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V-22 Osprey Tilt-Rotor Aircraft

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Christopher Bolkcom
Specialist in National Defense
Foreign Affairs, Defense, and Trade Division

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Committees of Congress

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Service

V-22 Osprey Tilt-Rotor Aircraft

Summary

The V-22 Osprey is a tilt-rotor aircraft, capable of vertical or short take off and landing, with forward flight like a conventional fixed-wing aircraft. The MV-22 is the Marine Corps' top aviation priority. Marine Corps leaders believe that the Osprey will provide them an unprecedented capability to quickly and decisively project power from well over the horizon. The Air Force's CV-22 version will be used for special operations. Army officials have testified that the service has no requirement for the V-22, but the Navy has expressed interest in purchasing MV-22s for a variety of missions.

The V-22 program has been under development for over 25 years. Safety and maintenance concerns have arisen during this period (due in large part to three fatal accidents). The commander of the V-22 maintenance squadron admitted to falsifying maintenance records to make the aircraft appear more maintainable than it was, and three Marines were found guilty of misconduct. The program has maintained support from many in Congress despite these deficiencies. The program has undergone restructuring to accommodate congressional direction, budget constraints, and recommendations from outside experts, and DOD managers.

After a 17 month hiatus, the Osprey embarked on its second set of flight tests in May of 2002. Tests were completed in June 2005 to the satisfaction of Navy testers, who believe that the V-22 has resolved all technical and engineering problems identified in internal and external reviews. On September 28, 2005 the V-22 program passed a major milestone when the Defense Acquisition Board approved it for military use and full rate production.

Supporters tout the V-22's potential operational capabilities relative to the helicopters it will replace. It will fly faster, farther and with more payload than the CH-46 Sea Knight the Marine Corps currently operate. They argue that this combination of attributes, coupled with the ability to take off and land vertically will provide the Marine Corps with new and potentially transformational capabilities. Detractors tend to emphasize the V-22's long development schedule, its three fatal accidents, and its high cost relative to the helicopters it will replace. V-22 opponents argue that modern helicopters also offer capabilities superior to the CH-46's and more cost effectively than the Osprey.

Through FY2006, $20 billion had been provided for the V-22 program. The Defense Department's Selected Acquisition Report of December 31, 2005, estimated the total acquisition of a 458-aircraft program would be $50.5 billion, which translates into a program acquisition cost of $88.5 million per Osprey.

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Introduction

The V-22 Osprey is the Marine Corps' top aviation priority.[1] Marine Corps leaders believe that the Osprey will provide them an unprecedented capability to quickly and decisively project power from well over the horizon. In the words of one former leader, its "...combination of increased payload with vastly improved speed and range make the Osprey the aircraft that defines the commander's area of influence as it relates to placing Marines on the ground."[2] The aircraft's promise, however, has been dimmed by a series of challenges to its affordability, safety, and program management.

The V-22 tilt-rotor design combines the helicopter's operational flexibility of vertical take off and landing with the greater speed, range, and fuel efficiency of a turboprop aircraft. The V-22 Osprey takes off and lands vertically like a helicopter but flies like a fixed-wing aircraft by tilting its wing-mounted rotors 90 degrees forward to function as propellers.

The V-22 is intended to perform a variety of Marine Corps and Air Force missions, including troop and equipment transport, amphibious assault, search and rescue, and special operations. The Marines' MV-22 version is to transport 24 fully-equipped troops some 200 nautical miles (nm) at a speed of 250 knots (288 mph), exceeding the performance of the CH-46 medium-lift assault helicopters the MV-22 will replace. The Air Force's CV-22 version (with a range of 500 nm) will be used for special operations. Army officials have testified that the service has no requirement for the V-22. The Navy has expressed interest in purchasing MV-22s for a variety of missions, (e.g., personnel recovery, fleet logistic support, aerial refueling, special warfare) but has no funds budgeted in the current Future Years Defense Plan (FYDP).

Developed and produced by Bell Helicopter Textron of Fort Worth, TX, and Boeing Helicopters of Philadelphia, PA, the aircraft is powered by two T406 turboshaft engines produced by Allison Engine Company of Indianapolis, IN, a subsidiary of Rolls-Royce North America. Fuselage assembly will be performed in Philadelphia, PA. Drive system rotors and composite assembly will be completed

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[1] For example, February 17, 2005, Marine Corps Commandant Gen. Michael Hagee testified that "The MV-22 remains the Marine Corps number one aviation acquisition priority." Testimony available on House Armed Services Committee website, at [http://armedservices.house.gov/schedules/].

[2] Lt. Gen. Frederick McCorkle, "Transforming Marine Aviation," *Marine Corps Gazette*, May 2000, p.26.

in Fort Worth, TX, and final assembly and delivery will be completed in Amarillo, TX.

