-based Air Force operations.<sup>47</sup> Analogies between TFX and JSF are rejected, however, by those who argue that TFX problems will be avoided in the JSF program by developing variants of a family of aircraft that can meet service requirements while sharing many common components and subsystems, such as engines, avionics, communications, and munitions.

Their argument is supported by a comparison of the origins of the two programs that suggests that JSF has thus far avoided the pitfalls of TFX by an apparent commitment to much better coordination of service requirements and the development of three variants for the Air Force, Navy, and Marine Corps/Royal Navy instead of one all-purpose airframe for both land- and carrier-based operations.<sup>48</sup> CBO analysts have noted, however, that "Many defense programs begin with the expectation of joint purchases by the services, but those expectations are seldom met." For example, in the mid-1980s the Navy and Air Force planned to buy each other's next-generation aircraft: the Navy's Advanced Tactical Aircraft — the A-12 that was cancelled in 1991 — and the Air Force F-22A, in which the Navy has not been interested since the early 1990s. Similarly, the V-22 program began in 1981 as the JVX tilt-rotor aircraft to be used by the Army, Marine Corps, Navy, and Air Force, but the Army soon dropped out and the other services reduced their projected buys.<sup>49</sup>

While designing an aircraft that meets both the Air Force's and the Navy's needs is challenging, the Marine Corps' STOVL requirement may be what makes or breaks this joint program because it appears the most technologically challenging variant and is a leading cost driver. The costs and complications of pursuing the STOVL variant (including reducing weight growth), are leading some to suggest that the JSF program would be more feasible and more affordable if the F-35B were cancelled. In this case, the Marine Corps would buy the CV JSF instead of the STOVL variant. It is also feared that changes to STOVL variant that are required to achieve its desired weight could reduce the level of commonality between the three variants.<sup>50</sup> This would be detrimental to the original goal of the JSF program.

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<sup>47</sup> For background on the TFX program, which produced the Air Force's F-111 and FB-111 strategic bombers in the 1960s, see Robert Art, *The TFX Decision — McNamara and the Military* (Boston, 1968); see also Robert Coulam, *Illusions of Choice* (Princeton, 1977).

<sup>48</sup> Mort Rolleston. "Learning the Lessons of TFX: the Joint Strike Fighter and Acquisition Reform." *International Affairs Review*. Summer/Fall 1999.

<sup>49</sup> U.S. Congressional Budget Office, *A Look at Tomorrow's Tactical Air Forces*, by Lane Pierrot and Jo Ann Vines, January 1997: 47-48. For discussion of the V-22 program, see CRS Issue Brief IB86103, *V-22 Osprey Tilt-Rotor Aircraft Program* (out of print; available from the author at 7-2577).

<sup>50</sup> Elizabeth Rees, "DOT&E: JSF Weight Reduction Raids Commonality Between Variants," (continued...)

The top ranking civilians in both the Air Force and the Navy have both expressed their strong support for the STOVL variant, calling it critical to the entire program.<sup>51</sup> Air Force procurement of STOVL may reduce the unit costs of these aircraft, with favorable implications for the program's affordability and multi-service support in the annual competition for funding. However, some in the Air Force have suggested that the Air Force STOVL variant may not share all the characteristics of the Marine Corps STOVL variant, thus creating a fourth variant of the F-35. This idea appears to have been quashed, reportedly in part, by strong, if informal congressional opposition. Increased cost and reductions in commonality appear to have been primary objections.<sup>52</sup>

Others point out that cancelling the STOVL version of JSF is complicated by the UK's investment in the program. Regardless, DOD is studying the incorporation of Marine Corps fixed wing aviation into the Navy, which would eliminate the requirement for STOVL.<sup>53</sup>

