V-22 OSPREY

**Navy ACAT IC Program:**
- Total Number of Systems: 458
- Total Program Cost (TY$): $37,334M
- Average Unit Cost (TY$): $66M
- Full-rate production: 2QFY00

**Prime Contractor**
- Bell-Boeing Joint Venture
- **Service Certified Y2K Compliant**
- No

**SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2010**

The V-22 Osprey is a tilt-rotor vertical/short takeoff and landing (VSTOL), multi-mission aircraft developed to fill multi-Service combat ORs. The MV-22 will replace the current Marine Corps assault helicopters in the medium lift category (CH-46E and CH-53D), contributing to the dominant maneuver of the Marine landing force, as well as supporting focused logistics in the days following commencement of an amphibious operation. The Air Force requires the CV-22 to provide a long-range VTOL insertion and extraction capability and to supplement the Special Operations Forces (SOF) MC-130 aircraft in precision engagement. The tilt-rotor design combines the vertical flight capabilities of a helicopter with the speed and range of a turboprop airplane and permits aerial refueling and worldwide self-deployment.

Two 6150 shaft horsepower turboshaft engines each drive a 38-ft diameter, 3-bladed proprotor. The proprotors are connected to each other by interconnect shafting which maintains proprotor synchronization and provides single engine power to both proprotors in the event of engine failure. The engines and flight controls are controlled by a triply redundant digital fly-by-wire system.
The airframe is constructed primarily of graphite-reinforced epoxy composite material. The composite structure will provide improved strength to weight ratio, corrosion resistance, and damage tolerance compared to typical metal construction. Battle damage tolerance is built into the aircraft by means of composite construction and redundant/separated flight control, electric and hydraulic systems. An integrated electronic warfare defensive suite including a radar warning receiver, a missile warning set, and a countermeasures dispensing system, will be installed.

BACKGROUND INFORMATION

The V-22 is being developed to meet the provisions of the April 1995 Joint Multi-Mission Vertical Lift Aircraft (JMVX) Operational Requirements Document (ORD) for an advanced vertical lift aircraft. The JMVX ORD calls for an aircraft that will provide the Marine Corps and Air Force with the capability to conduct assault support and long-range, high-speed missions requiring vertical takeoff and landing capabilities.

Since entry into FSD in 1986, the V-22 T&E program has principally concentrated on engineering and integration testing performed by the contractors. Three periods of formal development testing by Naval Air Warfare Center-Aircraft Division (NAWCAD) Patuxent River, plus OTA participation in integrated test team (ITT) activities at Patuxent River, provided early insight into the development effort. After transition to EMD in 1992, an integrated contractor/government test team conducted all tests until OT-IIA in 1994. Starting with OT-IIA in 1994, a total of four periods of OT&E have been conducted.

The first operational test period (OT-IIA) was performed by COMOPTEVFOR, with assistance from AFOTEC, from May 16-July 8, 1994, and accomplished 15 hours of actual flight test operations, within an extremely restricted flight envelope. The Navy, with Air Force support, published a joint evaluation report that addressed most of the mission areas that the V-22 is to perform.

OT-IIB was conducted from September 9-October 18, 1995, and comprised ten flight hours in 18 OT&E flights plus ground evaluations. A joint Air Force/Navy OT-IIB report was published. Partly in response to DOT&E concern expressed over the severity of V-22 downwash in a hover observed during OT-IIA, the Navy conducted a limited downwash assessment concurrently with OT-IIB, from July-October 1995.

OT-IIC, conducted from October 1, 1996-May 30, 1997, consisted of six phases of ground tests and flight tests, including: (1) shipboard assessment; (2) maintenance demonstrations; (3) tactical aircraft employment via FSD aircraft and manned flight simulator; (4) operational training plans; (5) program documentation review; and (6) software analysis. While considerable insight was gained into the strengths and weaknesses of the EMD design, no COIs were resolved, and concerns about the effects of downwash remained.

An LFT&E waiver from full-up, system-level testing was approved on April 25, 1997. Consistent with LFT&E legislation, the program was permitted to execute an alternative plan for LFT&E. The alternative plan, approved by DOT&E prior to the waiver request, includes comprehensive ballistic testing of components and major assemblies.
TEST & EVALUATION ACTIVITY