Through FY2006, $20 billion had been appropriated for the V-22 program. The Defense Department's Selected Acquisition Report (SAR Summary Tables) of September 20, 2006, estimated the total acquisition of a 458-aircraft program would be $50.5 billion, which translates into a program unit acquisition cost (PUAC) of $110 million per Osprey. The PUAC includes funding for both development and production of the aircraft and related activities. The average procurement unit cost (APUC), which, for the Osprey is estimated at $88.5 million does not include these sunk costs. The V-22 has been approved for full-rate production.

Background

The V-22 program has been under development for over 25 years. Safety and maintenance concerns have arisen during this period, but the program has maintained support from many in Congress nonetheless. The program has undergone restructuring to accommodate recommendations from outside experts and DOD managers.

System Description

The V-22 is a tilt-rotor aircraft, capable of vertical or short take off and landing, with forward flight like a conventional fixed-wing aircraft. About 65% of the airframe is made of graphite-epoxy composite materials. The Marine Corps's MV-22 version will have the following characteristics:

Propulsion:	2 T406 turboshaft engines
Crew:	3
Passengers:	24 combat troops
Max. vertical take off weight:	47,500 lb
Max. short take off weight:	55,000 lb
Speed at max. weight:	250 knots/hour
Combat radius:	200+ nm

The airframes of the Marine Corps MV-22 and the Air Force CV-22 variant for Special Operations Command will have some 90% commonality; the primary differences being in avionics. The CV-22 is to carry 18 troops, with auxiliary fuel tanks increasing combat radius to about 500 miles. This variant may carry a 50-cal GAU-19 nosegun for self defense.

DOD plans to field V-22s in four blocks: Blocks B and C for the Marine Corps, and Blocks 10 and 20 for the Air Force. Block B aircraft were produced first in FY2004 and will be the aircraft with which the Marine Corps will achieve initial operational capability (IOC). Block B aircraft will improve upon those used in EMD testing (Block A aircraft) with upgrades to avionics, communications, navigation. It will also feature a retractable fuel probe, a ramp gun (for self defense), a joist, and an improved position for the "fastrope" (a method for personnel to quickly exit the aircraft while in hover). The Air Force will achieve IOC with the Block 10 variant, which will be based on the Block B, but feature advanced avionics, such as terrain-following radar, and directed infrared countermeasures, that will allow special operations forces to penetrate hostile areas in all weather and terrain. The Marine Corps and Air Force plan to begin developing the most capable V-22 variants — the Block C and Block 20 respectively — in FY2006, and begin producing them in FY2009 and FY2012 respectively. See the appendix for a complete list of V-22 features by Block.

Figure 1. V-22 Osprey in Flight

Early Development

The V-22 is based on the XV-15 tilt-rotor prototype which was developed by Bell Helicopter and first flown in 1977. The Department of Defense began the V-22 program in 1981, first under Army leadership, but with the Navy/Marine Corps later taking the lead in developing what was then known as the JVX (joint-service vertical take-off/landing experimental aircraft). Full-scale development of the V-22 tilt-rotor aircraft began in 1986.

Like some other tactical aviation programs (such as the F/A-18E/F Super Hornet, F/A-22 Raptor and Joint Strike Fighter), the total number of V-22 aircraft planned for procurement has decreased over time. In 1989 the Defense Department projected a 663-aircraft program with six prototypes and 657 production aircraft (552 MV-22s, 55 CV-22s, and 50 HV-22s). As projected in 1994, however, the program comprised 523 production aircraft (425 MV-22s, 50 CV-22s, and 48 HV-22s). Procurement of these 523 aircraft was to continue into the 2020s, since the Defense Acquisition Board limited annual expenditures for Marine MV-22s to $1 billion (FY1994 dollars) when it approved entry into engineering and manufacturing development (EMD) in September 1994. The Quadrennial Defense Review (QDR), released May 19, 1997, recommended accelerated procurement of 458 production aircraft (360 MV-22s for the Marines; 50 Air Force CV-22s; and 48 Navy HV-22s). Such a 458-aircraft program is now projected.

On March 19, 1989, the first of six MV-22 prototypes was flown in the helicopter mode and on September 14, 1989, as a fixed-wing plane. Two of these aircraft were destroyed in crashes. Prototype aircraft numbers three and four successfully completed the Osprey's first Sea Trials on the USS Wasp (LHD-1) in December 1990. The fifth prototype crashed on its first flight (June 11, 1991), because of incorrect wiring in a flight-control system; the fourth prototype crashed on July 20, 1992, while landing at Quantico Marine Corps Air Station, VA, killing seven people and destroying the aircraft. This accident was caused by a fire resulting from hydraulic component failures and design problems in the engine nacelles.[3]

Flight tests were resumed in August 1993 after changes were incorporated in the prototypes. Flight testing of four full-scale development V-22s began in early 1997 when the first pre-production V-22 was delivered to the Naval Air Warfare Test Center in Patuxent River, MD. The first EMD Flight took place on February 5, 1997. The first of four low-rate initial production aircraft, ordered on April 28, 1997, was delivered on May 27, 1999. Osprey number 10 completed the program's second Sea Trials, this time from the USS Saipan (LHA-2) in January 1999.