Multi-service support of the JSF has also been threatened by concerns on the part of some Navy officials that the costs of developing these aircraft may be too high, given the service's other funding priorities. In August 1997, the Navy began a review of JSF costs, raising questions about the service's continued support. Chief of Naval Operations Admiral Jay Johnson described this cost review as a routine exercise that in no way indicated a lack of support for the program, adding that "The Navy is committed to the Joint Strike Fighter as much as our shipmates in the Marine Corps and the Air Force."<sup>54</sup> The Air Force and the Marine Corps are the major participants in the program in terms of projected procurement; however, the Air Force is strongly committed to funding its F-22A stealth fighter/attack plane while the Marine Corps is strongly committed to funding its V-22 tilt-rotor aircraft. Perhaps concerned that the Navy and Air Force might not fully support the Joint Strike Fighter program in their long-term budget plans and that this lack of support would slow down or even jeopardize the program, former Deputy Defense Secretary Rudy de Leon issued a letter on May 2, 2000 to leaders of both departments, directing them to fully fund the tri-service fighter program. Stating that the JSF program was at a "critical juncture," de Leon reminded the Navy and Air Force leadership that the JSF will be the "cornerstone of U.S. tactical aviation for decades to come."<sup>55</sup> Such

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<sup>50</sup> (...continued)

*Inside the Air Force*, January 28, 2005.

<sup>51</sup> Gordon Trowbridge, "Roche Voices Strong Support for Short-Takeoff-Vertical Landing Fighter." *AirForceTimes.com*. March 24, 2004. Lorenzo Cortes. "England Says STOVL Version of JSF is 'Critical Design' of Entire Program." *Defense Daily*. April 5, 2004.

<sup>52</sup> David Fulghum, "Back in the Box," *Aviation Week & Space Technology*, October 4, 2004.

<sup>53</sup> Frank Wolfe, "Navy to Submit Study on Incorporating Marine Corps Fixed-Air Wing." *Defense Daily*, September 4, 2001.

<sup>54</sup> Thomas E. Ricks, "Navy Begins to Question New Attack Jet That Air Force and Marines Support," *Wall Street Journal*, September 9, 1997: A4; Bender, Bryan, "Navy Says It's Fully Committed to Joint Strike Fighter," *Defense Daily*, September 12, 1997: 423-424.

<sup>55</sup> Christopher Castelli, "Air Force, Navy Directed to Fully Fund Joint Strike Fighter (continued...)"

friction between the services and DOD appears to have occurred more recently. In the summer of 2006 it was reported that due to financial considerations, Navy and Marine Corps officials proposed delaying fielding the JSF for over one year.<sup>56</sup> DOD reportedly rejected this proposal and directed the Navy to fully fund the procurement of six JSFs in FY2008.<sup>57</sup>

## Alternatives to JSF

According to some critics of the program, the U.S. armed services have alternatives to the JSF in the Air Force F-16, the Marine Corps AV-8B, and the Navy F/A-18E/F, which could be produced in upgraded and modified versions that would maintain force structures while providing at least some of the performance capabilities promised by the JSF. Moreover, they argue that more advanced versions of current aircraft designs might be developed and procured at less cost and with less risk of delays and technological problems than an entirely new family of aircraft variants may entail. Upgraded versions of existing aircraft designs could probably also be sold to allied governments that are likely to be JSF customers.

Noting the JSF's projected cost as well as past experience with new aircraft programs, Congressional Budget Office (CBO) analysts have suggested options that would either cancel development of the JSF, reduce procurement of the aircraft, or alter the types developed and their distribution among the services. CBO analysts have identified a number of alternatives to developing, procuring, and using JSF aircraft as currently proposed. These alternative options include reliance on modification of current fighter/attack planes already in operation or expected to be in service soon, such as the Navy F/A-18E/F and the Air Force F-22A, as well as procuring fewer JSFs than proposed or none of these aircraft, with their place being taken by F-16s, AV-8Bs, and F/A-18E/Fs.<sup>58</sup>

A CBO report requested by the House National Security Committee's Subcommittee on Military Research and Development and published in January 1997 analyzed the budgetary implications of the Administration's tactical aircraft modernization plans in regard to the JSF, F-22A, and F/A-18E/F programs. The study evaluated one option that assumed procurement of only the 1,320 JSFs planned for Air Force buys through 2020 but no Marine Corps or Navy JSF versions; this was estimated to save about \$2.5 billion FY1997 dollars in average annual procurement funding over the 2002-2020 period compared to current Administration plans, estimated to cost some \$11.9 billion annually. Another option assumed procurement of 660 STOVL variants of the JSF for the Marines and the Navy, with the Air Force

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<sup>55</sup> (...continued)  
Program," *Inside the Air Force*, May 5, 2000.

<sup>56</sup> See for example, Jason Sherman. "Navy, Marine Corps Propose 14-Month Joint Strike Fighter Delay." *Inside the Navy*. August 21, 2006.