OT-IID was conducted from September 1, 1998-October 31, 1998. OT-IID is the first operational test period to use V-22 aircraft developed under the EMD program as opposed to prototype aircraft from the earlier FSD activity. OT-IID was conducted using EMD aircraft numbers 9 and 10, the final two aircraft delivered under the EMD program. OT-IID consisted of 142.6 flight hours conducting operationally realistic missions in four locations: NAS Patuxent River, MD; New River MCAS, NC; Camp Dawson AAF, WV; and Eglin AFB, FL. Aircraft operations included confined area operations; mountainous area landings; formation flight; use of night vision devices; low altitude terrain tactics; and alternate insertion/extraction procedures, performed with marines and SOCOM personnel. Due to the developmental status of the test aircraft, some flight maneuver restrictions and other mission limitations were required, but these limitations did not prevent assessment of the potential operational effectiveness and suitability of the V-22. Of particular note for this stage of OT, Marine Corps and USAF personnel performed all operational-level maintenance on aircraft number 10 throughout OT-IID, providing valuable insights into the operational suitability of the V-22. In addition, the MOTT broke new ground via their use of a computer-generated warfare environment coupled with manned V-22 cockpit simulators and actual V-22 installed-hardware systems at the Navy’s Air Combat Environment Test and Evaluation Facility (ACETEF). Using ACETEF, several flight crews conducted realistic Search and Rescue missions in the face of threat defenses, allowing meaningful assessment of the situation awareness and task loading of V-22 crews in combat conditions.

In conjunction with developmental test sea trials in January 1999, COMOPTEVFOR will gain early insight into the compatibility of the MV-22 with aviation-capable amphibious ships of the US Navy.

OT-IIE, OPEVAL of the MV-22, is planned to begin in the 1st quarter of FY 2000 for a period of approximately seven months. OPEVAL will be conducted with four V-22 aircraft, aircraft number 10 from the EMD along with aircraft numbers 11, 12 and 13 from the first LRIP lot. Approximately 700 flight hours of these V-22 are planned.

Under the LFT&E alternative plan, the following components have been subjected to ballistic testing: conversion spindle/pylon support; fuel feed tank; wing torque box; engine; proprotor gearbox; proprotor controls; and, wing dry bays.

TEST & EVALUATION ASSESSMENT

Emerging results from OT-IID indicate that the V-22 will provide the required range and payload capabilities needed to meet Marine Corps and SOF requirements. The V-22 offers significant maneuverability and handling advantages as compared to rotary wing aircraft, e.g., rapid deceleration upon arrival at a landing zone and rapid acceleration during departure. With fully developed tactics, these capabilities should provide substantive maneuver and survivability advantages. In addition, OT-IID demonstrated that with modified procedures, some required functions could be performed despite the downwash experienced in the rotary mode, which had been an issue of concern in previous OT&E. Most downwash issues, with the exception of shipboard ones, have been answered favorably in OT-IID. For example, operational pilots demonstrated the ability to conduct mountainous area landings at unprepared sites, as well as being able to deploy a rubber boat and SOF team despite the sea spray generated by V-22 operations only a few feet above the water. Further testing of downwash effects is required, and will be accomplished in OT-IIE.
While the demonstrated capabilities and potential for operational effectiveness are impressive, several areas of concern remain to be resolved:

- Some operations in downwash, such as shipboard operations, rescue from the sea, and special insertion/extraction tasks, remain to be demonstrated.

- While the V-22 offers superior maneuverability and handling advantages in the hands of an experienced pilot, the level of training and experience needed to safely and effectively employ these capabilities, may require experienced pilots or extensive training for conversion to the V-22.

- Although the OT-IID data has not yet been fully analyzed, it appears that some areas affecting operational suitability require improvement; e.g., Mean Time Between Failure, false alarms and spurious caution and warning indications. Notwithstanding these problems, the MOTT achieved an average of over 47 flight hours per aircraft per month in OT-IID.

Although the MOTT has not yet completed the report from OT-IID, DOT&E’s initial assessment is that the V-22 is potentially operationally effective and potentially operationally suitable.

During ballistic LFT&E, the vulnerability of the sponson fuel tanks was shown to be greater than expected. Risk reduction ballistic tests on the sponson and related refueling and fuel transfer lines are being conducted to examine remedial design concepts. Other tests this year include: wing auxiliary tanks; fuel cell hydraulic ram (CV-22); pylon-mounted interconnect drive shaft; wing-mounted interconnect drive shaft; proprotor gearbox follow-on tests; and, pylon converter actuator. Realistic retest of the sponson to verify the chosen remedial design concepts is planned. Future tests include the tilt-axis gearbox, and extensive testing of the EMD Static Test Article.

The automatic fire suppression system, installed in the wing for safety and combat survivability, is credited with extinguishing a fire caused by a mechanical failure in one of the flight test aircraft, thus saving the aircraft from a catastrophic loss.

**LESSONS LEARNED**

Close cooperation between those responsible for system acquisition, operational test and the oversight thereof facilitates an understanding of system capabilities and problematic areas, and in focusing the efforts to specific problems. In this regard, via the opportunity afforded DOT&E representatives to witness OT-IID operations, some of our previously expressed concerns regarding downwash have been ameliorated, while others are now more precisely focused.

The use of ACETEF as part of the assessment of V-22 survivability indicated that the combination of man-in-the-loop, hardware-in-the-loop, and computer-generated combat environments has the potential to substantively complement operational field tests. While this initial effort was not without shortcomings, it is worthy of further development for use in OPEVAL not only for further assessment of survivability, but perhaps, also as a tool to assess V-22 operational capability as a function of pilot experience.