Operational evaluation (OPEVAL) testing of the MV-22 began in October 1999 and concluded in August 2000. On October 13, 2000, the Department of the Navy announced that the MV-22 had been judged operationally effective and suitable for land-based operations. On November 15, 2000, the Marine Corps announced that the Osprey had successfully completed sea trials and had been deemed operationally effective and suitable for both land- and sea-based operations.

Successfully completing OPEVAL should have cleared the way for full rate production. This decision was to have been made in December 2000, but was postponed indefinitely, due a mixed report from DOD's director of operational test and evaluation, and to two fatal accidents.

Accidents and Fatalities Worsen

On April 8, 2000, another Osprey crashed near Tucson, Arizona during an exercise simulating a noncombatant evacuation operation. All four crew members and 15 passengers died in the crash. An investigation of the accident found that the pilot was descending in excess of the recommended flight envelope which may have caused the aircraft to experience an environmental condition known as "power settling" or "vortex ring state." According to Lt. Gen. Fred McCorkle, the pilot was descending more than a thousand feet per minute. The recommended descent rate is 800 feet per minute." Following a two-month suspension of flight testing, the Osprey recommenced OPEVAL in June 2000, with pilots flying a slightly tighter flight

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[3] Former Secretary of Defense Cheney tried to terminate the program in 1989-92, but Congress continued to provide funds for development of the V-22. The George H. Bush Administration's FY1990 budget requested no funds for the program. In submitting that budget to Congress on April 25, 1989, Defense Secretary Cheney told the House Armed Services Committee that he "could not justify spending the amount of money ... proposed ... when we were just getting ready to move into procurement on the V-22 to perform a very narrow mission that I think can be performed ... by using helicopters instead of the V-22."

envelope. A July 27, 2000 report by the Marine Corps Judge Advocate General (JAG) (which had access to all non-privileged information from the safety investigation) confirmed that a combination of "human factors" caused the crash.

> This mishap appears not to be the result of any design, material or maintenance factor specific to tilt-rotors. Its primary cause, that of a MV-22 entering a Vortex Ring State (Power Settling) and/or blade stall condition is not peculiar to tilt rotors. The contributing factors to the mishap, a steep approach with a high rate of descent and slow airspeed, poor aircrew coordination and diminished situational awareness are also not particular to tilt rotors.[4]

A DOD Inspector General study concluded that the V-22 would not successfully demonstrate 23 major operational effectiveness and suitability requirements prior to the December 2000 OPEVAL Milestone III decision to enter full rate production in June 2001[5]. The Marine Corps agreed with DOD's assessment of the deficiencies, but said that they had been aware of these deficiencies before the beginning of OPEVAL. Furthermore, the Marine Corps said that they had an approved plan designed to resolve the deficiencies prior to the Milestone III decision.

On November 17, 2000, DOD's Director of Operational Test and Evaluation issued a mixed report on the Osprey; saying although "operationally effective" the V-22 was not "operationally suitable, primarily because of reliability, maintainability, availability, human factors and interoperability issues." The report recommended that more research should be conducted into the V-22's susceptibility to the vortex ring state blamed for the April 8, 2000 crash.

On December 11, 2000, a MV-22 Osprey crashed near Jacksonville, NC, killing all four Marines on board. This was the fourth Osprey crash since 1991 and the third lethal accident. The aircraft's pilot, Lt. Col. Keith M. Sweeney was the program's most experienced pilot and was in line to command the first squadron of Ospreys. The aircraft's copilot, Maj. Michael Murphy was second only to Sweeney in flying time on the Osprey.[6] The Marine Corps grounded the Osprey fleet pending a mishap board investigation. On April 5, 2001, the Marine Corps reported that the crash was caused by a burst hydraulic line in one of the Osprey's two engine casings, and a software malfunction that caused the aircraft to accelerate and decelerate unpredictably and violently when the pilots tried to compensate for the hydraulic

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[4] V-22 JAGMAN Executive Summary, United States Marine Corps, Division of Public Affairs, July 27, 2000, p.1.

[5] *Audit Report: V-22 Osprey Joint Advanced Vertical Aircraft*. Report No. D-2000-174. Office of the Inspector General. Department of Defense. August 15, 2000.

