

V-22 Osprey Program Executive Summary

This is the second DOT&E combined operational and live fire test and evaluation report on the V-22 Osprey. Following two crashes in 2000, the Navy restructured the V-22 program. New, improved aircraft capabilities were to incorporate changes in block upgrades. The Block A aircraft is intended for use in a training unit; this configuration incorporates modifications to address recommendations from the two mishap investigations and DOT&E's earlier report. Some capabilities were re-designated as threshold requirements for future MV-22 Block B aircraft. MV-22 Block B will be the first configuration procured for deployment and will undergo additional testing.

Similar aircraft performance is expected of the MV-22 Block B and CV-22 airframe. The CV-22 will have additional equipment for special operations missions and will be evaluated in future CV-22 operational testing scheduled for 2006 and 2008.

Test Adequacy

Operational testing was adequate to determine the effectiveness, suitability, survivability, and safety of the V-22. Previous live fire test and evaluation adequately addressed vulnerabilities to ballistic threats; no additional live fire testing was conducted in this test phase. Operational testing occurred in multiple locations using MV-22 Block A production aircraft. Commander, Operational Test and Evaluation Force, using a dedicated tiltrotor operational test squadron, conducted the V-22 OPEVAL Phase II called OT-IIG. VMX-22, the Marine Corps' V-22 test squadron, accomplished the operational testing with an eight-aircraft detachment with representative military and contractor manning equivalent to two thirds of a typical flight squadron. VMX-22 conducted the operational test in accordance with the DOT&E-approved V-22 Test and Evaluation Master Plan and the OT-IIG Test Plan.

Operational Effectiveness

OT-IIG demonstrated that the MV-22 Block A is operationally effective in low and medium threat environments.¹ The MV-22 Block A aircraft satisfied all key performance parameters as VMX-22 flew scenarios for the following mission areas:

- Ship-to-objective maneuver.
- Sustained operations ashore.
- Tactical recovery of aircraft and personnel.
- Self-deployment.
- Amphibious evacuation.

Performance of the Block A aircraft will be the baseline for future effectiveness evaluations of follow-on V-22 variants.

Enhancing Features. During operational testing, the V-22 system demonstrated significant mission advantages when compared to the medium-lift helicopters that it will replace. The V-22 advantages include:

- Extended range with high speeds and larger payloads for greater operational reach and reduced response times.
- Self-deployment capability for reduced strategic lift requirements.
- Advanced mission management systems and situational awareness equipment for precision navigation, increased battlefield situational awareness, and reduced aircrew workload providing greater tactical flexibility for commanders.

Follow-On Test Requirements. Some system performance shortfalls remain. Follow-on system upgrades and testing should include:

- Personnel hoist.
- Defensive weapons system.
- Weather radar.

Resolved Areas of Concern from Previous Operational Testing. The program resolved four areas of concern that DOT&E reported from the first operational test phase, including the safety problems associated with the two crashes in 2000:

1. Vortex Ring State. The Vortex Ring State (VRS) envelope for the V-22 is now well defined and avoidable. During OT-IIG, VMX-22 aircrews accomplished all operational missions while remaining outside the VRS-susceptible envelope and pilots are trained regarding its dangers.
2. Flight Control Software Reliability. Comprehensive evaluation in simulation laboratories verified the integrity of the flight control hardware and software prior to the MV-22 returning to flight in May 2002.

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3. Hydraulic Line Routing. The V-22 program conducted a thorough review, redesign, and re-routing of hydraulic lines. Over 5,000 flight hours with the new design provide confidence that the current hydraulic system is safe to operate.
4. Impact of Downwash on Operations. Flight and ground operations demonstrated that revised tactics, techniques, and procedures allow safe operations in downwash. VMX-22 routinely operated in remote terrain and unprepared areas. There was limited testing at night in severe brownout conditions. Air and ground crews demonstrated satisfactory external load hookup and transporting operations.

Operational Suitability

OT-IIG demonstrated that the MV-22 Block A is operationally suitable. The aircraft demonstrated improvement in the suitability metrics and satisfied thresholds for:

- Mean flight hours between aborts (25 hrs. vs. >17 hrs. required).
- Mean flight hours between failures (1.4 hrs. vs. >0.9 hrs. required).
- Maintenance man-hours per flight hour (7.2 hrs. vs. <20 hrs. required).
- Mission capable rate (78-88 percent vs. 82 percent required at 60,000 hrs. total fleet time).

The MV-22 did not meet the threshold for mean repair time for aborts, but this deficiency did not impact the overall operational suitability of the aircraft, as abort-causing failures accounted for only 5 percent of the overall maintenance workload.

