MEMORANDUM FOR UNDER SECRETARY OF DEFENSE (ACQUISITION, TECHNOLOGY AND LOGISTICS)

SUBJECT: V-22 Assessment Report

As you know, the apparent inefficiency of the current “minimum sustaining production rate” of 11 aircraft per year is an issue for consideration during the review of the V-22 by the DAB on May 20, 2003. I am not opposed to increasing the “minimum sustaining” rate for efficiency.

I am concerned, however, that the current content of OT-IIF in May 2004 is not adequate to form the basis of a certification by the Secretary that the V-22 “will be operationally effective,” as required by Section 123 of the Fiscal Year 2002 National Defense Authorization Act. The findings from the OT-IIF operational assessment (OA) will permit an evaluation of the V-22’s progress toward becoming operationally effective versus the certainty that it will be operationally effective. The currently planned scope of OT-IIF will permit, within limitations, an assessment of the demonstrated performance in each of the mission-related areas as required by Section 123.

The event-based recovery plan for the V-22 is a well thought-out sequence of analyses, DT, and OT. The program office and DOT&E are committed to faithful execution of that plan, which will support the resolution of all operational issues following OT-IIG in 2005.

My assessment of results to date is attached.

Attachment

As stated
The V-22 Flight Test Program has accomplished about one-third of a recovery plan intended to gain high confidence in the aircraft’s safety, effectiveness, and suitability prior to a full-rate production decision in 2005. This event-based recovery plan was approved by USD (AT&L) and DOT&E. Although no dedicated OT&E has been accomplished since OPEVAL in 2000, the operational testers have been participating in DT&E planning and execution.

Background. Since entering EMD in 1996, two fatal mishaps have occurred: the first mishap occurred at Marana, AZ, in April 2000 during an OPEVAL mission; the second mishap occurred eight months later at New River, NC. The Department’s recovery plan addresses all known problems stemming from those two mishaps.

This memo provides the current assessment of the testing to date to address the following mishap factors:

- Hydraulic system failures
- Vehicle Management Systems software
- High Rate-of-Descent/Vortex Ring State (HRDS/VRS) testing

In addition, the following factors will be addressed by future testing:

- Effects of rotor wake interaction on the V-22 both shore based and at sea
- Low airspeed maneuvering and handling qualities
- Power-off emergency landings
- Aircraft reliability, availability and maintainability

Hydraulic System Failures. The government/contractor hydraulics IPT and an Independent Review Team reviewed the entire hydraulic system in detail and recommended multiple design changes which were prioritized, validated, and are to be incorporated in a block approach. This block approach is reasonable and appropriate. After return to flight, special emphasis was focused on hydraulic line clearances in the nacelles, and the periodic inspection of them. On the basis of more than 430 flight-test hours, the inspections accomplished by the ITT have shown the hydraulic line clearances fixes to be effective in eliminating further chafing.

Vehicle Management Systems (VMS) Software. The VMS computer code that contributed to the December 2000 mishap was rewritten and validated, and other design improvements incorporated. These enhancements were tested extensively in the Bell-Boeing Triple Lab Tie-in (TLTI) by failure insertion and demonstration of all applicable emergency procedures. The TLTI integrates the real-time piloted simulator with actual aircraft avionics and actual flight control system hardware to provide high fidelity simulations of failure modes. Warnings, cautions, and advisories were reviewed and improved, and the NATOPS manual emergency procedures were reviewed and revised where necessary. DOT&E is satisfied with the enhancements.
High Rate-of-Descent (HROD)/Vortex Ring State (VRS) Testing. The OPEVAL mishap in Arizona occurred when the mishap aircraft, second in a flight of two, greatly exceeded the authorized sink rate limit of 800 fpm at slow speed and low altitude. The aircraft departed controlled flight, and there was not sufficient altitude to recover. Vortex ring state was cited as a contributing factor, and early testing following the return to flight in May 2002 has centered on HROD as a first priority. Little HROD flight test data was available for rotary wing aircraft of any kind. As a result, the V-22 program has used a cautious, safe buildup approach. Definition of the hazardous VRS envelope on the basis of steady state HROD testing is now complete. Further envelope verification (dynamic maneuvers to fully verify the existing flight envelope boundaries) is expected to be completed in late May. Such an evaluation of dynamic maneuvers and their effects on vortex ring state has never been done before. A final exploration phase may follow completion of the envelope verification testing.

To date, the V-22 NATOPS HROD authorized flight envelope is unchanged. HROD testing to well beyond that envelope has discovered no new or unexpected susceptibility to departure or roll-off when the aircraft is operated within authorized flight parameters. Additionally, testing shows the HROD warning system effectively warns pilots prior to exceeding NATOPS rate of descent limit of 800 fpm. HROD testing has demonstrated that there is at least a 100% margin (an additional 800 fpm) beyond the current authorized envelope before any possible adverse aircraft response is encountered. Such margin is significantly larger than that of conventional helicopters. The tiltrotor VRS phenomenon for steady state flight is now well defined in terms of:

- Boundaries (vertical and horizontal airspeed)
- Natural warning signs of impending VRS
- Effectiveness of an artificial warning system
- Flight characteristics during departure and recovery
- Recovery techniques (nacelle tilt has been demonstrated to be an effective means of recovery)

Two aspects of HROD/VRS T&E remain

Completing the evaluation of the VRS phenomenon in non-equilibrium flight (dynamic maneuvering); maneuvers tested to date have not initiated VRS roll-off. Completion of the approved HROD test plan is expected to accomplish this.

Determining whether, while operating within the authorized flight envelope, flight restrictions imposed by VRS have an impact on operational mission maneuvers in high-workload/stressful situations. OT&E will resolve this partially in OT-IIF in 2003 and fully in OT-IIIG (OPEVAL Phase Two) in late 2004.

Rotor Wake Interaction. A future segment of the recovery plan will address the effects of rotor wake interaction (Roll-on-Deck and Austere Environment) on V-22 handling qualities, both shore based in landing zones and drop areas, and at sea in a crowded flight deck.
environment. Preliminary DT&E has been conducted and more is planned. Operations in the realistic shore based and shipboard environments will be tested and evaluated in OT-II G.

**Low Airspeed Maneuvering and Handling Qualities.** Low airspeed maneuver testing at less than 60 knots for sustained load factor has been completed. Maneuvers were made up to maximum capability with no rotor stall tendencies. Low speed handling qualities testing was initiated recently to expand the critical azimuth/pitch up with sideslip flight envelope. This testing is being conducted jointly, at both NAS Patuxent River and Edwards AFB.

**Power-Off Emergency Landing.** Power-off emergency landing by autorotation is not a practical emergency procedure in the V-22 because of inherent rotor system characteristics. Emergency recovery procedures in the event of either a dual engine failure or a single engine failure combined with a cross-shaft failure require conversion to airplane mode and a power-off glide to a survivable landing. Additionally, the probability of a dual engine failure within the same one-hour period is assessed by NAVAIR as one in ten billion. Testing to evaluate and optimize flight profiles for this type of maneuver has recently begun.

**Aircraft Reliability, Availability and Maintainability.** The V-22 program is closely tracking all reliability and maintainability ORD metrics during its flight test program. Target values have been derived for the LRIP test aircraft in order to support the predictions of Block A OPEVAL performance. Although there are still too few hours on LRIP aircraft for statistical confidence, the program reports that the early results show that the LRIP aircraft are meeting all target values with the exception of Built In Test (BIT) false alarms per flight hour. The program has a plan in place to mature the BIT false alarm performance through both the Block A upgrades and additional software drops.