[6] James Dao, "Marines Ground Osprey Fleet After Crash Kills Four," *New York Times*, Dec. 12, 2000.

failure.[7] The Marine Corps report called for a redesign of both the hydraulics and software systems involved.[8]

Maintenance and Parts Falsifications

In December 2000, an anonymous letter was mailed to the media by someone claiming to be a mechanic in the Osprey program. The letter claimed that V-22 maintenance records had been falsified for two years, at the explicit direction of the squadron commander. Enclosed in the letter was an audio tape that the letter's author claimed was a surreptitious recording of the squadron commander directing maintenance personnel to lie about the aircraft until the V-22 LRIP decision was made. On January 20, 2001, it was reported that the V-22 squadron commander admitted to falsifying maintenance records. The Marine Corps subsequently relieved him of command and reassigned him to a different position. At a May 1, 2001 hearing, members of the Senate Armed Services Committee expressed their concern that false data might impede DOD's ability to accurately evaluate the V-22 program and identify problem areas and potential improvements. The Department of Defense's Inspector General (IG) conducted an investigation. On September 15, 2001, it was reported that three Marines were found guilty of misconduct and two were reprimanded for their actions.

In June 2005 a U.S. grand jury indicted a company that had supplied titanium tubing for the V-22 program. The indictment charged the company with falsely certifying the quality of the tubes. The V-22 test program was halted for 11 days in 2003 due to faulty tubes. Replacing deficient tubes cost the V-22 program $4 million. Navy officials do not believe that these deficient tubes caused fatal mishaps.[9]

Reviews and Restructuring

On April 19, 2001, a Blue Ribbon panel formed by then-Secretary of Defense William Cohen to review all aspects of the V-22 program, reported its findings and recommendations.[10] These findings and recommendations were also discussed during congressional testimony on May 1, 2001. The panel recommended that the

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[7] An un-redacted version of JAG investigation into the April 2000 V-22 crash indicates that investigators found three "noteworthy" maintenance "areas of concern", including the Osprey's hydraulics system. A Naval Safety Center presentation to the Blue Ribbon Panel brought to light several previously unreported maintenance problems — including hydraulics failures — that caused engine fires or other problems during the Osprey's operational testing.

[8] Mary Pat Flaherty, "Osprey Crash Blamed on Leak, Software," *Washington Post*, Apr. 6, 2001.

[9] Louise Story. "Maker of Tubes for Osprey Aircraft is Indicted." *New York Times*. June 8, 2005. Christopher J. Castelli. "Former Supplier of Hydraulic Tubing for V-22 Osprey Faces Indictment." *Inside the Navy*. June 13, 2005.

[10] This panel was chaired by retired Marine General John R. Dailey and included retired Air Force General James B. Davis, Norman Augustine, and MIT professor Eugene Covert.

program continue, albeit in a restructured format. The panel concluded that there were numerous problems with the V-22 program — including safety, training and reliability problems — but nothing inherently flawed in basic tilt-rotor technology. Because of numerous safety, training, and reliability problems, the V-22 was not maintainable, or ready for operational use.

The panel recommended cutting production to the "bare minimum" while an array of tests were carried out to fix a long list of problems they identified with hardware, software and performance. Cutting near term production was hoped to free up funds to pay for fixes and modifications. Once the changes had been made and the aircraft was ready for operational use, the Panel suggested that V-22 out year purchases could be made in large lots using multi year contracts to lower acquisition costs. Program officials estimated that the minimal sustainable production rate is 12 aircraft per year, which would be less than half the Ospreys once planned for FY2002.[11] In P.L.107-107 Sec.123, Congressional authorizers codified the Blue Ribbon Panel's recommendation to produce V-22's at the minimum sustainable rate until the Secretary of Defense can certify that the Osprey is safe, reliable, maintainable, and operationally effective.

DOD appears to have taken managerial and budgetary steps to incorporate the Blue Ribbon Panel's recommendations. For example, DOD's FY2001 supplemental funding request asked for a reduction of $475 million in procurement and an increase of $80 million in R&D funds. The additional R&D funding was to be used to support initial redesign and testing efforts to address deficiencies, logistics, flight test, and flight test support for V-22 aircraft. The reduction in procurement funding reflected the need to reduce production to the minimum rate while the aircraft design changes are being developed and tested.

Secretary of Defense Rumsfeld's FY2002 budget amendment, unveiled June 27, 2001, included a request for the procurement of 12 Ospreys. DOD comptroller Dov Zakheim and Marine Corps Commandant Gen. James Jones both stated that the procurement of 12 aircraft in FY2002 would allow them to sustain the V-22 subcontractor base while simultaneously addressing the Osprey program's needs.[12] V-22s were procured at a rate of 11 per year from FY2002 to FY2006.