<sup>57</sup> Christopher Castelli. "DoD Overturns Proposal to Delay Fielding of Marine Corps JSF." *Inside the Navy*. December 18, 2006.

<sup>58</sup> U.S. Congressional Budget Office, *A Look at Tomorrow's Tactical Air Forces*, by Lane Pierrot and Jo Ann Vines, January 1997: 55-71.

using F-16s and F-15Es in lieu of JSFs and F-22As, respectively, which was estimated to save about \$4.5 billion (FY1997 \$) per year from 2002 to 2020. The study also evaluated a share-the-pain option that would cap procurement funding for fighter/attack planes in 2002-2020 at the same level as the historical average for Air Force and Navy fighter/attack aircraft funding from 1974 to 1997. This option would continue current development plans, but because of the JSF cost cap it would be able to purchase only about 40% of the JSFs currently planned (42% for the Air Force, 30% for the Marine Corps, and 51% for the Navy) and about 50% of planned F-22As and 58% of planned F/A-18E/Fs, with estimated average savings of \$5.6 billion (FY1997 \$) in annual procurement funding. Each of these options presents risks and opportunities. The last option, for instance would save \$5.6 billion (FY1997 \$) in annual procurement funding but would also result in a smaller and older fighter force with less combat capability.

Lockheed Martin has initiated a study, and has briefed initial results to Air Force officials, of a radically modified version of the Raptor called the FB-22 (Fighter/Bomber). The purpose of this variant would be to significantly increase the F-22A's air-to-ground capabilities; primarily through a redesign that would double the aircraft's range, and significantly increase the aircraft's internal payload. These improvements would likely result in some performance tradeoffs, such as reduced acceleration and maneuverability.

Although not officially part of the F-22A program, and still very much in the conceptual phase, some Air Force leaders have expressed enthusiasm for the idea. Former Secretary of the Air Force James Roche, reportedly touted the FB-22 idea as the potential platform of choice for providing better close air support for tomorrow's ground forces.<sup>59</sup> Other Air Force leaders appear less enthusiastic.<sup>60</sup> Potential costs and schedule of the FB-22 concept are still quite notional. How this multi-role aircraft would compete with — or conversely compliment — the JSF has not yet been determined.

Another potential alternative to the JSF is the Joint Unmanned Combat Air System (J-UCAS). The J-UCAS is being jointly pursued by the Air Force and the Defense Advanced Research Projects Agency and is still in the development stage.<sup>61</sup> Originally designed to execute a relatively small range of missions, UAV advocates argue that the technology is evolving so rapidly, that J-UCASs could soon replace manned combat aircraft, not merely augment them. This perspective not universally held among defense analysts.

## Implications for U.S. Defense Industry

As DOD's largest weapon system acquisition program, the JSF is a focal point for discussions regarding the U.S. defense industrial base. The October 2001 award

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<sup>59</sup> Ron Laurenzo, "Roche Envisions Close Air Support F-22," *Defense Week*, July 1, 2002.

<sup>60</sup> Bill Sweetman, "Smarter Bomber," *Popular Science*, June 25, 2002.

<sup>61</sup> See CRS Report RL31014, *Unmanned Combat Air Vehicles: Issues and Outlook*, for more information on UCAVs.

of the JSF EMD 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. This, in turn, would have a negative effect on the U.S. industrial base.<sup>62</sup>

Similar concerns were raised in 2006 when DOD proposed terminating the F136 Alternate Engine. In this case, some worried that if the F136 were cancelled, General Electric (GE) would not have enough business designing and manufacturing fighter jet engines to continue competing with Pratt & Whitney (the manufacturer of the F135 engine) in the future. This would leave, some feared, the United States dependent on only one manufacturer of this class of engine. Others argued that GE's considerable business in both commercial and military engines was sufficient to sustain GE's ability to produce this class of engine in the future.<sup>63</sup>

The JSF program could also have a strong impact on the U.S. defense industry through export. Most observers believe that the JSF could dominate the combat aircraft export market much as the F-16 has. Some estimate that the potential export market for the JSF approaches 4,000 aircraft. Like the F-16, the JSF appears to be attractive due to its relatively low cost, flexible design, and promise of high performance. Also, analysts note that during his first stint as Defense Secretary, Donald Rumsfeld played an instrumental role in launching the F-16 program by including foreign partners in the aircraft's development.<sup>64</sup> Many competitors, including France's Rafale, Sweden's JAS Gripen, and the European Typhoon are positioned to challenge the JSF in the fighter export market, or take its market share if the program is cancelled. Also, few countries have expressed interest in buying either the F-22A or the F/A-18E/F.