Shipboard testing on USS Bataan (LHD 5) verified improvements in the aircraft's operating envelope and the blade-fold wing-stow system. The MV-22 is compatible with flight and hangar deck operations. Deck heating and shipboard power compatibility deficiencies were discovered during operational testing.

The MV-22 satisfied its top-level information exchange requirements. During mission-representative flights, VMX-22 pilots were able to plan and re-create missions before and after flight, maintain in-flight situational awareness and communications with other service platforms and data links, and use navigation aids and required Identification, Friend-or-Foe transponder modes. Planned corrections to the avionics system for the Single Channel Ground and Airborne Radio System (SINCGARS) will be evaluated in follow-on testing.

The following human factors and safety items remain:

- The congested cabin and cumbersome seat belts may increase the debarkation time for the 24 combat-loaded Marines, and pose a safety risk during combat or emergency evacuations. The Navy plans to install and test new seats and restraints as part of the Block B upgrade.
- The restricted field of view to the left from the cabin limits the ability of the crew chief to keep a safe lookout.
- The environmental control system does not cool the cabin adequately in hot weather.
- Emergency landing after the sudden failure of both engines in the Conversion/Vertical Take-Off and Landing modes below 1,600 feet altitude are not likely to be survivable. The likelihood of sudden, dual-engine failure is remote, but possible. The V-22 cannot autorotate to a safe landing.

Survivability

Live fire test and evaluation results, and Phase I and II operational testing indicate that the MV-22 Block A is a survivable aircraft in low and medium threat environments. The basic design and speed, range, and altitude performance of the V-22 reduce its overall susceptibility as compared to legacy transport helicopters. Ballistic vulnerability testing demonstrated that the V-22 is capable of withstanding impacts by expected threat projectiles. Live fire test results led directly to several vulnerability reduction improvements.

The integrated defensive electronic countermeasures system provides an adequate capability for detecting radio frequency and laser energy directed at the aircraft. There are major deficiencies in spatial coverage and threat displays that should be addressed. The quantity and placement of the countermeasure expendables are not sufficient for multiple threat encounters on long missions.

The MV-22 Block A aircraft does not have a defensive weapon. This is a Block B requirement.

During the susceptibility testing versus ground threats, pilots noted that the current flight restrictions on aircraft maneuvering in airplane mode (roll and pitch attitude) restricted the aircraft's ability while performing defensive maneuvers. While developing tactics, current bank angle and pitch attitude limitations may prove insufficient to counter threat systems. The maneuvering envelope of the aircraft should be expanded as necessary through follow-on developmental testing.

Analysis of the aircraft design and infrared emission sources indicates that the V-22 exhibits a decreased susceptibility to man portable air defense systems compared to legacy transport conventional helicopters. This decrease in susceptibility comes

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from the design feature that places most of the infrared emission at the end of the nacelles, which are displaced from both the engines and fuselage.

Recommendations

Operational Effectiveness

- Assess V-22 survivability in realistic tactical approaches to landing zones in high-threat areas during follow-on testing and tactics development.
- Training, which is critical for this hybrid aircraft, should emphasize:
 - Aerial refueling at night and in turbulence.
 - Landing techniques in severe brownout conditions.
 - High-tempo operations, particularly aboard ship.
- Resolve remaining deficiencies in Joint Mission Planning System (JMPS) version 5.2.
- Pursue a radar altimeter that allows the V-22 to carry dual-hook external loads at night.
- Pursue flight testing to define V-22 performance in extreme environmental conditions.
- Install and test an effective personnel hoist.
- Consider installing a weather radar in the MV-22.

Operational Suitability

- Implement planned upgrades to seats and harnesses.
- Implement logistics support plans to support deploying MV-22 squadrons.

Survivability

- Develop appropriate tactics for coordination with helicopter and fixed-wing fire support aircraft.
- Equip the flare and chaff dispensing system with sufficient capacity for multiple threat encounters on long missions.
- Install and test a defensive weapon (planned for Block B aircraft).
- Correct the deficiencies in the defensive electronics countermeasures system.
- Consider adding active fire suppression systems to the wheel well and under floor dry bays.
- Determine the effectiveness of the engine bay fire extinguishing system against actual threat-induced fires.
- Devise/improve cabin wall battle damage repair methods and procedures. Damage to this wall can make the aircraft unavailable for an extensive period.

¹ Low threat includes sporadic small arms fire from random locations (maximum caliber 7.62 mm/.30 cal), and automatic weapons (assault rifles). Medium threat includes those threats, plus larger caliber weapons (.50 cal/12.5 mm and 23 mm, but not AAA) adapted for anti-aircraft fire, more sophisticated aiming devices, and legacy MANPADS (SA-7 and variants).