Following the Blue Ribbon panel's recommendations, former DOD Undersecretary for Acquisition Edward "Pete" Aldridge assumed acquisition authority for the V-22 program. Undersecretary Aldridge changed the V-22 program's status from an ACAT 1C program — which gives the Department of the Navy the highest required authority for production decisions — to an ACAT 1D program. Under the latter category, the Defense Acquisition Board (DAB) will decide if and when the program is ready to enter full rate production. Other ACAT

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[11] Adam Hebert, "Minimal Sustainable Rate Will Dramatically Cut Near-Term V-22 Buys," *Inside the* Air Force, Apr. 20, 2001.

[12] DOD News Briefing, Wed. June 27, 2001, 1:30PM and Kerry Gildea, "New V-22 Plan Sustains Lower Tier Contractors, Jones Reports," Defense Daily, May 15, 2001.

1D programs, for example, include the F-22 Raptor and the now-cancelled RAH-66 Comanche helicopter.[13]

A NASA-led review of the V-22 program, released November 6, 2001, concluded that there were no known aero-mechanical phenomena that would stop the tilt rotor aircraft's development and deployment. The study focused on several aero-mechanics issues, including Vortex Ring State, power problems, auto-rotation, and hover performance.[14]

In a December 21, 2001 memo to the Secretaries of the Air Force and the Navy, and the Commander, Special Operations Command, Undersecretary of Defense Aldridge gave his authorization for the V-22 to resume flight testing in the April 2002 time frame. Secretary Aldridge expressed support for range, speed, and survivability goals of the V-22. He noted, however that the program still had numerous technical challenges to overcome, and emphasized that the V-22 must demonstrate that "1) it can meet the needs of the warfighter better than any other alternative, 2) it can be made to be reliable, safe, and operationally suitable, and 3) it is worth its costs in contributing to the combat capability of U.S. forces." Secretary Aldridge approved the flight test program under the condition that the production rate be slowed to the minimum sustaining level, that it be comprehensive and rigorous, and that the restructured program is fully funded in accordance with current estimates.[15] Undersecretary Aldridge estimated that the V-22 would require at least two years of flight testing before DOD could conclude that the aircraft is safe, effective, and "worth the cost."[16]

Mechanical adjustments slowed the V-22 test schedule, and the MV-22 took its first test flight on May 29, 2002. The Air Force CV-22 resumed flight tests on September 11, 2002. Flight tests were designed to explore both technical and operational concerns. Technical concerns include flight control software and the reliability and robustness of hydraulic lines. Operational concerns explored included whether the Osprey is too prone to Vortex Ring State to make it a safe or effective aircraft, whether this potential problem is further exacerbated by multiple Osprey's flying in formation, and how well the V-22 handles at sea.[17]

The principal differences between the aircraft that were grounded in 2000 and the aircraft that began testing 17 months later (called "Block A" aircraft) are re-

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[13] "Navy Loses Osprey Authority," Washington Post, May 22, 2001 and Hunter Keeter, "Aldridge Maneuvers V-22 Acquisition Authority Away from Navy," *Defense Daily*, May 22, 2001 and Linda de France, "V-22 Osprey Production Authority Transferred from Navy to DoD," *Aerospace* Daily, May 22, 2001.

[14] Christopher Castelli, " NASA Review Panel Endorses Resumption of V-22 Flight Tests," InsideDefense.com,. Nov. 14, 2001.

[15] "Text: Aldridge Memo on V-22," *Inside the Navy*, Jan. 7, 2002.

[16] Tony Capaccio, "Textron-Boeing V-22 Needs Two years of Testing, Aldridge Says," *Bloomberg.com*, Oct. 16, 2001.

[17] Thomas Ricks, "V-22 Osprey to Face Make or Break Tests," *Washington Post*, Dec. 25, 2002, p.14.

routed hydraulic lines, and an improved caution and warning system.[18] Technical glitches were experienced during tests. Hydraulic failures, for example, continued during the reinstated flight test program, once on August 4, 2003, (due to a mis-installed clamp) and again on September 5, 2003. In June 2004 a V-22 was forced twice to make an emergency landing. During one landing, the aircraft suffered a "Class B" mishap (one causing between $200,000 and $1 million in damage).[19] An investigation revealed that the V-22 suffered from widespread problems with an engine component that required replacement every 100 flight hours.[20]

In conjunction with resuming flight testing, the Navy Department modified certain V-22 requirements. For instance, the V-22 is no longer required to land in helicopter mode without power (also known as "autorotation"), protection from nuclear, chemical and biological weapons has been eliminated. The V-22 is no longer required to have an "air combat maneuvering" capability; instead it must demonstrate "defensive maneuvering." Also, the requirement that troops be able to use a rope or rope ladder to exit the cabin at low altitudes has been eliminated.[21] Also concurrent with the resumption of V-22 flight testing, DOD began an in-depth study of alternatives to pursue in case the aircraft does not pass muster. Options reportedly include purchasing the S-92, or upgrading CH-53, or EH101 helicopters.[22]

After one calendar year and 466 hours of flight testing, DOD reviewed the Osprey's progress. On May 15, 2003, Thomas Christie, DOD's Director of Operational Test and Evaluation (DOT&E) graded Bell-Boeing's improvements to the Osprey's hydraulics as "reasonable and appropriate" and "effective."[23] Christie also at that time approved of the testing that had been completed and was satisfied with what had been learned about the V-22's susceptibility to Vortex Ring State. On May 20, 2003, the Defense Acquisition Board also reviewed the program and approved of the flight test program's progress.