It can also be argued that the demand for civilian transport aircraft after 2000 will be strong enough to sustain a robust U.S. aviation industry, given the need to replace aging aircraft with quieter and more fuel-efficient planes for expanding domestic and international travel markets. For example, the worldwide fighter/attack market in 2005 has been estimated to be worth about \$13.2 billion while the commercial jet transport market is projected to be worth about \$43.5 billion at that time. Compared with its European and Asian competitors, the U.S. aviation industry appears to be well positioned to meet the needs of an expanding world market for civil aircraft after the turn of the century.<sup>65</sup> The extent to which such economic conditions may preserve an adequate U.S. defense industrial base for the development and production of combat aircraft is debatable, however, given the

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<sup>62</sup> 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 Else.

<sup>63</sup> For more information, see CRS Report RL33390, *Proposed Termination of Joint Strike Fighter (JSF) F136 Alternate Engine*, by Christopher Bolkcom.

<sup>64</sup> Vago Muradian, "Coffman: JSF Critical to Preserving U.S. Leadership in World Fighter Market," *Defense Daily*, February 26, 2001.

<sup>65</sup> Richard Aboulafia, "Market Overviews — Commercial Jet Transports, Fighter/Attack Aircraft," *World Military and Civil Aircraft Briefing*, Teal Group Corp., March 1997.

significant differences between civilian and military aircraft requirements and technologies.

Others fear that by allowing foreign companies to participate in this historically large aircraft acquisition program, DOD may be inadvertently opening up U.S. markets to competitors who enjoy direct government subsidies. These government subsidies could create an unfair for them relative to U.S. companies, it is argued, and the result could be the beginning of a longer-term foreign penetration of the U.S. defense market that could erode the health of the U.S. defense industrial base. In May 2004 the GAO release a report that found the JSF program could “significantly impact” the U.S. and global industrial base.<sup>66</sup> The GAO found that two laws designed to protect segments of the U.S. defense industry, the Buy American Act and the Preference for Domestic Speciality Metals clause, would have no impact on decisions regarding which foreign companies would participate in the JSF program. This is because DOD has decided that foreign companies that participate in the JSF program, and which have signed reciprocal procurement agreements with DOD to promote defense cooperation, should be granted a waiver.

## Implications for Military Bases

In October 2006 Air Force officials announced the six initial locations where F-35s would be based. These locations were Nellis AFB, NV; Edwards AFB CA; Hill AFB, UT; Eglin AFB, FL; Shaw AFB, SC; and Kadena Air Base, Japan. The Marine Corps announced that it would make Miramar MCAS, CA, home to its F-35s. It is expected that the F-35 will be based at additional locations in the future.

Basing decisions for the JSF may be of interest to many in Congress. The F-35 is thought by many to be the last manned aircraft that DOD is likely to develop and is projected to be in service long after other combat aircraft have been retired. Those wishing to keep military bases relevant and to potentially “BRAC-proof” them, may compete vigorously for the JSF.

## Allied Participation

Allied participation in the JSF development program has been actively pursued as a way to defray some of the cost of developing and producing the aircraft, and to “prime the pump” for export. Congress insisted from the outset that the JAST program include ongoing efforts by the Defense Advanced Research Projects Agency (DARPA) to develop more advanced STOVL aircraft, opening the way for British participation. Eight countries have pledged about \$4.5 billion to join in JSF development as partners.<sup>67</sup> The United States is currently negotiating with these eight countries to determine the level of their participation — if any — in the next stage of the JSF program: Production Sustainment and Follow-on Development (PFSD).

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<sup>66</sup> General Accountability Office *Joint Strike Fighter Acquisition: Observations on the Supplier Base*, GAO-04-554, May 2004.

<sup>67</sup> Katie Fairbank, “Strike Fighter’s Support Extends,” *Dallas Morning News*. July 12, 2002.

