V-22 Osprey

The V-22 Osprey is a tilt-rotor vertical/short takeoff and landing multi-mission aircraft developed to fill multi-Service combat operational requirements. The MV-22 is intended to replace the current Marine Corps medium-lift assault helicopters (CH-46E and CH-53D). The Air Force requires the CV-22 to provide a long-range vertical takeoff and landing insertion and extraction capability and to supplement Special Operations Forces MC-130 aircraft. The tilt-rotor design combines the vertical flight capabilities of a helicopter with the speed and range of a turboprop aircraft, permits aerial refueling, and allows for worldwide self-deployment. The current design also affords a greater degree of survivability than existing medium-lift helicopters.

DOT&E completed an independent evaluation of test adequacy, operational effectiveness, suitability, and survivability and submitted the required OT&E and LFT&E reports to the Secretary of Defense and congressional defense committees in time to support the Milestone III decision review in November 2000. Based on the findings in these reports, the Navy delayed the Milestone III decision. The Milestone III decision was delayed again following a V-22 mishap in December 2000. All V-22 flying was halted following the December 2000 mishap.

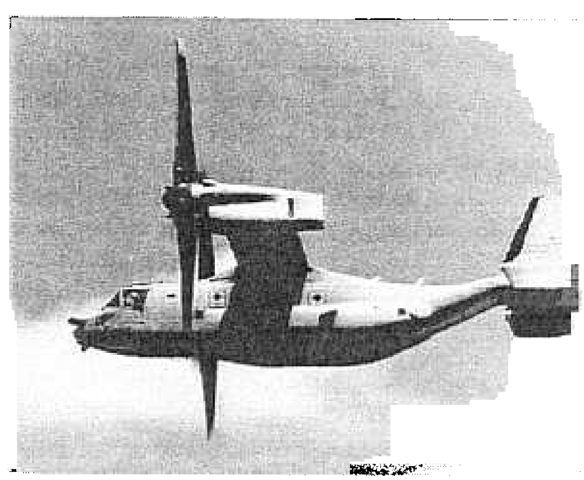
During the non-flying period, the program conducted complete design reviews of all critical V-22 systems and designed an extensive developmental and operational test program to address concerns raised by several high-level independent review panels and to lead to the fleet's return to flight. DOT&E participated in these reviews and approved a revised Test and Evaluation Master Plan. As soon as the first aircraft was modified with system safety changes, developmental flight testing resumed.

TEST & EVALUATION ACTIVITY

The first MV-22 returned to flight on May 18, 2002. Flight testing was deliberate and methodical, with flights interspersed with a rigorous schedule of inspections for mechanical defects. In August 2002, the CV-22 returned to flight at Edwards Air Force Base, California, following a similar pattern of flights and inspections. As of November 1, 2003, nine V-22 aircraft are in service, amassing a total of more than 930 developmental flight-test hours at three locations.

The approach to return the V-22 to operational flight was, and continues to be, event-based; each block of testing begins only upon completion of the necessary preceding test events. After a thorough ground-test of the flight control software in laboratories and simulators and flight validation, the first priority was high-rate of descent (HROD) flight-testing to investigate vortex ring state (VRS). In addition, testing of low-speed maneuvering flight and all engine-off characteristics were conducted, as well as continued developmental testing of communication and navigation systems, tactical sensors, antenna patterns, climb performance, handling qualities, aerial delivery of passengers and cargo, aircraft infra-red signature, a new anti-vibration suppression system, and the CV-22 multi-mode radar and electronic warfare systems. One aircraft has been fitted with a complete anti-ice/de-ice system and is deployed to Nova Scotia for icing trials.

All aircraft have been involved in a series of line clearance inspections to verify that the new line clearance requirements have solved aircraft reliability problems with hydraulic lines. The line clearance inspections performed by the Integrated Test Team since returning to flight confirmed that the solutions to the V-22 hydraulic system reliability problems are effective. In more than 930 flight hours, there has been no evidence of hydraulic line chafing on any of the flight-test aircraft, and inspection intervals have increased as planned on all aircraft. The Block A configuration further improves the design of electrical and hydraulic lines, with the goal of no line clearance inspections on fleet aircraft.



The V-22 offers significant maneuverability and handling advantages compared to conventional helicopters.

On August 28, 2003, the Marine Corps activated a new tilt-rotor test squadron, VMX-22. The squadron, which will report to the Navy's Commander, Operational Test and Evaluation Force, will plan and conduct OT&E and develop tactics, techniques, and procedures for the operational employment of the V-22. An operational assessment (OT-IIF) will be done in conjunction with developmental test and evaluation beginning in mid-2004. After confirmation of the safe flight envelope in the HROD tests, the Navy plans to issue a limited flight clearance to operational V-22 units which will allow training flights to prepare for a second phase of operational evaluation (OPEVAL II or OT-IIG) to address the issues raised in the November 2000 OT&E report (testing not conducted, waived items, and correction of deficiencies). Overall degree of mission accomplishment by a sea-based Marine Expeditionary Unit equipped with MV-22 aircraft will be evaluated in OPEVAL Phase Two, scheduled to begin in late 2004. Following that, DOT&E will submit a second OT&E report containing an assessment of test results and the design changes.