Marine Corps officials recommended increasing the production rate in FY2006 from the minimum sustainable rate of 11 to 20 aircraft. However, in a August 8, 2003, memorandum, Undersecretary of Defense for Acquisition Michael Wynne announced that this acceleration "presents more risk than I am willing to accept." Instead, Wynne restructured the planned procurement, reducing the FY2006 purchase to 11 aircraft. "For subsequent years' procurement planning, production rates should

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[18] Jefferson Morris, "Pilot: Resumption of V-22 Testing To Be Treated Like First Flight," *Aerospace Daily*, Apr. 29, 2002.

[19] Christopher Castelli. "Navy Convenes Mishap Board to Investigate Latest V-22 Incident." *Inside the Navy.* July 5, 2004.

[20] Christian Lowe. "V-22 Ospreys Require New Engine Component Every 100 Hours." *Navy Times.* July 16, 2004.

[21] Joseph Neff, "Eased Standards 'Fix' Osprey," *Raleigh News & Observer*, May 19, 2002, p.1.

[22] "Aldridge Makes Progress Check on MV-22 at NAS Patuxent River," *Defense Daily*, Feb. 11, 2003.

[23] Tony Capaccio, "Boeing-Textron B-22 Gets Favorable Review From Pentagon Tester," *Bloomberg.com*, May 19, 2003.

increase by about 50% per year for a total of 152 aircraft through FY09," according to the August 8th memo. Wynne directed that the savings resulting from the reduced procurement (estimated at $231 million) be invested in improving the V-22's interoperability, by funding the Joint Tactical Radio System, Link 16 and Variable Message Format communication. Wynne also directed that a multi-year procurement (MYP) of the V-22 be accelerated. While some suggest that this restructuring will more quickly deliver high-quality aircraft to the Marines and Special Operations Forces, others fear that slowing procurement will inevitably raise the platform's cost.

In December 2004 the V-22 budget and schedule were restructured again. Program Budget Decision 753 (PBD-753) cut 22 aircraft from the V-22's production schedule and $1.3 billion from the budget between FY2006 and FY2009

Current Status

On June 18, 2005, the MV-22 program completed its second round of operational evaluation (OPEVAL) flight. The test program was marked by two emergency landings, a Class B mishap, a small fire in an engine compartment, and problems with the prop-rotor gear box. However, Navy testers recommended that DOD declare the V-22 operationally suitable, and effective for military use. This recommendation was based, in part, on observations that the MV-22 had complied with the objectives of P.L.107-107 Sec.123: hydraulic components and flight control software performed satisfactorily, the aircraft was reliable and maintainable, the MV-22 operated effectively when employed with other aircraft, and the aircraft's downwash did not inhibit ground operations.[24]

On September 28, 2005 the V-22 program passed a major milestone when the Defense Acquisition Board approved it for military use and full rate production.[25] The MV-22 continues testing to assess survivability and to develop tactics. The CV-22 is in developmental test and evaluation. The program continues to experience technical and operational challenges, and mishaps. For example, an inadvertent takeoff in March 2006 caused wing and engine damage in excess of $1 million. An engine component has been replaced because its failure in flight has caused seven unexpected flight terminations. In October 2005 a V-22 experienced engine damage during flight due to icing. An engine compressor failure during the V-22's first overseas deployment (July 2006) forced the aircraft to make a precautionary landing before reaching its destination. An engine fire on December 7, 2006, caused more than $1 million to repair, and the Marine Corps grounded all of its V-22s in February 2007 after it was found that a faulty computer chip could cause the aircraft to lose control during flight.

MV-22 Initial Operational Capability (IOC) is anticipated for May 2007. The May 2005 flight test schedule for CV-22 was extended by more than a year.

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[24] "Letter of Observation in Support of MV-22 Program Compliance with Section 123 of the National Defense Authorization Act for Fiscal Year 2002." Commander, Operational Test and Evaluation Force. Department of the Navy. February 18, 2005.

[25] Andy Pasztor. "Pentagon Clears Full Production for Osprey Aircraft." *Wall Street Journal*. September 29, 2005.

Developmental testing is scheduled to be completed in September 2007 and OPEVAL in November 2007. IOC is anticipated in February 2009. DOD anticipates the following procurement V-22 procurement schedule:

	FY08	FY09	FY10	FY11	FY12	FY13	Complete	Total
MV-22	21	30	30	30	30	30	135	408
CV-22	5	6	5	5	5	5	8	48
Total	26	36	35	35	35	35	143	456

Key Issues

Should the Defense Department Procure the V-22 Aircraft?