Various contractual relationships with allied governments and foreign firms are possible, depending on the amount of funding invested in the program, ranging from the British government's participation as a collaborative partner to associate partners, informed customers, observers or Foreign Military Sales (FMS) participants. On December 20, 1995, the U.S. and UK governments signed a memorandum of understanding (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 towards the cost of the 1997-2001 concept demonstration phase.<sup>68</sup> British Aerospace, Rolls-Royce, and other UK defense firms that have long been involved in major U.S. aircraft programs are expected to be subcontractor participants in the JSF program.<sup>69</sup> On January 17, 2001, the United States and the United Kingdom signed an MOU that committed the British government to spend \$2 billion supporting the JSF SDD phase. Britain's investment equates to approximately eight percent of the SDD program, and has been described by many analysts as a boon for the JSF program. Britain's — and other allies' — participation in the program makes it much more difficult for Congress or the Administration to cancel the program, they say.<sup>70</sup> In his nomination hearing, DOD acquisition chief Pete Aldridge testified that the any decision on the fate of the JSF would have to weigh its “international implications.”<sup>71</sup>

On April 16, 1997, the Dutch and Norwegian governments signed an MOU, which was later signed by the Danish government on September 10, 1997, committing a total of \$32 million from these NATO allies, who see the JSF as a replacement for the F-16 fighters they have operated since the late 1970s. On January 2, 1998, the Canadian government signed an MOU agreement, committing \$10 million to the JSF program as an observer of its management innovations. Canadian officials have stated that there is no commitment to buy the aircraft, however, and that Canada does not expect the JSF to replace its F/A-18A/Bs (operated as the CF-118A/B since the early 1980s).<sup>72</sup>

On April 21, 2000, it was reported that DOD had extended offers to Australia and Belgium to become partners in the JSF development. Both countries declined the offer. However, in June 2002, Australia changed its position, and pledged \$150

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<sup>68</sup> “U.S., U.K. Sign JAST Agreement,” *Aerospace Daily*, December 21, 1995: 451.

<sup>69</sup> Since the 1970s many European and Japanese firms have been major participants in U.S. aircraft, avionics, and munitions programs as subcontractors or affiliates of U.S. firms; e.g., F-15, F-16, AV-8, F/A-18, and AWACS programs.

<sup>70</sup> Greg Schneider, “Britain Backs Joint Strike Fighter Effort,” *Washington Post*, January 18, 2001, “British commitment seen as major boost to the Joint Strike Fighter,” *Inside the Air Force*. January 19, 2001.

<sup>71</sup> Marc Selinger, “Jsf Decision Should Weigh ‘International Implications,’ Nominee for Acquisition Post Says,” *Aerospace Daily*, April 27, 2001.

<sup>72</sup> Conversations with Canadian Embassy officials, February 13, 1998; “Canada, U.S. Sign MOU for JSF Program,” *Navy News and Undersea Technology*, February 9, 1998:7; *Joint Strike Fighter: Opportunities for Canadian Industry*. Report prepared by BDM International, Inc. for the Government of Canada, March 1997: 15 p.



million toward JSF SDD.<sup>73</sup> Turkey, Italy, Denmark, Norway and the Netherlands have accepted roles in the JSF SDD phase. While the exact details are still to be determined, participation in SDD is expected to cost each country from \$250 million to \$1.25 billion over 11 years. The smallest financial input a country can make to be a JSF partner is 1-2 percent of SDD cost.<sup>74</sup> The main benefit derived from participation is a strong commitment by the U.S. to export the aircraft to partner countries once the JSF is in production.<sup>75</sup> Another benefit of participation could be the transfer of military aviation expertise. Turkish officials have stated that participation in the JSF program is a “major opportunity for our defense industry.”<sup>76</sup>

In early February 2002, Canada and the Netherlands joined Britain as foreign partners in the JSF’s SDD phase. As a “Level III” partner, Canada pledged to provide \$150 million over the next 10 years for the system development and demonstration phase.<sup>77</sup> The Netherlands committed \$800 million to the program, making it a “Level II partner.”<sup>78</sup>

JSF program managers also offer FMS-level of participation for those countries unable to commit to partnership in the JSF’s SDD phase. Israel and Singapore are believed to have contributed \$50 million each, and they are “Security Cooperative Participants.” This relationship provides “specific case scope outside the cooperative development partnership.”<sup>79</sup> JSF officials have discussed the aircraft with the defense staffs of many other allied countries as prospective customers, including Germany, Italy, Turkey, and Spain. Britain’s Royal Air Force (RAF) as well as its Royal Navy may also buy some JSF aircraft over the long run. In the near term, however, the RAF is expected to buy the Eurofighter, which is to be produced by British, German, Italian, and Spanish companies as Europe’s next-generation

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<sup>73</sup> Nick Jonson, “Australia to Join Joint Strike Fighter Program as Level 3 Partner,” *Aerospace Daily*, June 28, 2002.