The first full-up Block A aircraft was delivered to Naval Air Station Patuxent River in August. This configuration forms the basis of all fleet aircraft and includes completely redesigned engine nacelle areas, reliability improvements, and several system upgrades. The Block A configuration will be tested in both OT-IIF and OT-IIG.

TEST & EVALUATION ASSESSMENT

In the November 2000 OT&E report, DOT&E concluded testing had been adequate to determine the MV-22's operational effectiveness, operational suitability, and survivability. However, additional testing was needed to verify correction of deficiencies, the effectiveness and suitability of waived items, and to investigate the phenomenon of VRS. The MV-22 was assessed by DOT&E as operationally effective, but not operationally suitable. Results from OT-IIE (OPEVAL Phase I) indicated that the V-22 would provide major range, speed, and payload improvements to meet Marine Corps and Special Operations Forces requirements. The V-22 offers significant maneuverability and handling advantages compared to conventional helicopters (e.g., rapid deceleration upon arrival at a landing zone and rapid acceleration during departure). When tactics are fully developed, these capabilities should provide substantive advantages in mission accomplishment and survivability.

Based on developmental tests since returning to flight, DOT&E has increased confidence that the V-22 characteristics involving VRS are well understood and knowledge of VRS consequences is widespread in the V-22 community. Several factors contribute to this confidence:

Extensive HROD testing confirmed the V-22 VRS envelope; the flight conditions necessary to enter VRS were verified and closely matched predictions by aerodynamic modeling and simulations.
Published operating limitations appear adequate for normal conditions. DOT&E and the program will investigate the question of whether that margin may be reduced under unusual wind or maneuvering conditions.
Published operating limitations are equivalent to all other rotorcraft and testing has proven that V-22 has more margin between the limitation and the VRS boundary.
In maneuvering testing inside the VRS region, pilot control inputs delayed VRS onset and did not precipitate it.
The flight simulators and flight syllabus emphasize avoiding the phenomenon.
Flight manual cautions, warnings, and advisories were amended.
An HROD warning system is present for both pilots and appears functional.
Readability of the pilots' vertical speed indicator has improved.
Nacelle tilt is a powerful VRS recovery tool, demonstrated and understood.

These items tend to reduce the likelihood of another mishap caused by VRS.

For any rotorcraft, including the V-22 tiltrotor, the ability to save the aircraft– or at least ensure the survival of its occupants– in the event of a single or dual engine failure must be determined. In either the airplane or helicopter mode, the recommended procedure in the event of an engine failure is to convert to airplane mode, proceed immediately to a suitable landing spot, convert back to helicopter mode and land as soon as possible. The ability of the V-22 to perform single-engine landings is better than the helicopters it replaces. In the event of either sudden dual-engine failures, or a single failure of one engine coupled with a failure of the interconnecting drive train, while the aircraft is in either airplane or in the helicopter mode, the recommended method to recover is to tilt the nacelles down and attain the best glide speed available, then flare to a survivable landing. In 2003, the program demonstrated by flight-test the recommended speed and altitude approaches to the landing field that allow the pilot to perform a survivable landing if the second engine fails during approach. This testing validated the fidelity of the V-22 simulators. Although testing of this procedure all the way to landing is not practicable, limited testing has confirmed that, while the aircraft can perform an auto-rotative descent, it cannot consistently auto-rotate to a safe landing. The approach to safety adopted long ago by the program is to minimize the possibility of such disastrous occurrences through system design. DOT&E will pursue, in conjunction with the program office and VMX-22, possible means to minimize the Fleet Marine Force mishap rate.

The effectiveness of the V-22's vulnerability reduction features was demonstrated during LFT&E. A continuous process of design refinements has been an integral part of the overall system engineering effort since the start of live fire testing, and several design changes have been made based on the test results, such as revising the sponson fuel tank structure. This process continues with particular emphasis on addressing the concerns outlined in the November 2000 LFT&E report.

The following are survivability assessments of the design changes and efforts to address the results of the original LFT&E program:

- Fire protection can be effectively provided to the mid-wing nacelles, main landing gear dry bays, and underfloor areas.
- The design changes to the hydraulic system made since November 2000 have a negligible impact on the aircraft's vulnerability.
- The aircraft battle damage repair program continued to experience delays due to insufficient funding and is now nearing a contract award. It is programmed to be funded through FY06.
- The impact of adding internal mission auxiliary fuel tanks, countermeasure dispensers, and improvements to the engine nacelles require further study.