Main Arguments of Those Who Say "Yes". The Defense Department should accelerate procurement of the V-22, which the Marine Corps considers its most important aviation program, in order to obtain these aircraft sooner and at more economical production rates. The V-22 is needed to replace aging military helicopters in all the services, which are costly to maintain and operate safely and effectively. The Army should reconsider its decision not to buy the V-22, which the Air Force wants to procure for its Special Operations missions and combat search and rescue. The Osprey represents a truly joint capability, as evidenced by the Navy's desire to purchase MV-22s for search and rescue, and other missions.

This tilt-rotor aircraft will provide the operational flexibility of a helicopter without the helicopter's inherent limitations of speed, range, and altitude. While there may be new helicopters that could replace and improve on today's military helicopters, V-22 proponents say that none of them would match the Osprey's capabilities. When landing on hostile shores in a third-world conflict (typically lacking important infrastructure such as airfields and roads), the V-22 would be critical for the transport of Marines from ship to shore. Senior DOD officials have testified that the V-22 would have, for example, made a significant contribution the to war on terrorism in Afghanistan.

The Osprey has been rigorously tested and its accident rate is consistent with other aircraft development programs, supporters say. While some technical problems have been encountered, leading experts have testified that there are no technological barriers to the employment of tilt-rotor technology. Engineering-level modifications have, put the Osprey program back on track. The recently complete OPEVAL demonstrates that the V-22 program has resolved all of the concerns expressed by the Blue Ribbon Panel and by Congress.

Supporters of the V-22 also cite the tilt-rotor's potential value for civil aviation, law enforcement, and foreign sales by the U.S. aerospace industry.[26] The

[26] Sen. Ted Stevens et al., "Continuation of the V-22 Aircraft Program," remarks in the (continued...)

development of tilt-rotor aircraft for the armed services could have significant spin-off effects for civil aviation and U.S. technology, giving the U.S. aerospace industry a major competitive advantage in the international market.[27]

Main Arguments of Those Who Say "No". The V-22 is unaffordable in the present budgetary environment, when the cost of buying large numbers of these transport/cargo aircraft would most likely be at the expense of more critical defense needs. Ship-to-shore logistical operations can be performed by less expensive helicopters for the kinds of landing operations in which the Marines are likely to be involved, where the V-22's greater speed and range would not be needed. Moreover, Marine assault missions in an opposed landing would involve ship-to-shore movement of troops and equipment, which would require coordination with aircraft having less speed and range than the V-22. Others have argued that the Osprey's hypothetical contribution to the war in Afghanistan is questionable due to the high altitude of that country, and the Osprey's inability to improve greatly over helicopter performance in this area.

Opponents cast doubt on the Osprey's operational capabilities and operational concepts. A January 12, 2001 presentation by the GAO to the V-22 Blue Ribbon Panel for instance said that the V-22's cabin may not be large enough to carry 24 combat-equipped Marines, and that the severe rotor down wash might impede the ability of troops to exit the aircraft and move into combat positions. Also, to avoid entering Vortex Ring State, Osprey's will have to descend slowly, which will make them vulnerable to ground fire in combat situations. Critics also challenge comparison's that are made between the Osprey and conventional helicopters. The Osprey can, they concede, lift three times more dead weight than can the CH-46. But the Osprey is also three times heavier and five times more expensive than the Sea Knight. Also, the CH-46 is a 1970s-era helicopter. Critics argue that the V-22's performance should be compared to contemporary aircraft (such as the EH-101), not one that is 30 year's old. When compared to contemporary helicopters, critics argue, the V-22's capabilities don't appear nearly as impressive.[28]

In light of several V-22 crashes, three involving fatalities, many argue that the tilt-rotor technology is not sufficiently mature to merit the Osprey's production and fielding. Studies suggest that tilt-rotor aircraft are more susceptible to airflow

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[26] (...continued)
Senate, *Congressional Record*, daily edition, Apr. 19, 1989, pp. S4507-S4509.

[27] The potential civil application of tilt-rotor technology is also considered by some a good reason to pursue the V-22 program. A February 1988 study by the FAA and NASA concluded that tilt-rotors could help relieve airport congestion by diverting commuters and short-distance passengers to vertiports in urban centers. The importance of U.S. production of a tilt-rotor aircraft for civilian purposes was the subject of a hearing on July 17, 1990, by the House Committee on Science, Space, and Technology's Subcommittee on Transportation, Aviation, and Materials. In 1992, Congress enacted legislation (H.R. 6168) directing the Secretary of Transportation to establish a "civil tilt-rotor development advisory committee" to evaluate the feasibility and viability of developing civil tilt-rotor aircraft and infrastructure necessary to incorporate tilt-rotor aircraft into the national transportation system.