<sup>74</sup> Robert Wall, “Pentagon Broadens Foreign Options for JSF,” *Aviation Week & Space Technology*, June 5, 2000: 46.

<sup>75</sup> “Australia, Belgium Enter Joint Strike Fighter Program as EMD Partners,” *Inside the Air Force*, April 21, 2000.

<sup>76</sup> Bekedil, Burak Ege and Umit Enginsoy, “Turks to Pay up to \$1 Billion to Join JSF Development,” *Defense News*, July 17, 2000:6.

<sup>77</sup> Jim Garomone, “Canada Joins Joint Strike Fighter Effort,” *American Forces Press Service*, February 7, 2002.

<sup>78</sup> “Dutch Government Decides to Join Joint Strike Fighter,” *Defense Daily*, February 11, 2002.

<sup>79</sup> Selected Acquisition Report. Office of the Secretary of Defense for Acquisition. December 31, 2005.

fighter/attack plane.<sup>80</sup> The Polish government is reportedly leaning toward an FMS investment of \$75 to \$100 million in the JSF program.<sup>81</sup>

As the first aviation program to heavily incorporate foreign participation in development, the JSF's industry cooperation and technology sharing mechanisms may still be evolving. As the United States carries on negotiations with partner countries on the PSFD phase of the JSF program, a number of them have expressed concern over workshare and technology sharing. The issue for U.S. policy makers is how to balance legitimate yet often contradictory concerns regarding security, policy, investment, and industrial competitiveness.

British government officials have expressed some frustration over their perception that British industries have not garnered their fair share of work on the project.<sup>82</sup> British officials reportedly also fear that U.S. concerns about maintaining control over proprietary U.S. stealth technology may limit UK access to JSF production and maintenance work, and require Britain to depend on U.S. industry to upgrade and maintain their F-35s.

From early to mid-2003, British officials began making the case for establishing a second JSF assembly line in the United Kingdom. According to press accounts, British industry officials argued that establishing an assembly line is required because it is of "critical importance" for the UK to establish an indigenous ability to support and modify the JSF throughout its life span.<sup>83</sup> After noteworthy public tension between policy makers in London and Washington DC, it was announced that

Both governments agree that the U.K. will have the ability to successfully operate, upgrade, employ, and maintain the Joint Strike Fighter such that the United Kingdom retains operational sovereignty over the aircraft. Further, both governments agree to protect sensitive technologies found within the Joint Strike Fighter program.<sup>84</sup>

In the end, British officials insisted on the establishment of a UK-based maintenance, repair (MRO) and upgrade facility, and the ability to verify the aircraft's stealthiness

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<sup>80</sup> Michael J. Witt, "Britain's Air Force Considers JSF as Harrier Follow-on," *Defense News*, January 12-18, 1998: 1, 27. Richard Scott and Nick Cook, "UK Air, Naval Forces Sign on Joint Future Aircraft," *Jane's Defence Weekly*, January 7, 1998: 3.

<sup>81</sup> Grzegorz Holdanowicz, "Poland Steps Up Interest in JSF," *Jane's Defense Weekly*. July 18, 2001.

<sup>82</sup> Elizabeth Rees, "U.K. Frustrated by JSF's Touted International Partnering Scheme," *Inside the Air Force*, February 28, 2003 and Robert Wall, "Export Issues Bedevil JSF," *Aviation Week & Space Technology*, March 3, 2003.

<sup>83</sup> Paul Lewis, "UK Builds Case For JSF Assembly Line," *Flight International*, February 18-24, 2003 and Douglas Barrie, "Disjointed Strike Fighter," *Aviation Week & Space Technology*, May 19, 2003.