[28] See, for example, Everest Riccioni, "Osprey or Albatross?," Defense News, Jan. 27, 2004.

instabilities that can cause Vortex Ring State than are traditional helicopters.[29] And our understanding of the kinds of airflow anomalies that have caused numerous deaths in V-22 flight testing are still very immature. Whatever commercial value a tilt-rotor aircraft might some day have for civil aviation, the V-22's value as a military system is insufficient to justify its high cost ($110 million per aircraft) in these times of budgetary constraints and higher priority defense needs. Finally, critics also argue that the Navy is "dumbing down" the V-22's requirements and making it a less effective aircraft.

Congressional Action

Throughout the program, supporters have called for accelerating procurement beyond the levels projected in the Administration's plan, arguing that this would reduce program costs over the long term and would get more aircraft in service sooner. The administration's FY2008 request included $2.4 billion in procurement and RDT&E funding for the V-22. The request is summarized in **Table 1**, below. DOD also requested five CV-22s and two MV-22s in its FY2008 emergency supplemental.

Table 1. Summary of V-22 FY2008 Congressional Action
(millions of dollars)

	USN	USAF	SOCOM
Budget Request			
Procurement	(21 aircraft)	(5 aircraft)	(5 USAF aircraft)
• FY2008	1,758.7	453.7	0
• Advance Procurement	200.7	41.2	0
• Mods	68.4	16.5	238.6
RDT&E	117.9	16.6	23.4
Authorization, House			
Authorization, Senate			
Appropriations, House			
Appropriations, Senate			

The administration's FY2007 request included $2.2 billion in procurement and RDT&E funding for the V-22. The request, as well as congressional action, is summarized in **Table 2**, below.

[29] Michael Dornheim, "Tiltrotor Wake 'More Complex' Than Classic Vortex Ring State," *Aviation Week & Space Technology*, July 15, 2002.

Table 2. Summary of V-22 FY2007 Congressional Action

(millions of dollars)

	USN	USAF	SOCOM
Budget Request Procurement • FY2007 • Advance Procurement • Mods RDT&E	 (14 aircraft) 1,304 194.1 85.8 268.4	 (2 aircraft) 208.6 34.4 .5 26.6	 0 0 168.8 0
Authorization, Conference H.R. 5122 (109-702)	Matched requests		
Appropriations, Conference H.R. 5631 (109-676) Procurement • FY2007 • Advance Procurement • Mods RDT&E	 -10	Matched requests	Matched requests

The administration's FY2006 request included $1.8 billion in procurement and RDT&E funding for the V-22. The request, as well as congressional action, is summarized in **Table 3**, below.

Table 3. Summary of V-22 FY2006 Congressional Action

(millions of dollars)

	USN	USAF	SOCOM
Budget Request Procurement • FY2006 • Advance Procurement • Mods RDT&E	(9 Aircraft) 993.3 67.3 81.0 206.3	(2 Aircraft) 233.8 10.5 .1 39.5	0 0 117.9 29.9
Authorization Conference H.R. 1815 (109-360)	Matched request	+ 2 RDT&E	Matched request
Appropriations, Conference H.R. 2863 (109-359)	Matched request	-11.5 FY06 proc. +3.5 mods +1 RDT&E	Matched request

Appendix. V-22 Block Configurations

MV-22 Block A (OPEVAL and Training configuration)

- Improvements to hydraulic line clearances
- Flight Control software improvements

MV-22 Block B

- Improved Nacelle maintenance
- Retractable fuel probe
- Avionics, communications, navigation upgrades
- Production icing system
- Ramp gun
- Hoist
- Improved fastrope location

MV-22 Block C

- Flight incident recorder
- Radar altimeter sling load modification
- Fuel dump modification
- Weather radar
- Wheel well fire suppression
- Oil cooler inlet screen
- Main Landing Gear brake redesign
- Mid wing gear box indicator
- Slip ring
- Cargo hook door upgrade

CV-22 Block 10

- SIRFC
- DIRCM
- Multi mode radar
- "Silent Shield"
- Flight engineer's data display
- Flight engineer's seat
- Low probability of intercept/detection radar altimeter
- TCAS (terrain collision avoidance system)
- Troop commander's situational awareness
- ALE-47 decoy
- Navigation improvements
- Lower antenna
- Dual digital map
- GATM (global air traffic management)

CV-22 Block 20

- Geo-reference coupled approach to hover
- Terrain Following below 50 kts corrections
- CV-22 Heads up Display (HUD)
- Digital Map System upgrades
- Great Circle Navigation corrections
- Performance calculator
- Passenger Oxygen
- JTRS cluster 1 with Link 16
- Emergency power
- Fuel dump corrections