<sup>84</sup> Michael Sirak, "U.S., U.K. Reach Accord On Joint Strike Fighter Technology Sharing," *Defense Daily*. May 30, 2006.

following such maintenance or repair.<sup>85</sup> In June 2006 it was reported that U.S. and Italian officials were finalizing a deal that would establish a second JSF final assembly line in Italy.<sup>86</sup>

Representatives from Dutch companies have been outspoken regarding their disappointment with a perceived lack of work on the F-35 program. Norwegian government officials have also voiced complaints about a perceived lack of JSF workshare and have threatened to withdraw from the program. In January 2003, Norway signed an industrial partnership agreement with the Eurofighter Consortium, a move many believe to be motivated by Norway's increasing dissatisfaction with that country's access to JSF business.<sup>87</sup> Danish companies have also reportedly considered withdrawing from the program due to their unhappiness with workshare.<sup>88</sup> Italian and Turkish defense officials have also threatened to reduce its investments in the JSF program because firms from these countries are dissatisfied with the work they have won.<sup>89</sup> Turkish officials have also expressed concern that the United States is withholding key technology.<sup>90</sup> Australian officials have also expressed concern that the United States is not releasing sufficient F-35 technology to its partner nations.<sup>91</sup>

Perhaps in response to growing international frustration with JSF workshare arrangements, in June 2003, DOD released a report assessing the return on investment for international JSF participants. According to the study, the amount of return on investment varied greatly among participants from an estimated \$5 to \$40 dollars of revenue in return for every \$1 invested into the program.<sup>92</sup>

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<sup>85</sup> Douglas Barrie. "Final Assembly and Check Out Line Not a U.K. Priority." *Aviation Week & Space Technology*. June 12, 2006.

<sup>86</sup> Amy Butler. "Italy Wins JSF Final Assembly; U.K. Presses Maintenance, Support." *Aerospace Daily & Defense Report*. June 19, 2006.

<sup>87</sup> "Norway Signs Industrial Partnership with Eurofighter Consortium," *Defense Daily*, January 29, 2003.

<sup>88</sup> Joris Janssen Lok, "Frustration Mounts Among JSF Partners," *Jane's Defense Weekly*. March 24, 2004. Thomas Dodd, "Danish Companies Consider Quitting JSF Programme," *Jane's Defence Weekly*, January 9, 2004.

<sup>89</sup> 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.

<sup>90</sup> Nuray Babacan. "US Does Not Intend to Provide Software Codes for F-35 Fighters." *Istanbul Hurriyet*. June 23, 2006.

<sup>91</sup> Peter La Franchi. "Austral Demands JSF Resolution." *Flight International*. April 7, 2006.

<sup>92</sup> John Liang, "DoD Study: JSF Could Generate High Return on Investment for Partner Countries," *Inside Defense.Com*, June 13, 2003 and John Liang, "DoD Assessing JSF's Financial Impact on Foreign Suppliers," *Inside the Air Force*, May 9, 2003.

## Appendix. JSF Operational/Performance and Cost Requirements

Characteristics	USAF	USN	USMC
Range (nm) <sup>a</sup>			
- Objective	690	730	550
- Threshold	590	600	450
Payload <sup>b</sup>	4,000-lb AIM-120	4,000-lb AIM-120	4,000-lb AIM-120
Speed	Subsonic cruise with supersonic dash. speeds comparable to F-16 and F/A-18 <sup>c</sup>		

**Note:** *Selected Acquisition Report*. Office of the Secretary of Defense for Acquisition. December 31, 2005. Craig E. Steidle, "The Joint Strike Fighter Program," *Johns Hopkins APL Technical Digest*, v. 18, January-March, 1997: 9. For more current USAF payload requirements, see Vago Muradian, "AF Seeks 2,000-Pound Weapons Capability in New JSF Requirement," *Defense Daily*, September 16, 1997: 445-447.

- a. Aircraft range is normally stated in nautical miles (nm) of 6,080 ft, equivalent to 1.15 statute miles (mi) or 1.85 kilometers (km).
- b Christopher Castelli, "Marine Corps Wins Change to Boost Internal Payload of STOVL JSF," *Inside the Navy*, November 11, 2002.
- c The maximum dash speeds of these aircraft for short duration at high altitude with a clean configuration are reportedly Mach 2 for F-16s and Mach 1.8 for F/A-18s. Mach 1, the speed of sound, varies from 762 mph (662 nmph) at sea level to 654 mph (576 nmph) at 35,000 ft., *Jane's All the World's Aircraft, 1996-97*: 649 and 657.